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A. Summary of Technical Activities

A.1. Euro-Link Network Status and Institutions

A.1.a. CERN

On February 16, technicians at CERN performed emergency maintenance on the backbone router that supports the line to Chicago. Analysis of the problems pointed out a fault in a hardware component that brought about circuit connection instability. The maintenance is expected to solve this problem, as well as prepare for the introduction of a Gigabit Ethernet interface.

A.1.b. IUCC

No updates to report.

A.1.c. NORDUnet

NORDUnet's Peter Villemoes reported NORDUnet issued an Invitation to Tender for Network Connections to the USA. [http://www.nordu.net/tender/USA2001] This network connection, to take effect July 1, 2001, would be for 467-622Mbps to the Abilene PoP in NYC and 155Mbps to STAR TAP in Chicago, out of a total transatlantic

capacity of 2.5Gbps. NORDUnet is also considering bringing all its research traffic to STAR TAP in Chicago to connect to US and international research networks.

A.1.d. Renater2

No new information to report.

A.1.e. SURFnet

Final details are being negotiated to realize a 2.5 Gbps lambda connection between SARA and the StarLight facility (710 N. Lake Shore Drive on Northwestern University's campus) in Chicago, to be able to experiment with new types of technology for a completely optical Internet. In parallel, SURFnet is starting to build its POP at 710 N. Lake Shore Drive. [Note: On March 5, SURFnet announced the results of its Tender, which we will cover in our March Euro-Link report.]

A.2. Engineering Services

A.2.a. International Transit Network (ITN)

The STAR TAP "Connect" web page is in the process of being updated to reflect International Transit Network service information.

A.2.b. STAR TAP Router and Peering

Juniper M5 Router interface incompatibility problems have been resolved. The router will enable STAR TAP engineers to provide connecting networks with advanced services, such as line-speed forwarding, traffic filtering and sampling without a performance penalty, MPLS, and Class of Service features.

Euro-Link member networks will soon have an opportunity to peer with networks from Korea, Ireland and Brazil. Korea and Ireland will connect to STAR TAP in the coming months. The Saõ Paulo/Brazil Foundation for the Advancement of Research (FAPESP) 155 Mbps link to Miami has been operational since December 2000. Connection to STAR TAP is still pending resolution of Cable & Wireless issues.

A.2.c. 6TAP

No updates to report.

A.2.d. STAR TAP NLANR Web Cache

No updates to report.

A.2.e. DiffServ

No updates to report.

A.3. NOC Services

The Global Research NOC is preparing to issue a regular, online newsletter in the next few months.

The NOC continues to seek permission from STAR TAP peers to gather host router network statistics for a planned STAR TAP animated traffic map. No accurate or useful statistics beyond MRTG graphs can be gathered for Euro-Link without closer cooperation and coordination among Euro-Link NRN members and the NOC.

John Hicks is looking into adapting MIRnet-type traffic graphs for the Euro-Link and TransPAC projects.

See [http://noc.startap.net] [http://noc.euro-link.org] [http://globalnoc.iu.edu/].

B. Euro-Link Performance Analysis Tools

B.1.a. Network Monitoring Tools

Bandwidth Utilization Radar Map

EVL student Brenda Lopez has enhanced the iGrid 2000 STAR TAP network map, (which showed bandwidth utilization of networks participating in iGrid), to illustrate all country-to-country source and destination of packets

arriving at STAR TAP/Euro-Link. This can now be accessed from the STAR TAP web site; from [http://www.startap.net/ENGINEERING/], click on "Bandwidth Utilization Radar Map."
This summer, Lopez plans to develop snapshots of network traffic spikes to STAR TAP/Euro-Link, rather than just previous history.

uCAN: unified Collaboratory for Analyzing Networks

EVL student Naveen Krishnaprasad started development of the unified Collaboratory for Analyzing Networks (uCAN) software, which will enable remote network researchers and application developers to collaboratively execute an application and monitor network utilization, as well as other application-specific parameters. uCAN will enable users to correlate, in real time, how the actions taken by an application directly impact the underlying networks, and vice versa. A network researcher could also alter router configurations, such as a router's queuing algorithm, to determine how it might improve application throughput. Estimated completion of a usable version is end of Spring 2001. The prototype currently allows users to initiate bandwidth measurement experiments and perform SNMP queries of routers.

B.1.b. Network Performance Studies for European/US Collaborative Art Project

EVL co-director Dan Sandin is assisting in the development of Yggdrasil, a script-based, authoring environment for networked VR applications by EVL PhD candidate Dave Pape. This tool will allow non-programmers to create effective, behavior-rich art and science virtual-reality environments. Sandin is extending the library for behaviors, performing network performance tests and developing applications. In coming months, Dan will supervise EVL student Joseph Tremonti in the development and execution of network performance tests to Austria, and later Sweden, Hungary and The Netherlands, in anticipation of the Ars Electronica Center's Festival in Austria, September 1-6. [http://www.aec.at] (See Section D, Collaboration Activities)

B.1.c. Low Latency State Transmission Over Long Distance Networks

Parallel Socket Tests

Jason Leigh, in network performance studies with SARA in The Netherlands, was getting between 32-60 Mbps throughput doing TCP experiments over SURFnet's 155Mbps link. The problem has been isolated to a bottleneck in CAVERNsoft's parallel socket code that was limiting it to 32Mbps transmission. In theory, the parallel socket code should achieve 70Mbps since EVL's internal 100Base-T network connects to the campus' OC-3 network to STAR TAP. TCP normally provides about 70% throughput.

Reliable Blast UDP (RUDP)

On February 7, Jason's student Eric He conducted more RUDP experiments between EVL and SARA.

Sending Bandwidth (Mbps)	Effective Bandwidth	Number of NAKs
20	19.7	0
40	38.5	0
60	54-57	1
80	56-70	2
90	61-77	3

Since QoS is currently not available between the two sites, we chose to send data at rates well below the maximum available bandwidth of the network link; in essence, emulating a smaller, reserved QoS link. The table shows the bandwidth at which RUDP data was transmitted, and the effective throughput of the total file transfer. Note that on an over-provisioned network, effective throughput is almost as high as the sending bandwidth. This is in contrast to TCP, which typically incurs a 30% bandwidth loss by requiring frequent acknowledgements.

As we approach the bandwidth limit of the link, performance begins to decrease; however, performance is no poorer than what is expected of optimally tuned TCP. Because these experiments were conducted without the benefit of QoS, interference from competing traffic streams was both possible and likely. We predict that our results would yield even better performance with QoS. It would be very interesting to test this scheme using DiffServ between EVL and CERN. (For full report, see Sect. C.2. Publications, "Adaptive Networking for Tele-Immersion," Proceedings of the 5th Immersive Projection Technology/ 7th Eurographics Virtual Environments Conference, May 16-18, 2001, Stuttgart, Germany.)

C. Accomplishments

C.1. Meetings

February 28, 2001. StarLight meeting at EVL (with Tom DeFanti (EVL et. al.), Joe Mambretti of Northwestern, and Charlie Catlett and Linda Winkler of ANL) to discuss engineering progress and strategy, and involvement in the Terascale RFP.

February 21-23, 2001. EVL's Dan Sandin, recently appointed to the Academic Review Board of the Interactive Institute of Sweden, toured four of the Institute's seven studios, as part of the Board's annual review of research work. He met with the director of the Tools for Creativity Studio to discuss future collaborations, including the Ars Electronica Festival in Austria, September 1-6, 2001.

February 14, 2001. Andre Choo, previously of Teleglobe and currently with Velocita, visited Chicago to talk with Tom DeFanti and Maxine Brown of EVL, Joe Mambretti of Northwestern University and Charlie Catlett of ANL about I-WIRE and StarLight and how his new company might work with us.

February 13, 2001. Olivier Martin of CERN visited Chicago to talk with Tom DeFanti and Maxine Brown of EVL and Joe Mambretti of Northwestern University about StarLight.

C.2. Publications

J. Leigh, Yu, O., Schonfeld, D., Ansari, R., He, E., Nayak, A., Ge, J., Krishnaprasad, N., Park, K., Cho, Y., Hu, L., Fang, R., Verlo, A., Winkler, L., DeFanti, T., "Adaptive Networking for Tele-Immersion," Proceedings of the 5th Immersive Projection Technology/7th Eurographics Virtual Environments Conference, May 16-18, 2001, Stuttgart, Germany. http://www.evl.uic.edu/cavern/papers/jleigh_EGVEIpt2001.pdf

A. Johnson, J. Leigh, "Tele-Immersive Collaboration in the CAVE Research Network," chapter to appear in the: Collaborative Virtual Environments: Digital Places and Spaces for Interaction, edited by Churchill, Snowdon and Munro, to be published in March 2001, pp.225-243. (Pushed back from original publication date of January 2001.)

C.3. Software Releases

In January, CAVERNsoft was deployed at [openchannelsoftware.org]. The latest version of CAVERNsoft G2, version 1.2.1, released December 2000, is available at [http://www.evl.uic.edu/cavern/cavernG2/].

QoSIMoTo (QoS Internet Monitoring Tool) [www.evl.uic.edu/cavern/qosimoto] is available on the web for IRIX and Linux.

D. Collaboration Activities

EVL's Dan Sandin is organizing a large, shared VR environment for the Ars Electronica Festival, September 1-6, 2001, in Austria. Participants include artists from Hungary's C3 [http://www.c3.hu/], The Netherlands' V2 [http://www.v2.nl/], The Interactive Institute of Sweden [http://www.interactiveinstitute.se/], and the United States (UIC, Chicago and SUNY, Buffalo).

Working with SARA in The Netherlands to do network performance studies over long, fat networks using various transmission techniques (TCP, UDP, FEC, RUDP).

Talking with Harvey Newman at Caltech and Olivier Martin at CERN about DiffServ tests.