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Tom DeFanti, Maxine Brown, Andy Johnson, Dan Sandin, Jason Leigh, Andy Schmidt, Laura Wolf
Electronic Visualization Laboratory
University of Illinois at Chicago

Linda Winkler
Argonne National Laboratory

Jim Williams, Stephen Peck
Indiana University

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A. Summary of Technical Activities

A.1. Euro-Link Network Status and Institutions

A.1.a. CERN

STAR TAP engineers are setting up direct BGP peering between UIC/EVL and CERN in order to run RUDP bandwidth tests over CERN's 100Mbps link. See Section B.1.c. Reliable Blast UDP.

CERN is preparing a proposal (DataTAG: Research and Technological Development for a Trans-Atlantic Grid) to the European Union (EU) for a high-speed research link between CERN and StarLight, in addition to the existing 155Mbps circuit they plan to upgrade to 622Mbps by April 2002.

A.1.b. IUCC

Hank Nussbacher of IUCC asked Euro-Link participants if they would allow the NOC to SNMP poll their routers to make the STAR TAP Weather Map <http://hydra.uits.iu.edu/startap-atm/> more informative. (See NOC Services, Section A.3.)

A.1.c. NORDUnet

NORDUnet completed a tender for USA connectivity, to take effect July 1, 2001. NORDUnet will have an STM-4c (OC-12, 622Mbps) link directly between Stockholm and the Abilene PoP in New York, and 155Mbps from New York to STAR TAP in Chicago. KPNQwest is the provider. We recently learned, however, that the local loop was never ordered for NORDUnet (NORDUnet switched providers, from Teleglobe to Qwest), and an OC-3 from the Qwest POP in Chicago to the NAP, if ordered immediately, will not be ready until late October. Andy Schmidt is in the process of contacting Peter Villemoes to propose that NORDUnet come to 710 N. Lake Shore Drive (StarLight) using QwestLink fiber that was recently installed and then using an OC-12 from StarLight to backhaul to the NAP.

Previously, NORDUnet had considered connecting at 622Mbps directly to StarLight (peering with Abilene in Chicago), but was concerned that there might not be sufficient Abilene capacity in Chicago for both NORDUnet and SURFnet. STAR TAP management is working with Internet2 to resolve this problem.

A.1.d. Renater2

RENATER's peering with the STAR TAP Router continues to be disrupted. It is expected to resume once France Telecom circuit arrangements are made. Linda Winkler is still waiting on PVC information.

In late May, RENATER's Dany Vandromme confirmed he wanted to re-establish peering with the STAR TAP router, but first had to sort out technical issues with France Telecom. Apparently, RENATER recently changed its circuit arrangements with France Telecom in Chicago, which caused them to lose peering with most research networks. Linda first contacted RENATER technical engineers about re-establishing peering in April.

A.1.e. SURFnet

On July 1, 2001, SURFnet will close its New York PoP and bring two 622Mbps connections (one provided by Teleglobe and the other by Global Crossing) to the StarLight facility in Chicago. SURFnet is now building its PoP at 710 N. Lake Shore Drive (StarLight). Equipment shipped from the Netherlands arrived in Chicago in May. Initially, SURFnet will have one Cisco 12008 router installed at StarLight, plus one Cisco 2620 for out-of-band access to the Cisco 12008. The 12008 will have OC-12c POS connections to both Teleglobe and Global Crossing, and an OC-12c ATM connection from StarLight to STAR TAP. Between the 12008 and STAR TAP they will install a small ATM switch to access 6TAP. This will also involve a router dedicated to IPv6, which SURFnet will connect to a v6-exchange facility at the StarLight location as soon as it becomes available. SURFnet engineer Erik-Jan Bos contacted Internet2's Steve Corbató about Abilene/SURFnet peering in Chicago.

On September 1, 2001, SURFnet will bring a 2.5 Gbps lambda connection from Amsterdam to StarLight (provided by Teleglobe).

A.2. Engineering Services

A.2.a. StarLight/Abilene Connectivity

In May, a meeting between STAR TAP (Tom DeFanti, Maxine Brown, Linda Winkler, Joe Mambretti) and Internet2 (Heather Boyles, Steve Corbató and Doug Van Houweling) was held to discuss increasing Abilene's bandwidth in Chicago to meet the needs of Euro-Link networks. Abilene agreed to put an OC-48 router in the Qwest PoP at the NBC Tower building in September, and connect to 710 N. Lake Shore Drive with I-WIRE fiber once it is installed.

A.2.b. StarLight/STAR TAP Connectivity

STAR TAP is contracting for two OC-12 connections from the StarLight facility at 710 N. Lake Shore Drive to the Ameritech NAP. [Ameritech does not yet offer OC-48 service.] One of these OC-12s will be dedicated to SURFnet/Abilene traffic. The second link is to be shared by SURFnet (for non-Abilene traffic) and other NRNs that co-locate at 710. Ameritech assures us that these connections will be operational on July 1.

In May, a description of StarLight's project goals, facility and proposed services was added to the STAR TAP web page at <http://www.startap.net/starlight/>

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

In April and May, the STAR TAP CONNECT web page <http://www.startap.net/CONNECT/> was updated to include information about the International Transit Network, with links to CA*net3 and Internet2 ITN information: <http://www.canet3.net/optical/peering_info/intl_peering.html> and <http://www.internet2.edu/abilene/html/itnservice.html>.

The site was also updated to include information about Distributed STAR TAP and NAP connectivity (Ameritech provisioning) information.

A.2.d. STAR TAP Router and Peering

On June 18, REUNA disconnected its circuit to STAR TAP. It now connects through AMPATH and is considered an International Transit Network (ITN) participant.

Brazil's RNP network's DS-3 is ready for testing from Ameritech. It should be fully operational within weeks. Ireland's (HEAnet) connection is expected to be up in about 30 days. Brazil's Sao Paulo research network FAPESP-ANSP to STAR TAP has been held up; it is expected to be up in about 60 days. The Saõ Paulo/Brazil Foundation for the Advancement of Research (FAPESP) 155 Mbps link to Miami has been operational since December 2000.

For over a month, the new STAR TAP/TransPAC Juniper M5 router installed in May at the AADS/NAP produced occasional peering outages while engineers debugged it. This router, when fully operational, will enable STAR TAP engineers to provide connecting networks with advanced services, such as line-speed forwarding, traffic filtering and sampling, MPLS, and Class of Service.

The STAR TAP Logical Map, Architecture Diagram and Peering Matrix have been updated and posted to the STAR TAP web site.
<http://www.startap.net/ENGINEERING/GENINFO.html>
<http://www.startap.net/ENGINEERING/STARTAP_PeeringMatrix.pdf>

On May 31, University of Iowa upgraded its port bandwidth from DS-3 to OC-3.

On May 30, UIUC's National Center for Supercomputing Applications (NCSA) connected to STAR TAP and began passing traffic. (NOTE: NCSA previously shared its MREN institutional membership with UIUC, but now has established a separate link to the NAP.)

In April, STAR TAP engineers were anticipating the connection of Korea's KOREN/KREONet2, Ireland's HEAnet and Brazil's FAPESP-ANSP and RNP. Korea's (KOREN/KREONet2) began passing packets on May 2.

A.2.e. 6TAP

Bob Fink and Marc Blanchet are starting to talk with Linda about StarLight activities to determine if/when to relocate the IPv6 Router to 710 N. Lake Shore Drive.

A.2.f. STAR TAP NLANR Web Cache

Information about STAR TAP's collaboration with NLANR MOAT will appear soon on the website.

A.2.g. DiffServ

No updates to report.

A.3. NOC Services

On June 15, the NOC put Footprints, the interim trouble ticket system for Abilene and the Global networks, into production. This system provides increased functionality for tracking and escalating trouble tickets, increased accessibility to trouble tickets for those in TransPAC, STAR TAP and Euro-Link administration, and much more robust reporting. The NOC will be providing ticket summary updates on associated web pages. Eventually, the NOC will permanently replace Footprints with Peregrine Systems.

The NOC is continuing to upgrade and modify its network traffic tools to be compatible with the new Juniper M5 Router. It expects to complete the process by the end of July.

In May, Hank Nussbacher of IUCC began discussions with the NOC and Euro-Link participants to ask if they will allow SNMP polling to make the STAR TAP Weather Map <http://hydra.uits.iu.edu/startap-atm/> more informative. To date, IUCC and CERN have offered to comply. Jim Williams raised the issue again at the June 5 STAR TAP International Advisory Committee meeting at INET.

Ongoing activities: The Global Research NOC is preparing to issue a regular, online newsletter in the next few months. John Hicks is working on adapting MIRnet-type traffic graphs for the Euro-Link and TransPAC projects.

B. Euro-Link Performance Analysis Tools

B.1.a. Network Monitoring Tools

Bandwidth Utilization Radar Map

EVL student Brenda Lopez is updating the STAR TAP bandwidth radar for the new Juniper M5 router and has expanded the radar to include separate charts for national and international traffic.
<http://www.evl.uic.edu/cavern/startap/index-test.php3>
<http://www.evl.uic.edu/cavern/startap/international.php3>

Previous plans for her to develop snapshots of network traffic spikes to STAR TAP/Euro-Link have changed. Instead, she will design a graphical optical traffic map for StarLight.

uCAN: unified Collaboratory for Analyzing Networks

EVL student Naveen Krishnaprasad, under the supervision of Dr. Jason Leigh, completed development of the unified Collaboratory for Analyzing Networks (uCAN). uCAN enables remote network researchers and application developers to collaboratively execute an application and monitor network utilization, as well as other application-specific parameters. uCAN also allows users to correlate, in real time, how the actions taken by an application directly impact the underlying networks, and vice versa. A network researcher can also alter router configurations, such as a router's queuing algorithm, to determine how it might improve application throughput.

Development proved to be more difficult than anticipated, however, the resulting solution is general enough that it will be relatively simple to develop future collaborative desktop applications. This capability will be embedded in a future release of CAVERNsoft to allow tele-immersive applications to work with 2D desktop applications.

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

EVL PhD graduate Dave Pape developed Yggdrasil (YG), a script-based, authoring environment for networked VR applications, which enables non-programmers to create effective, behavior-rich art and science virtual-reality environments. EVL co-director Dan Sandin is extending the library for behaviors, performing network performance tests and developing applications. Sandin is supervising 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. High Bandwidth Transmission Over Long Distance Networks

Parallel Socket Experiments

In anticipation of SURFnet's 2.5 Gigabit connection to STAR TAP in September, Jason Leigh has been speaking with Cees de Laat (SURFnet), Paul Weilinga (SARA) and Henri Bal (Vrje University, Amsterdam) to develop ideas for testing bandwidth-intensive applications over SURFnet. SARA and SURFnet are both interested in attempting to stream compressed CAVE video. EVL has ordered a GigE card for the Onyx in preparation for this. Vrje University is interested in testing parallel cluster-to-cluster simulation and visualization codes. EVL shared information about its cluster with Vrje to maximize compatibility between systems. Bob Grossman, director of UIC's National Center

Data Mining (NCDM), wants to install a data mining server in Amsterdam and performing tera-mining queries between Chicago, Amsterdam and Canada.

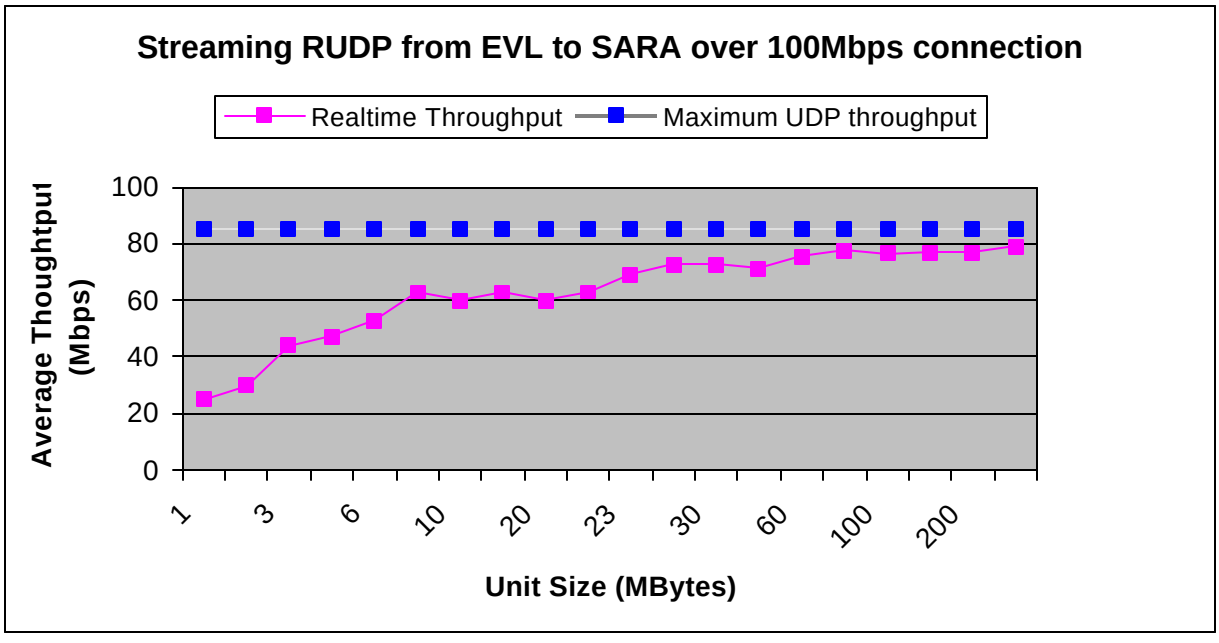
EVL is also in the process of building and optimizing its Linux cluster to maximize throughput over GigE networks. In the past, EVL was able to only achieve ~500Mbps (local area) out of the box. With appropriate tuning using Interrupt Coalescing and Jumbo frames, EVL has been able to achieve bandwidth of 850Mbps. Other applications that EVL would like to test over SURFnet include VNC for streaming of clustered desktops, WireGL for streaming OpenGL visualizations, and streaming of stereoscopic visualizations.

In April, Jason Leigh and student Atul Nayak, in network performance studies with SARA, were getting between 32-80Mbps throughput doing parallel TCP experiments over SURFnet's 155Mbps link (note that EVL's LAN is 100Mbps). They were unable to consistently achieve 80Mbps throughput; averaging instead 32Mbps. They began working with Bob Grossman to incorporate codes to attempt to predict the number of parallel sockets that need to be opened for optimal throughput.

Reliable Blast UDP (RUDP)

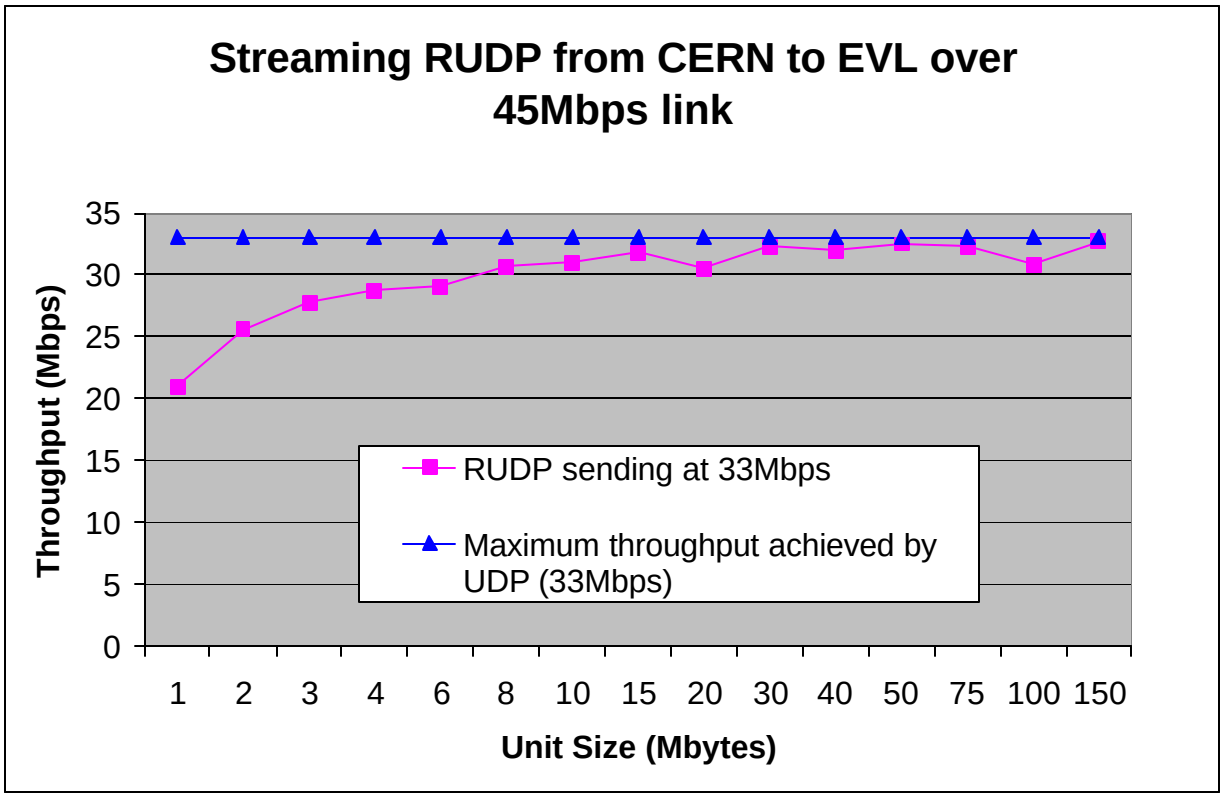
In June, EVL student Eric He refined his RUDP work into a reusable library for CAVERNsoft. He is testing it over a local-area GigE network at EVL and will expand his experiments to I-WIRE and eventually to Amsterdam in September. Eric is also working with Linda Winkler to configure the network to experiment with RUDP from Chicago to CERN over a 100Mbps connection. The 100Mbps limitation is constrained by the network interface cards at the endpoint computers.

In April, Jason Leigh and Eric He did tests to improve and extend their RUDP algorithm, in order to increase performance. The extension allowed for smaller transmission buffer sizes, which proved useful if a reliable **streaming** protocol was desired. Results below show the performance trade-off between using smaller buffer sizes and obtainable throughput from sending large data streams from EVL to SARA (the Ethernet card had a limit of 100Mbps although the link from EVL to SARA is 155Mbps).



The blue line is the maximum achievable throughput via UDP (approximately 85Mbps). The graph shows that for very large buffer sizes, bandwidth utilization can be as high as 80Mbps. This is good for bulk data transfer applications that have really massive amounts of data to ship from one place to another; Jason and Eric have not been able to achieve this degree of stability with parallel TCP. The downside is that performance suffers if one incrementally streams the data for use as it comes along. They are developing ways around this.

Results from performing the same experiment from EVL to CERN are also shown below. Since the bandwidth to CERN is lower, RUDP achieved results similar to their former parallel TCP technique. However, they expect that as CERN's bandwidth increases it will suffer similar predictability problems using parallel TCP as SARA.



C. Accomplishments

C.1. Meetings

June 28, 2001. Joe Mambretti and Andrew Schmidt met with SBC representatives Anthony Haeuser, Caitlin Brown and Gary Misner to discuss better support of STAR TAP and MREN in the future. Points of discussion included a general network status review, points of contacts between the organizations, and setting an agenda to work together in coming months. Also discussed were current and future network architectures, gigabit Ethernet Metro service and how it fits into STAR TAP's future plans, updated pricing reflecting higher education discounts, and connectivity to the Abilene network. Attendees concluded the most likely direction for the networks would be gigabit Ethernet based, and Ameritech would work with us to extend their gigabit Ethernet capabilities. Ameritech agreed to create a billing structure to facilitate dividing the OC-12 Abilene connection charge among the MREN participants.

June 22-27, 2001. Tom DeFanti, Maxine Brown and Jason Leigh met with collaborators at NTT and University of Tokyo in Japan. In addition to EVL research projects, the possibility of an iGrid 2002 event in Amsterdam was discussed. Tomonori Aoyama, EVL's collaborator at University of Tokyo, is now chairman of the recently established Photonic Internet Forum (PIF), supported by the Japanese government. While Aoyama is interested in bringing a lambda to StarLight, funding hasn't yet been allocated. We discussed the possibility of NTT or another telecommunications company donating a lambda for the iGrid 2002 event so Japanese applications could be represented.

June 21, 2001. EVL's Andy Schmidt and Alan Verlo and Northwestern's Tim Ward and Joe Mambretti met to discuss OMNInet and StarLight optical networking plans and how they intended to interface cluster computers to the optical backbone being created at StarLight.

June 13, 2001. Jason Leigh presented his current work on Euro-Link, STAR TAP and protocols for high throughput data transmission in tele-immersion at the Undersea Weapon Simulation Based Design Workshop in Baltimore, Maryland. <http://sbdonr.umd.edu/>

June 11-14, 2001. Maxine Brown attended a SC'2001 Paper Committee meeting in Denver, which was held at the same time as other SC meetings. While there, she talked with Wes Kaplow of Qwest, who was attending the SC SCInet (Supercomputing networking committee) meetings, about Qwest's bringing an OC-192 from Chicago into Baltimore for SC'2002 to promote StarLight demonstrations.

June 3-7, 2001. A series of STAR TAP and StarLight meetings were held during INET 2001 in Stockholm, Sweden. (June 3) A dinner was organized, to include Bill St. Arnaud, Kees Neggers, Larry Smarr, Joe Mambretti, Tom DeFanti, Maxine Brown, Linda Winkler, Andy Schmidt, Laura Wolf, Jason Leigh, Bob Grossman and others involved in StarLight. (June 4) Tom DeFanti met informally with Tom Greene and Chip Cox of NSF to discuss STAR TAP meeting presentations. (June 5) The annual STAR TAP meeting was held at the Center for Parallel Computers (Parallelldatorcentrum or PDC), Royal Institute of Technology (Kungl Tekniska Högskolan or KTH); the agenda and Power Point presentations appear at <http://www.startap.net/ABOUT/meetingInet2001.html>. (June 5) Tom DeFanti, Bob Grossman, Laura Wolf and Maxine Brown had dinner and discussed setting up data mining servers at both StarLight and SARA in Amsterdam for future lambda-effort applications. (June 6) Larry Smarr, Tom DeFanti, Maxine Brown and Kees Neggers continued discussions on StarLight, meeting later with Tom Greene and Yves Poppes (Teleglobe). (June 7) Tom DeFanti, Maxine Brown, Kees Neggers and Karel Vietsch of TERENA met to discuss having an International Lambda Workshop in Amsterdam, September 12-13; see <http://www.terena.nl/conf/lambda/>. They also discussed plans for holding an iGrid 2002 event in Amsterdam in September 2002 to showcase advanced applications over optical networks. Maxine is to follow up with Jacqueline Tammenoms Bakker who heads up Holland's GigaPort project, as she would help provide funding for this event. (June 7) Tom DeFanti and Maxine Brown had dinner with Lennart Johnsson, a professor at University of Houston and director of PDC in Stockholm, as well as members of PDC's Board of Directors to discuss future trends in high-performance computing.

May 31, 2001. Tom DeFanti and Oliver Yu of EVL/UIC and Joe Mambretti of Northwestern University met with representatives of the Photonics Internet Forum (PIF), which was recently established by Japan's Ministry of Post & Telecommunications to make recommendations to the government to establish national policies and obtain research funds for photonic networking technologies for the IT industries and IT users in Japan. The PIF sent a delegation to North America, headed by Professor Aoyama, in order to see how US and Canadian governments and public sectors are handling photonic network testbeds, and how they provide research funding to research groups involved with photonic networking. The group visited STAR TAP/ StarLight, as well as NSF (Aubrey Bush) and CANARIE (Bill St. Arnaud). PIF representatives who visited STAR TAP/StarLight were:

- Tomonori Aoyama, University of Tokyo and Japanese Gigabit Networks
- Ken-ichi Kitayama, Osaka University
- Ken-ichi Sato, Photonic Transport Network Laboratory, NTT Network Innovation Laboratories
- Wataru Chujo, Ultrafast Photonic Network Group, Communications Research Laboratory,
- Masahiro Ojima, Telecommunication Systems Division, Hitachi, Ltd.
- Akira Hakata, Advanced Photonic Network Systems Development Div., Fujitsu Ltd.
- Shingo Inoue, Information Technology Research Department, Mitsubishi Research Institute, Inc.
- Sumiyasu Hidaka, Research Division, Support Center for Advanced Telecommunications Technology Research

May 30, 2001. Jason Leigh presented his current work on Euro-Link, STAR TAP and protocols for high throughput data transmission in tele-immersion at AT&T Visualization Days in New Jersey. [http://www.visdays.com/]

May 29, 2001. Tom DeFanti, Maxine Brown and others from EVL/UIC, Joe Mambretti and Tim Ward of Northwestern, and Linda Winkler and Bill Nickless of Argonne met with Internet2's Doug Van Houweling, Heather Boyles, Steve Corbató and Greg Wood to discuss increasing Abilene bandwidth in Chicago for Euro-Link networks. Abilene agreed to put an OC-48 router in the Qwest POP at the NBC Tower building in the September timeframe, and will connect to 710 with I-WIRE fiber once it is installed.

May 23-25, 2001. Tom DeFanti, Maxine Brown and Jason Leigh participated in the NCSA/Alliance All Hands Meeting (AHM). Leigh and four EVL students hosted a poster session describing EVL development and deployment activities, including Euro-Link network performance monitoring efforts and StarLight. DeFanti was the AHM general chair, and as part of the program, invited Bill St. Arnaud to talk about optical networks and Bob Grossman to talk about large-scale data mining.

May 18, 2001. Maxine Brown gave a presentation, "StarLight: In Support of Global Scientific Research Communities," at the Advanced Internet Session at the Internet Global Conference in Barcelona <http://www.igconference.net/>. The session was organized by Artur Serra of Universitat Politecnica de Catalunya (UPC), and also included speakers:

- Latif Ladid, Vice President of Ericsson and President of the IPv6 Forum
- Pascal Drabik, Scientific Officer, European Commission
- Xavier Kirchner, Director Centre de R&D, Nortel Networks, Barcelona

May 16-17, 2001. At the invitation of Artur Serra of the Universitat Politecnica de Catalunya (UPC), Maxine Brown visited the school to meet with networking and virtual-reality faculty and staff, as well as faculty at related schools and local government officials responsible for university research funding initiatives. Serra and Sebastia Sallent run the i2CAT program <http://www.i2-cat.net>, a university/commercial/government initiative to fund collaborative projects requiring advanced networking. Serra has been closely monitoring Kees Neggers' efforts to lead the optical Internet in Europe. People that Brown met with include:

- Jordi Domingo-Pascual, Computer Architecture Department (runs the GigaPoP), UPC
- Pere Brunet, Industrial Design Department (runs a CAVE-like facility, funded by Volkswagen), UPC
- Montserrat Meya I Llopart, Catalunya Government (University research)
- Josep Blat, Escola Superior Politecnica

May 16, 2001. Jason Leigh presented his current work on Euro-Link, STAR TAP and protocols for high throughput data transmission in tele-immersion at the Fifth Immersive Projection Technology Workshop in Stuttgart, Germany. [http://vr.iao.fhg.de/ipt-egve]

May 11, 2001. Tom DeFanti and Maxine Brown met with Bob Grossman of UIC's National Center for Data Mining about his placing a data warehouse at StarLight and at SARA in Amsterdam to stress-test the optical links once they are in place.

May 8, 2001. Anne Richeson of Qwest and representatives of QwestLink (the local company) visited the StarLight facility at 710 and then visited EVL to discuss opportunities in advanced networking with Tom DeFanti, Maxine Brown and Joe Mambretti.

May 3, 2001. Lazaros Efraimoglou, president of the Foundation for the Hellenic Worlds (FHW) in Athens, Greece, visited EVL with his wife to learn more about future virtual-reality and networking research activities. EVL graduate Maria Roussou works for the FHW, where she is responsible for its virtual-reality activities (it has a CAVE-like display and an ImmersaDesk, and develops cultural heritage applications of Greek temple ruins for educational purposes). FHW participated in iGrid 2000 in Yokohama that EVL organized. Tom DeFanti and Maxine Brown impressed upon Efraimoglou the importance of high-speed interconnectivity for remote collaboration.

April 27, 2001. Tom DeFanti presented "StarLight: Optical Switching for the Global Grid" to the Computer Science Department at Northwestern University. Maxine Brown, Laura Wolf and others from EVL met with Ian Foster and his staff about SC Global, a major international event for SC'2001 in Denver in November.

April 24-27, 2001. Dan Sandin of EVL visited Umeå University in Stockholm, Sweden. He attended the Umeå Forum, presented "Interaction Design in the CAVE," and participated in the "Life in Networked Society" panel. Sandin visited Umeå's HPC2N lab and presented a talk on the latest networking research at EVL. He met with Umeå's Kenneth Homlund to discuss setup for the upcoming tele-immersive art event in conjunction with the Ars Electronica Center festival in Austria in September. Sandin conducted a real-time, collaborative test between EVL and HPC2N. He intends to develop an on-going persistent collaborative relationship. Sandin also spoke at the Tools

for Creativity Studio at the Interactive Institute of Sweden, another partner in the Ars Electronica event. (See Section D.)

April 22, 2001. Tom DeFanti attended the UCAID Board of Trustees meeting in Washington DC, where he spoke with Doug Van Houweling, Heather Boyles and Steve Corbató about upgrading Abilene's 622 Mb link to Chicago, primarily to accommodate SURFnet and other internationals, such as NORDUnet or CERN, as well as MREN customers, as bandwidth increases. It was decided that we would hold a meeting in Chicago to discuss this issue, as well as share information on future plans under non-disclosure. For Internet2, this involves Abilene evolution and a next generation backbone network as well as DTF. For STAR TAP, it involves information on Star Light. The meeting was set to occur on May 29 at EVL.

April 19, 2001. Olivier Martin of CERN visited EVL and toured the StarLight facility in downtown Chicago. Met with Tom DeFanti, Maxine Brown and Joe Mambretti about a possible high-speed research link between CERN and StarLight, in addition to the existing link CERN plans to upgrade to 622Mbps by March/April 2002.

April 17, 2001. Joe Mambretti hosted an OMNInet technical meeting at Northwestern University. OMNInet, the Optical Metropolitan Network Initiative network, is co-located with StarLight at the 710 facility. Tom DeFanti, Maxine Brown, Jason Leigh, Linda Winkler, Alan Verlo and Andy Schmidt attended.

C.2. Publications

Tom DeFanti, Dan Sandin, Maxine Brown, Dave Pape, Josephine Anstey, Mike Bogucki, Greg Dawe, Andy Johnson and Thomas S. Huang, "Technologies for Virtual Reality/Tele-Immersion Applications: Issues of Research in Image Display and Global Networking," Frontiers of Human-Centred Computing, Online Communities and Virtual Environments, Rae Earnshaw, Richard Guedj, Andries van Dam and John Vince (editors), Springer-Verlag London, 2001, pp. 137-159. (Report from the European Commission/National Science Foundation Advanced Research Workshop on Human-Centered Computing, Online Communities, and Virtual Environments, Chateau de Bonas, France, June 1-4, 1999.)

J. Leigh, Yu, O., Schonfeld, D., Ansari, A., He, E., Nayak, A., Ge, J., Krishnaprasad, N., Park, K., Cho, Y., Hu, L., Fang, R., Verlo, A., Winkler, L., DeFanti, T. A., "Adaptive Networking for Tele-Immersion," presented at Immersive Projection Technologies/Eurographics Virtual Environments (IPT/EGVE), Stuttgart, Germany, 2001.

C.3. Software Releases

No new software upgrades or releases.

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).

EVL is working with CERN on RUDP tests. EVL is talking to CERN about DiffServ tests.

In April, a team from EVL deployed an ImmersaDesk in Valparaiso, Chile as part of REUNA's "Science, Culture and Education over Internet2 Networks" meeting, April 4-6. Real-time, tele-immersive collaborative demonstrations between Chile, University of Illinois at Chicago and University of Michigan featured geological earthquake data and medical models. REUNA director Florencio Utraras invited EVL to showcase tele-immersive virtual reality to stimulate interest among the Chilean scientific community for future collaborations with North America and Europe via the REUNA link to STAR TAP. [Note: Subsequently, due to funding issues, REUNA disconnected from STAR TAP but continues to maintain its connection to AMPATH; we are working on ways to connect AMPATH with STAR TAP.]

E. Problems

No significant problems were encountered this quarter.

F. Any Proposed Changes in Future Plans

No changes to date.

G. Summary of Award Expenditures (April-June)

Available upon request.