National Science Foundation, Directorate for Computer Information Science and Engineering
Division of Advanced Networking Infrastructure & Research (ANIR)

Euro-Link

High Performance International Internet Services between Research and Education Institutions in the United States and Europe/Israel

NSF Cooperative Agreement No. ANI-9730202
Quarterly Status Report
July 1, 1999–September 30, 1999

Submitted October 8, 1999

Submitted by:
Thomas A. DeFanti, EVL Director, Principal Investigator
Maxine D. Brown, EVL Associate Director, co-Principal Investigator
Andrew E. Johnson, EVL Assistant Professor, co-Principal Investigator
Daniel J. Sandin, EVL Director, co-Principal Investigator
Jason Leigh, EVL Senior Research Scientist
John Jamison, EVL Senior Research Scientist

Electronic Visualization Laboratory (EVL)
University of Illinois at Chicago (UIC)
851 S. Morgan St., Room 1120
Chicago, IL 60607-7053
(312) 996-3002
(312) 413-7585 fax
tom@uic.edu

Table of Contents

A. Significant Results or Events in the Past Quarter

- All Euro-Link consortia members are connected to STAR TAP and peering with vBNS, bringing the number of international (non-USA) networks to ten:
  - France's RENATER2
  - The Netherlands' SURFnet
  - Israel's IUCC
  - Nordic countries' NORDUnet
  - CERN *[Note: In September, CERN peered with the vBNS, and henceforth is a member of the Euro-Link consortium.]*
- Started obtaining the Euro-Link domain name.
- Started work on Euro-Link web page design.
- Started work on network performance activities.
- Started discussing Euro-Link NOC activities with Indiana University

B. Expected Results or Events in the Coming Quarter

- Configure the STAR TAP router to peer with most of the networks participating in STAR TAP.
- Install the Cisco 7507 DiffServ router at STAR TAP.
- Continue development of the Euro-Link web site.
- Obtain statistics reports from Indiana University NOC.
- Continue to work with Teleglobe, C&W, and other commercial carriers on a distributed STAR TAP topology.
- Continue to work with Internet2 to encourage international connectivity to STAR TAP.
- Continue to work with SARA in Amsterdam and sites in Russia on network performance studies.

C. Summary of Technical Activities

C.1. Euro-Link Network Peering Status

C.1.a. CERN

CERN peers with vBNS, FermiLab and CANARIE, and is in the process of peering with NASA and Abilene (as an MREN-connected site).

C.1.b. IUCC (Israel)

IUCC currently peers with the vBNS, Abilene, CANARIE, and SingAREN. They are very interested in using the vBNS+ to peer with NIH.

C.1.c. NORDUnet (Nordic Consortium)

NORDUnet is in the process of peering with the vBNS. They also peer with Abilene.

C.1.d. RENATER2 (France)

RENATER2 has been peering with vBNS for some time now. They are very interested in using the vBNS+ to peer with NIH.

C.1.e. SURFnet (The Netherlands)

SURFnet has been at STAR TAP for some time now and is peering with the vBNS in Chicago. SURFnet also peers with Abilene and NACSIS.

C.2. Engineering Services

C.2.a. STAR TAP Router

On August 19, a router that provides STAR TAP layer 3 services came online. The STAR TAP router provides participating networks with a way to pick up the routes of additional networks without having to set up separate

peering sessions. For those countries/consortia planning to exchange a large amount of traffic with another country/consortium, they will be encouraged to have their networks peer directly.

To date, the STAR TAP router is peering with APAN and several North American networks. We will be configuring the STAR TAP router to peer with most of the networks participating in STAR TAP over the next few months.

C.2.b. IPv6 Tunnel service at the 6TAP

The 6TAP an IPv6 service run by ESnet and hosted by the STAR TAP project is up and running. See www.6tap.net for more information. The "IPv6 Tunnel service at the 6TAP" is a new 6TAP service that Bob Fink of ESnet recently proposed. It will enable IPv6 networks to be connected at the 6TAP using IPv6 over IPv4 tunnels, compared to native IPv6 links as the current offering of the 6TAP, since many organizations will not be able to connect to the 6TAP via native links. This will help the deployment of the IPv6 Internet.

A router will be placed in the STAR TAP (we are currently working with Ameritech to find the space) and will BGP peer with Chicago NAP members in the full PVC mesh by announcing an IPv4 class C network and receiving all routes. This router will be connected to a tunnel server via a service LAN. The tunnel server will have an IPv6 native ATM link to the 6TAP router. The tunnel server will be the end-point of all IPv6 over IPv4 tunnels.

An additional service of the tunnel server will be to provide "6to4" relay service, providing a way for automatic tunnels to be created using the newly defined "Connection of IPv6 Domains via IPv4 Clouds without Explicit Tunnels." See: http://www.ietf.org/internet-drafts/draft-ietf-ngtrans-6to4-02.txt

C.2.c. STAR TAP Web Caches

Over the next few months, there are plans to install two web cache platforms at the STAR TAP. Duane Wessels of the NLANR Caching project is building a Web Cache running the Squid caching software for deployment at the STAR TAP. Once the Web Cache is installed at STAR TAP, Duane will integrate it into NLANR's Global Caching Hierarchy.

We are also working with Jamshid Mahdavi of Novell and Mich Beck of the Internet2 Distributed Storage Initiative to deploy an Internet2/Novell Cache system at the STAR TAP.

C.2.d. STAR TAP Performance Measurement Systems

Over the next few months, there are plans to install performance measurement systems at the STAR TAP. With the help of Matt Zekauskas of Advanced Network & Services, we will be installing a Surveyor box. Alan Verlo is working with Hans-Werner Braun and Tony McGregor of NLANR to install an NLANR AMP (Active Measurement Platform) box.

C.2.e. DiffServ

EVL has Cisco 7507 DiffServ routers on order for its own laboratory as well as for STAR TAP (for Euro-Link and DOE EMERGE-funded activities). Russia/MIRnet is very interested in collaborating in our EMERGE DiffServ experiments.

C.2.f. Routing Registry

Abha Ahuja of MERIT/University of Michigan and JJ Jamison discussed the Internet2 Routing Registry (RR) and using it to configure the STAR TAP router's routing filters.

C.2.g. Renting Co-Location Space at Ameritech

STAR TAP currently has rack space co-located at Ameritech that is owned by MREN. We are in the process of renting a second rack for the STAR TAP router, IPv6, DiffServ router, etc. Four racks – STAR TAP, STAR TAP, MREN, and MREN/Merit – would be co-located.

C.3. NOC Services

JJ, Linda Winker, and Doug Pearson met at Indiana University on September 9 to discuss setting up a STAR TAP/Euro-Link NOC. Highlights of the meeting:

- The Indiana University NOC will provide first-level and second-level NOC service for STAR TAP/Euro-Link, which means that troubles will escalate up to the Abilene engineering team (Steve Wallace, Brent Sweeny and

Rick Wood). It is unclear what, if any, burden this will place on the Abilene folks, and we are open to negotiating paying more fees to Indiana University for additional staff, if necessary.
- Indiana University will host NOC web pages [to be called http://noc.startap.net] that will contain contact information, documentation, statistics, weather maps, etc.
- JJ and Linda met, and will continue to communicate with Steve Peck, NOC manager; Dave Jent, Network Services manager IUPUI; and Damon Beals, network engineer.

C.4. Euro-Link Performance Analysis Tools

C.4.a. Network QoS of Real-Time Multimedia

Two professors at UIC, Dan Schonfeld and Rashid Ansari, have considerable experience developing techniques for real-time multimedia; however, their work is primarily done through computer simulation. EVL appointed one of its students as a Research Assistant for the Fall semester to implement their model and test it to confirm the simulation results over STAR TAP, between UIC in Chicago and SARA supercomputer center in Amsterdam, as well as between UIC and University of Tokyo in Japan.

C.4.b. Meeting on Network Performance

At a planning meeting on July 28th, EVL decided to host a major network performance meeting in order to understand available networking tools in-depth, and to develop a testing strategy for the coming months. This meeting occurred on September 23, and brought together all the major players working on Euro-Link and EMERGE networking activities. Attendees included:

- Andy Johnson, Oliver Yu, Bob Kenyon, Tom DeFanti, Kyoung Park, Alan Verlo, Dan Sandin, Laura Wolf, EVL
- Phoebe Lenear, Ruth Aydt, UIUC CS
- Von Welch, Randy Butler, Mike Haberman, John Shalf, NCSA
- Ian Foster, Darcy Quesnel, Argonne National Laboratory
- Joe Mambretti, Jim Chen, Jeremy Weinberger, Dan Weaver, Northwestern University
- Chris Pratico, SGI

The group spent much of the day discussing various measurement techniques, such as:

- PCHAR path characterization software
- NETW network weathermap code from Internet2
- Brian Tierney's Netlogger (currently used in CAVERNsoft)
- UDP Traffic Generator
- Virtue, Pablo and AutoPilot from UIUC
- Globus' gloperf and Heartbeat Monitor
- An LDAP-based discovery capability to allow us to discover what data sources are available (i.e., Globus MDS)
- An archiving capability, perhaps based on an SQL database

DeFanti also defined complementary applications, which, if instrumented, would help us better understand network performance in a variety of situations. While we intend to instrument international applications, particularly efforts with SARA in The Netherlands and Russia, the immediate applications we discussed are DOE EMERGE-related:

- University of Chicago to LLNL/LANL – The FLASH Center at University of Chicago supposedly has 100Mb out of their lab but gets about 500Kb to LLNL/LANL. Linda Winkler will look into this problem.
- Some video streaming between the iCAIR center at Northwestern and Argonne.
- A CAVERNsoft/Globus application
- A NCSA to ANL app with GSP enabled (probably a test case first then Heath?)

C.4.c. Modeling Network Performance using Petri Nets

EVL successfully worked with SARA to add CAVERNsoft to their SARANav application, and they integrated their real-time radiosity code, which will allow us to look at tracker, audio, video, and simulation data in a single application with multiple collaborators across Euro-Link. SARA demonstrated the technology at the Telecom'99 in August.

We investigated both probabilistic and non-probabilistic models using Petri Nets. As part of this process, EVL collected data on the properties of the various legs and routers between EVL and SARA in Amsterdam. These properties were used to generate accurate probabilistic distributions, and used as inputs for the various Petri-Net network performance models. EVL evaluated and tuned TCP and UDP models for CAVERNsoft between Chicago and Amsterdam. This fall we will upgrade SARANav to the latest release of CAVERNsoft, CAVERNsoft G2 [www.evl.uic.edu/cavern/cavernG2].

This fall, we want to apply our TCP and UDP Petri-Net models to the AccessBot, a data-intensive, high-bandwidth and high-fidelity video-streaming application that is currently maintaining a persistent connection between Chicago and Washington DC, to determine if these models can accurately predict network utilization and behavior.

Furthermore we intend to continue to create new networking models at the IP layer.

D. Accomplishments

D.1. Meetings Attended

September 29, 1999. International Internet2 meeting at NCSA/ACCESS Center, Washington DC. Tom DeFanti, Maxine Brown, John Jamison from EVL; Heather Boyles and Guy Almes from Internet2; and, Steve Goldstein, Bill Decker and Aubrey Bush from NSF attended. The goal was to agree upon a common Internet2/STAR TAP strategy for international groups desiring Abilene connectivity. UCAID/Internet2 endorses international connectivity to STAR TAP; exact wording still needs to be determined.

September 27, 1999. Meeting with Mark Luptak of Cable & Wireless (C&W). Tom DeFanti and Maxine Brown attended. C&W is seeking ways of assisting their international customers connect to STAR TAP. (Discussions similar to those with Teleglobe at September 14 meeting. See below.)

September 23, 1999. Network Performance meeting at EVL. See Section C.4.

September 17, 1999. Meeting with Henry Bienan, Northwestern University president and a member of the UCAID Board of Trustees. Tom DeFanti, Joe Mambretti and Mort Rahimi attended, to bring Bienan up-to-date on STAR TAP and its activities. One specific discussion item, which is not Euro-Link-centric, was APRU (Association of Pacific Rim Universities) and their interest in creating APRUnet (an advanced Internet capability among APRU universities and APEC economies).

September 14, 1999. Meeting with Andre Choo of Teleglobe at EVL. Tom DeFanti and Maxine Brown attended. Teleglobe is seeking ways of assisting their international customers connect to STAR TAP. DeFanti explained our interest in developing a distributed STAR TAP, with certain key places like 60 Hudson in New York becoming "STAR Nodes," and carriers providing "STAR Links" to Chicago – whether or not their customers. We are waiting to hear back from Teleglobe.

September 13-17, 1999. Russia trip. JJ traveled to Russia with an NSF delegation headed by Bob Borchers to consult with them about the MIRnet/STAR TAP connection. (See Section E.)

August 31, 1999. EVL/Indiana U meeting at EVL. Tom DeFanti, Maxine Brown, Michael McRobbie and Karen Adams attended. We discussed (a) the Euro-Link NOC subcontract, (b) an applications-focused iGrid 2000 event at INET 2000 in Yokohama, Japan in July 2000 (EVL would encourage European participation), and (c) an NSF HPIIS Review, which we shall propose take place in September 2000.

August 9-11, 1999. NASA's "Bridging the GAP Workshop" in San Jose. JJ Jamison attended. This meeting provided updated information on multicast, QoS and security efforts of NASA and other US Agency networks.

August 3-6, 1999. Eighth IEEE International Symposium on High Performance Distributed Computing in Redondo Beach, California. Jason Leigh and Oliver Yu of EVL/UIC attended. They took the tutorial "Distributed Systems

Performance Analysis Using Net Logger and Pablo" taught by Brian Tierney of Lawrence Berkeley National Laboratory and Ruth Aydt of UIUC.

July 30, 1999. Internet2 Routing Registry training class held at Merit in Ann Arbor, Michigan. JJ Jamison and Alan Verlo attended. Skills will be used to register Euro-Link routes in the Internet2 Routing Registry.

July 28, 1999. Ameritech meeting, to discuss the delays in connecting CERN, NORDUnet and IUCC and how to prevent this from happening in the future. Ameritech made it clear they were in the process of reorganizing in order to better serve the STAR TAP community. Attendees from UIC: Tom DeFanti, Maxine Brown, JJ Jamison. From Ameritech: William Cannon, VP Sales Strategy and Network Services; Kimberly Price, VP New Product/Business Development; Jay Zollinger, VP Operations; Christina Fulton, Director of New Products-IP Networking; John Christensen, NAP Sales Engineer; David Savage, Sr. Acct Manager, government and education; and, Andy Schmidt, Business Development, STAR TAP.

July 20, 1999. JET (Joint Engineering Team) meeting, National Science Foundation, Arlington, Virginia. JJ Jamison attended and represented the interests of both the STAR TAP and Euro-Link projects.

D.2. Publications

Leigh, Jason, Andy Johnson, Maxine Brown, Dan Sandin, Tom DeFanti, "Tele-Immersion: Collaborative Visualization in Immersive Environments," IEEE Computer, December 1999 (to appear). (Features a description of the work being down with SARA in Amsterdam.)

Zhou, Y., T. Murata, T. DeFanti; "Modeling and Analysis of Collaborative Virtual Environments by Using Extended Fuzzy-Timing Petri Nets," IEEE Transactions on Systems, Man and Cybernetics, special issue on Discrete Systems and Control, submitted for publication.

DeFanti, Tom, Dan Sandin, Maxine Brown, Dave Pape, Josephine Anstey, Mike Bogucki, Greg Dawe, Andy Johnson, Tom Huang, "Technologies for Virtual Reality/Tele-Immersion Applications: Issues of Research in Image Display and Global Networking," European Commission/National Science Foundation Advanced Research Workshop on "Human-Centered Computing, Online Communities, and Virtual Environments" (editors Judy Brown, Andy van Dam, Rae Earnshaw, Jose Encarnacao, Richard Guedj, Jennifer Preece, Ben Shneiderman, John Vance), Chateau de Bonas, France, June 1-4, 1999, (to be published by Springer Verlag).

DeFanti, Tom (contributor), "Special Report on Human-Centered Computing, Online Communities and Virtual Environments," Judy Brown, Andy van Dam, Rae Earnshaw, Jose Encarnacao, Richard Guedj, Jennifer Preece, Ben Shneiderman, John Vance (editors), ACM SIGGRAPH Computer Graphics, Vol. 33, No. 3, August 1999, pp. 42-62.

E. Collaboration Activities

- John Jamison traveled to Russia, September 13-17, to consult with them on MIRnet/STAR TAP connectivity. JJ gave a presentation on "US High Performance Networking and the STAR TAP" at Moscow State University and met with their network engineers. JJ also gave a presentation to the Telecommunications Working Group of the Gore-Putin Commission, held at the Russian Science Ministry and attended by many Russian government and US Embassy people. Last, JJ visited St. Petersburg to talk with their network engineers. He had an agreement, at least in principle, that they would send St. Petersburg traffic out through Moscow; it was still uncertain how the traffic would be routed and who would pay the extra cost.
- Ongoing with SARA in Amsterdam (see C.4.c.)

F. Problems

No significant problems were encountered this quarter.

G. Any Proposed Changes in Future Plans

No changes to date.

H. Summary of Award Expenditures (July-September)

H.1. Award Expenditures

The spending rate is within budget. Notable activities for this quarter include:

- Continuing to work with Indiana University to complete paperwork in order to execute the UIC subcontract. (Vacations among Indiana University staff kept the paperwork from being completed.)
- UIC has processed the RENATER2, NORDUnet, and SURFnet invoices for their first year $400,000 payment. IUCC, NORDUnet and SURFnet acknowledged receipt of payment; RENATER2 is in the process of receiving payment.
- No NSF reimbursement for this fiscal year is expected by CERN.

Euro-Link Expenditures

Itemized Expenses	Year 1 Budget	Current Quarter Expenses	Year to Date
Salaries and Fringe Benefits	212,923.00	32,519.00	32,519.00
Travel	50,000.00	1,004.00	1,004.00
Computer Equipment and Supplies	100,000.00	13,612.00	13,612.00
Subcontracts/Services (Ameritech and Indiana U)	96,780.00	0.00	0.00
Other (HPIIS services to NRNs)	1,600,000.00	1,600,000.00	1,600,000.00
Indirect Costs	159,221.00	27,048.00	27,048.00
Total Expenditures	**2,218,924.00**	**1,674,183.00**	**1,674,183.00**

H.2. New Ameritech Port Fees

Ameritech recently agreed to restructure our port fees; DS-3 costs have come down considerably, with only a small reduction in OC-3 costs. This pricing includes the connection to any Inter-eXchange or competitive local access service provider who provides a carrier-to-carrier meet point at the Ameritech Franklin or Wabash Central Offices in Chicago. *Note: The new rates take effect for both yearly contract renewals and for new contracts.*

MREN DS-3/OC-3c ATM NAP Prices

(Based on 36 months)	Old Fees	New Fees
DS-3 with VBR or CBR Class of Service	$4,500.00	$2,200/$3,000 (Franklin/Wabash)
OC-3 with VBR or CBR Class of Service	$5,600.00	$4,100/$5,500 (Franklin/Wabash)

VBR = Variable Bit Rate
CBR = Constant Bit Rate