



TransLight / StarLight

NSF Cooperative Agreement OCI-0441094

www.startap.net/translight

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1. Participants

1.A. Primary Personnel

Participant's Name(s)	Project Role(s)	>160 Hours/Yr
Thomas A. DeFanti (1)	Principal Investigator	Yes
Maxine Brown (2)	Co-Principal Investigator	Yes

- (1) Tom DeFanti, PI, focuses on managing the link procurement process, network engineering, budgets and accounts payable, interfacing with personnel from Internet2, ESnet, NLR and DANTE/GEANT2, coordinating project management and oversight activities with the NSF, and performing day-to-day project management. He participates in regularly scheduled IRNC phone calls and attends meetings as requested.
- (2) Maxine Brown, co-PI, focuses on managing documentation and education and outreach activities, and is responsible for TransLight/StarLight quarterly and annual reports, web pages and events planning. She also participates in regularly scheduled IRNC phone calls and attends meetings as requested.

1.B. Other Senior Personnel (Excluding PI and Co-PI)

Additional people who contribute greatly to the project are listed below. While some receive a salary from this grant, others provide in-kind services:

Participant's Name(s)	Project Role(s)	>160 Hours/Yr
Alan Verlo (3)	Professional staff	Yes
Laura Wolf (4)	Professional staff	Yes
Steve Sander (5)	Professional staff	Yes
Patrick Hallihan (6)	Professional staff	Yes
Lance Long (7)	Professional staff	Yes
Linda Winkler (8)	Professional staff	Yes
Rick Summerhill (9)	Professional staff	Yes
Roberto Sabatino (10)	Professional staff	Yes
Erik-Jan Bos (11)	Professional staff	Yes
Kees Neggers (12)	Other Senior Personnel	Yes
Joe Mambretti (13)	Other Senior Personnel	Yes
Dana Plepys (14)	Professional staff	Yes

- (3) Alan Verlo is the TransLight/StarLight network engineer, and is a member of the StarLight engineering team. For many years Verlo has also been a member of the SC conferences' SCinet committee, focusing on enabling international SC research demos that have network connections at StarLight in Chicago. He was also co-chair of the iGrid 2005 international cyberinfrastructure team, responsible for clusters and international networking. Verlo regularly participates in JET and GLIF Tech meetings.
- (4) Laura Wolf was responsible for TransLight/StarLight technical writing and web documentation; she left UIC in August 2009 for a position at Argonne National Laboratory.
- (5) Steve Sander was the TransLight/StarLight budget, accounts payable and equipment procurement person. He retired from UIC in August 2010 and his responsibilities were taken over by Dana Plepys.
- (6) Patrick Hallihan reported to Alan Verlo and was technical support staff. He left UIC in August 2010.
- (7) Lance Long reports to Alan Verlo and is technical support staff.
- (8) Linda Winkler of Argonne National Laboratory, while not compensated by UIC, serves as part-time StarLight engineer with Alan Verlo and assists with TransLight/StarLight. For many years, Winkler has been a member of the SCinet committee, helping enable international SC research demos with network connections at StarLight in Chicago. She was also co-chair of the iGrid 2005 international cyberinfrastructure team, responsible for clusters and international networking.
- (9) Rick Summerhill was the Internet2 Chief Technology Officer and, while not compensated by UIC, was one of the stewards of the TransLight/StarLight link that connects the Internet2 network at MAN LAN to the GEANT2 POP at the Amsterdam Internet Exchange. Summerhill retired June 2009.

- (10) Roberto Sabatino is the DANTE Chief Technology Officer and, while not compensated by UIC, is one of the stewards of the TransLight/StarLight link that connects the Internet2 network at MAN LAN to the GÉANT2 POP at the Amsterdam Internet Exchange.
- (11) Erik-Jan Bos is SURFnet Chief Technology Officer; he leaves SURFnet March 1, 2011 for a new job opportunity. While not compensated by UIC, he has been one of the stewards of the TransLight/StarLight link connecting StarLight in Chicago to NetherLight in Amsterdam.
- (12) Kees Neggers is SURFnet Managing Director and a founder and current chair of GLIF. While not compensated by UIC, he does the tenders and procures both TransLight/StarLight links on UIC's behalf, and is one of the stewards of the TransLight/StarLight link connecting StarLight in Chicago to NetherLight in Amsterdam.
- (13) Joe Mambretti is the StarLight managing director and head of the International Center for Advanced Internet Research (iCAIR) at Northwestern University. While not compensated by UIC, he has been a strong supporter and advisor regarding our IRNC efforts. Mambretti has assisted with connectivity issues, not only at StarLight, but also at MAN LAN.
- (14) Dana Plepys assumed responsibility for managing the TransLight/StarLight budget after the previous person (Steve Sander) retired.

1.C. Other Organizations That Have Been Involved as Partners

Argonne National Laboratory

Argonne National Laboratory's Mathematics and Computer Science Division (MCS) <www.mcs.anl.gov> has been, and continues to be, a strong supporter of US international networking activities. Linda Winkler has facilitated STAR TAP/StarLight network engineering since its inception, and continues to serve as a senior engineer today; her salary comes from Argonne.

Northwestern University

Joe Mambretti, director of Northwestern's International Center for Advanced Internet Research (iCAIR) <www.icair.org>, also runs the StarLight facility <www.startap.net/starlight>, and assists with connectivity issues.

SURFnet

SURFnet, the national network for research and education in the Netherlands <www.surfnet.nl>, is a TransLight/StarLight "key institutional partner," and has been responsible for negotiating, procuring and implementing the TransLight OC-192 circuit(s) between Open Exchanges in the US and in Europe, which UIC paid for upon receipt of an invoice from SURFnet, as was our practice since our previous NSF HPIIS Euro-Link award.

1.D. Other Collaborators or Contacts

CANARIE

The Canadian Network for the Advancement of Research, Industry and Education (CANARIE) <www.canarie.ca> is Canada's advanced Internet development organization. It operates the CANARIE Network, a series of point-to-point optical wavelengths, most of which are provisioned at 10Gbps speeds, interconnecting Canada's provincial research networks with each other and international peer networks, and forming an innovative framework to support grids and e-Science.

DANTE

Owned by European NRENs, the DANTE <www.dante.net> organization plans, builds and operates pan-European networks for research and education. The GÉANT2 project is a collaboration among 30 National Research & Education Networks representing 34 countries across Europe, the European Commission, and DANTE. Its principal purpose is to develop the GÉANT2 network -- a multi-gigabit pan-European data communications network for research and education <www.geant2.net>.

TransLight/StarLight funding provides a 10Gbps routed infrastructure to connect the Internet2 network, NLR PacketNet and DOE/ESnet with DANTE/GÉANT2. TransLight/StarLight also makes a 10Gbps

switched infrastructure available for use.

ESnet

The Energy Sciences Network (ESnet) <www.es.net> is funded by the DOE Office of Science to provide network and collaboration services in support of the agency's research missions, serving thousands of DOE scientists and collaborators worldwide. ESnet provides direct connections to all major DOE sites with high-performance speeds, as well as fast interconnections to more than 100 other networks. TransLight/StarLight funding provides a 10Gbps routed infrastructure to connect the Internet2 network, NLR PacketNet and DOE/ESnet with DANTE/GÉANT2. TransLight/StarLight also makes a 10Gbps switched infrastructure available for use.

Global Lambda Integrated Facility (GLIF)

GLIF <www.glif.is> is an international virtual organization of NRENs, consortia and institutions that promotes lambda networking. GLIF provides lambdas internationally as an integrated facility to support data-intensive scientific research, and supports middleware development for lambda networking. It brings together premier networking engineers to develop an international infrastructure by identifying equipment, connection requirements, and necessary engineering functions and services.

GLORIAD

GLORIAD, the Global Ring Network for Advanced Applications Development, <www.gloriad.org> is constructing a dedicated lightwave round-the-world connecting scientific organizations in the US, Russia, China, Korea, Canada, the Netherlands and the Nordic countries. GLORIAD currently has 3x1Gbps VLANs on the TransLight/StarLight CHI/AMS link to NetherLight. Russia, a GLORIAD partner, connects to NetherLight in Amsterdam from Moscow via Stockholm.

Internet2

Internet2 <www.internet2.edu> is a consortium of leading US research universities working in partnership with industry and government to develop and deploy advanced network applications and technologies. In Spring 2007, the new Internet2 network <www.internet2.edu/network/>, a hybrid optical and packet network designed in collaboration with Level 3 Communications, came online. TransLight/StarLight funding provides a 10Gbps routed infrastructure to connect the Internet2 network, NLR PacketNet and DOE/ESnet with DANTE/GÉANT2. TransLight/StarLight also makes a 10Gbps switched infrastructure available for use by Internet2, initially the Internet2-DCN (Dynamic Circuit Network) and now the Internet2-ION (Interoperable On-demand Network).

National LambdaRail (NLR)

NLR <www.nlr.net> is a major initiative of US research universities and private sector technology companies to provide a national-scale infrastructure for research and experimentation in networking technologies and applications. TransLight/StarLight considers itself, in part, to be the international extension of NLR, and encourages data-intensive e-science drivers needing gigabits of bandwidth to use NLR FrameNet and international links for schedulable production services not available with "best effort" networks. TransLight/StarLight funding provides a 10Gbps routed infrastructure to connect the Internet2 network, NLR PacketNet and DOE/ESnet with DANTE/GÉANT2. TransLight/StarLight also makes a 10Gbps switched infrastructure available for use by NLR FrameNet.

TransLight/PacificWave

TransLight/PacificWave <www.pacificwave.net/participants/irnc> is an IRNC-supported distributed exchange facility on the West Coast (in Seattle, Sunnyvale, and Los Angeles) to allow interconnection of international research and education networks with US research networks. TransLight/PacificWave is the sister project to TransLight/StarLight.

2. Activities and Findings

2.A. Research Activities

2.A.1. Goals and Objectives

The original NSF International Research Network Connections (IRNC) TransLight/StarLight award funded UIC to provide a minimum of OC-192 connectivity between the US and Europe (UIC provided two). The goals of the IRNC program in general, and TransLight/StarLight specifically, have been to:

- Fund international network links between US and foreign science and engineering communities
- Encourage the use of advanced architectures
- Support advanced science and engineering requirements
- Encourage the development and leveraging of deployed infrastructure to meet current and anticipated needs
- Enable network engineers to engage in system and technology demonstrations and rigorous experimentation

In cooperation with US and European national research and education networks, TransLight/StarLight has continued to implement a strategy to best serve established production science, including use by scientists, engineers and educators who have persistent large-flow, real-time, and other advanced application requirements.

The original IRNC (heretofore referred to as IRNC #1) was a five-year program. TransLight/StarLight was initially funded for the period February 1, 2009 – January 31, 2010. As NSF was unable to complete reviews for its follow-on, five-year IRNC program (IRNC #2), we were asked to request a supplement for two months (through March 31, 2010), to continue to provide the US research and education community with international networks and services until such time as NSF OCI could support the IRNC #2 program.

Given this supplement was for 2 months of support, or 1/6th of a year, we essentially took previous annual budgets and requested 1/6th the amount in most categories (e.g., salaries, travel, telecommunication costs, etc). We received \$167,000, awarded January 14, 2010, for a six-month period, to end July 31, 2010.

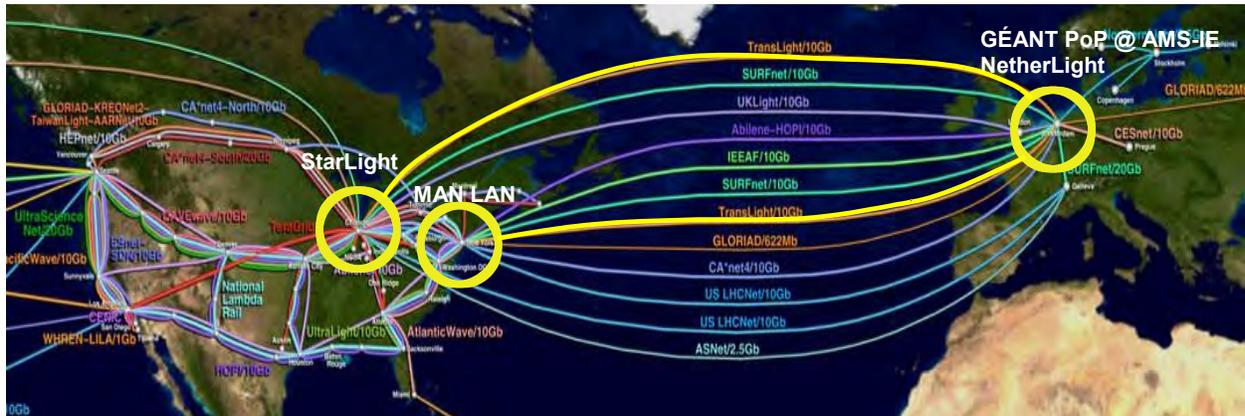
Given that this supplement had \$90,000 to extend production networking for several months, and given that we were not awarded an IRNC:ProNet grant, we asked NSF's permission to reallocate this money to other categories, particularly to cover salaries as we scale down operations, and to provide a one-year extension, so that the award would end July 31, 2011. Alan Blatecky of NSF granted both the rebudget and the no-cost extension requests.

These funds have primarily been applied to salaries for the co-principal investigators and network engineer, with some funding for administration and web documentation, plus some travel, as we transitioned the operation of our US/Europe circuits to the new IRNC:ProNet awardee, documented user applications and requirements, and participated in network-relevant workshops and meetings.

NSF awarded a three-year IRNC #2 Experimental Networking grant, also named TransLight/StarLight, to Tom DeFanti and Tajana Rosing, UCSD; Maxine Brown, UIC; and Joe Mambretti, Northwestern University, in the amount of \$1,200,000, for the period July 1, 2010 – June 30, 2013. While some individuals are funded by both IRNC #1 and IRNC #2 during this period of overlapping awards, they are actively working on both awards to ensure this team's efforts to continue to expand upon experimental networking technologies through the development of international communication services and advanced applications, and to leverage existing collaborations to make significant science impacts.

2.A.2. Accomplishments and Milestones

In Year 6 (from February 1, 2010 – July 1, 2010), TransLight/StarLight continued to fund two international circuits, which were both delivered July 2005: an OC-192 routed connection between MAN LAN in New York City and NetherLight at the Amsterdam Internet Exchange (AMS-IE) connecting the US Internet2, NLR and ESnet networks to GÉANT2, and an OC-192 switched connection between StarLight in Chicago and NetherLight that is part of the GLIF fabric. These links were procured and operated by SURFnet. On April 16, 2010, the NYC/CHI segment of the AMS/CHI IRNC circuit from Global Crossing was switched over to NLR.



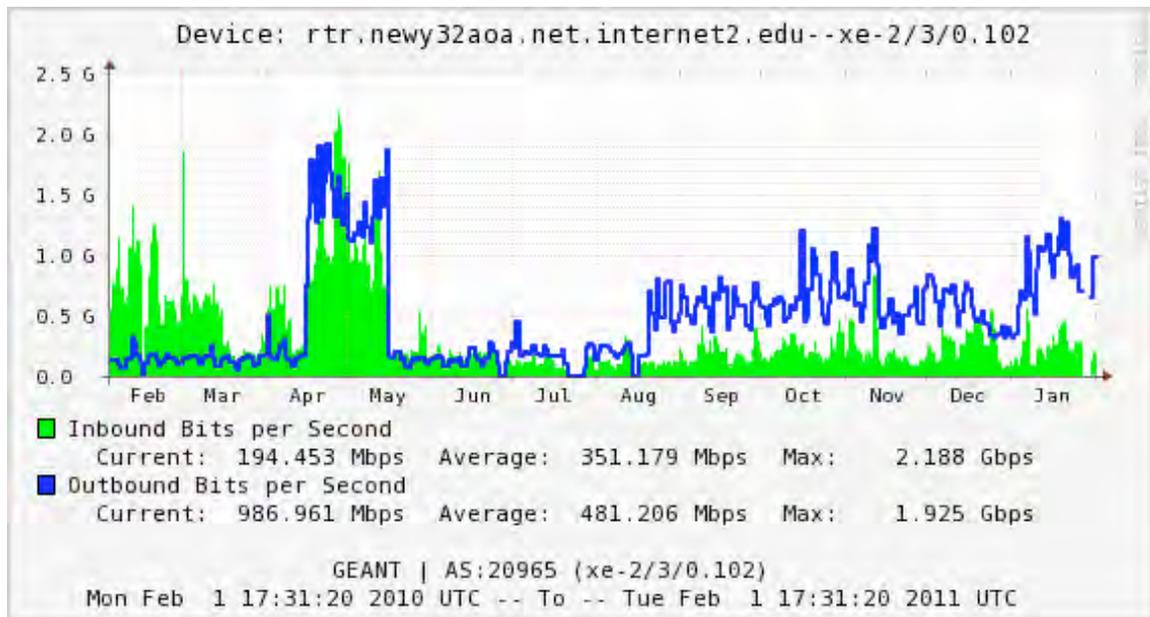
Starting July 1, 2010, Indiana University, which received the IRNC #2 award *America Connects to Europe (ACE)* for US/European connectivity, signed an MOU with SURFnet to keep these circuits in place until such time as Indiana could tender and procure its own circuits to Europe.

2.A.3. NYC/AMS Network Operations and Engineering

PoP Connectivity and Peering

TransLight/StarLight peered with the Internet2 router at MAN LAN and the GÉANT2 router at the AMS-IE. The same goes for ESnet/GÉANT2 and NLR/GÉANT2 peerings as well.

Usage



Aggregate Internet2, NLR and ESnet traffic utilization for the NYC/AMS circuit is not readily accessible; however, utilization for Internet2 is available, and usage peaked over 2Gb throughout the year, as shown in the chart above; see <http://dc-snmp.wcc.grnoc.iu.edu/i2net/old/show-graph.cgi?title=rtr.newy32aoa.net.internet2.edu--xe-2/3/0.102&rrdname=rtr.newy32aoa.net.internet2.edu--xe-2_3_0.102.rrd>.

Routing Policies

The NYC/AMS link is a routed, L3 connection providing connectivity between Internet2, ESnet, NLR and CANARIE at the MAN LAN exchange point and GÉANT2 at the Amsterdam Internet Exchange in The Netherlands. While other links between Internet2 and GÉANT2 exist, this is the preferred link for traffic between Internet2 and GÉANT2.

Peering Policies

The Internet2 and GÉANT2 networks follow established peering policies with respect to accessing and transiting traffic that might flow over this link. A list of Internet2 direct peers (i.e., those for which Internet2 has BGP peering sessions set up) can be found at <www.internet2.edu/network/peers/>. From the Internet2 network, one can reach ~80 international research and education networks, many via transit over direct peer networks like GÉANT2.

GÉANT2 connects 30 European national research and education networks across 34 countries <www.geant2.net/server/show/nav.00d009001>. GÉANT2 also benefits from connections to other world regions that have been achieved through related DANTE research networking projects.

Security

For Internet2 DDoS and Transit security information, see <<https://wiki.internet2.edu/confluence/display/network/Forms%2C+Maps%2C+Policies%2C+and+Procedures>>. GÉANT2 security information is documented at <www.geant2.net/server/show/nav.1822>.

Engineering

IRNC has benefitted from past collaborations among Internet2, ESnet, GÉANT2 and CANARIE.

NOC Operations

The Global NOC at Indiana University handles Internet2 NOC operations: <<http://noc.net.internet2.edu>>.

The Global NOC at Indiana University also handles NOC operations for the MAN LAN facility (through which the Internet2 network, ESnet, NLR and GÉANT2 peer in New York): <<http://noc.manlan.internet2.edu>>.

The GÉANT2 NOC handles GÉANT2 NOC operations: <www.geant2.net/server/show/nav.759>.

RENOG

RENOG, the Research & Education Network Operators Group <www.renog.org>, was created to facilitate technical discussion among network operators in global research and education networks. StarLight, TransLight/StarLight and Internet2 network engineers are subscribed to the RENOG mailing list. *Note: GLIF facilitates the international technical coordination of lambda networking.*

2.A.4. CHI/AMS Network Operations and Engineering

PoP Connectivity and Peering

CHI/AMS...In Chicago, the TransLight/StarLight OC-192 connected to a CANARIE-owned HDXc box at StarLight and then to StarLight's Force10 switch. From there, it peered with numerous international R&E networks, as well as the Internet2, NLR, ESnet, and regional optical networks. In March 2010, CANARIE consolidated the GOLE SONET infrastructure at StarLight. They decommissioned the HDXc and Cisco ONS15454. This had little impact on the existing connections except for the IRNC 10Gbps connection, which was re-terminated to connect straight into the Force10, bypassing the HDXc. The HDXc configuration of the IRNC connection took up two 10Gbps ports, which was necessary because the Force10 WANPHY port required full OC-192 capacity. It made more sense to terminate the IRNC 10Gbps straight into the Force10, as there was no other way to sub-rate the 10Gbps SONET circuit.

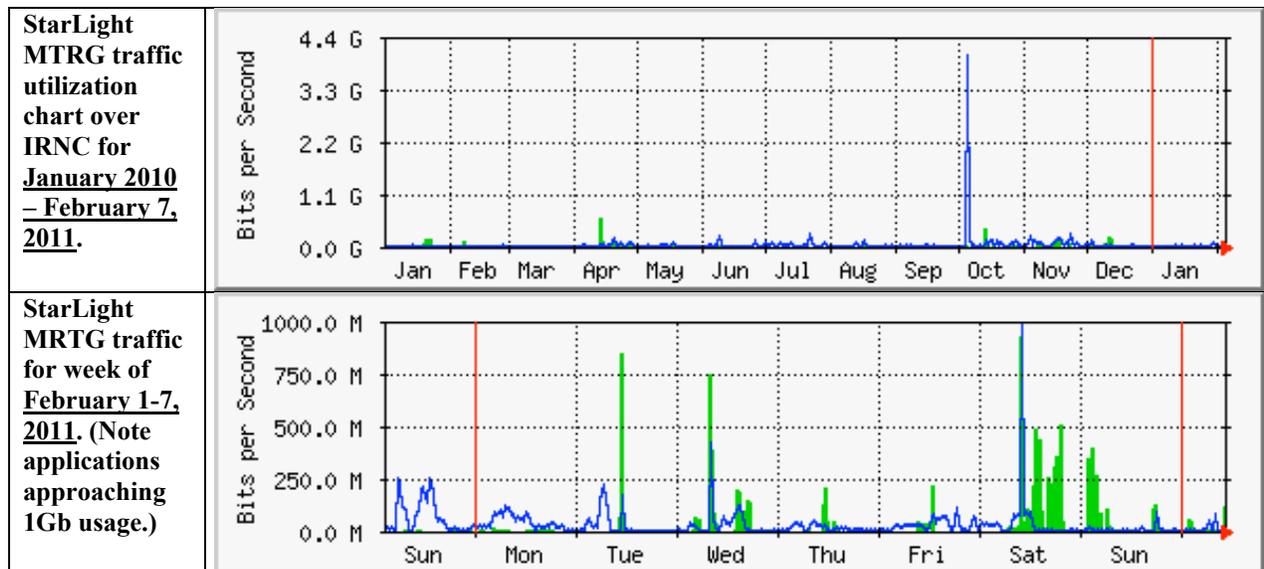
In Amsterdam, the TransLight/StarLight circuit connects to a SURFnet-owned HDXc box and Nortel NERS8600R switch at NetherLight.

TransLight...As of June 30, 2006, StarLight and Pacific Wave (Seattle) are directly connected through a 10GigE lightpath connection donated by Cisco Systems and deployed on NLR. This network fabric connecting TransLight/StarLight and TransLight/Pacific Wave creates a way for participating networks to easily configure direct connections when needed, and can be used for peering/exchange and transit. This connection is still operational.

Usage

MRTG traffic utilization information for the CHI/AMS TransLight/StarLight link can be accessed from the TransLight/StarLight website <www.startap.net/translight/pages/measurement.html>.

Note: Daily and weekly StarLight MRTG usage charts appear in this report to substantiate bandwidth for some of the heroic applications and experiments that took place over the past year (Section 2.B.2). Traffic utilization software averages information over time, so weekly, monthly, and annual charts lose significant information due to averaging – particularly when the applications are bursty and only utilize Gigabits/second in short time periods – which is why we include daily/weekly MRTG charts with specific application descriptions. To illustrate this point, we include the MRTG graph for the week of February 1-7, 2011, to show that usage approached 1Gb, though this is not reflected on the first chart.



Routing Policies

The CHI/AMS link is a 10Gbps lambda implemented between StarLight and NetherLight. Since no IP routers are on the lambda, there are no routing policies to report.

Peering Policies

Lightpaths are L1 point-to-point connections, so traditional peering policies don't apply. Instead, peering is based on the GLIF principle that resources are shared among collaborating participants; resource owners decide use.

Security

StarLight and NetherLight security information is documented on the TransLight/StarLight website <www.startup.net/translight/pages/security.html>. StarLight security can be found at <www.startup.net/starlight/ENGINEERING/starlight%20security.html>. SURFnet/NetherLight security is documented at <www.surfnet.nl/info/en/services/security/home.jsp>.

Engineering

TransLight/StarLight network engineer Alan Verlo and StarLight engineer Linda Winkler participate in GLIF Technical Working Groups, which focus on dynamic lightpath management and control. TransLight/StarLight is involved in these discussions and will implement best practices as the results of these working groups mature. Given that much of this work involves standardization, the GLIF Technical Working Group works with the Open Grid Forum (OGF) and Internet Engineering Task Force (IETF) standards bodies. GLIF task force documentation can be found at <www.glif.is/working-groups/tech/>.

Engineering: LightPath Services

Network engineer Alan Verlo worked with his international counterparts to create the following VLANs on the TransLight/StarLight link. While Indiana University's IRNC #2 MOU with SURFnet remains in place and the CHI/AMS circuit continues to be operational, these VLANs are still operational and new VLANs are being created.

- **GLORIAD...** TransLight/StarLight provides 3 x 1Gbps VLANs on its CHI/AMS link to GLORIAD.
- **NOAA...** A 1Gbps lightpath on the TransLight/StarLight-GLORIAD infrastructure from NOAA's National Geophysics Data Center (NGDC) in Boulder, CO, to Chicago (via NLR FrameNet), from Chicago to Amsterdam (via TransLight/StarLight), and from Amsterdam to Moscow (via NORDUnet and RBnet) to the Center of Geophysical Data Studies of the Russian Academy of Sciences.
- **Teraflow Testbed...** Bob Grossman, director of the UIC National Center for Data Mining and head of the Teraflow Testbed project, has a VLAN on the TransLight/StarLight-GLORIAD infrastructure between Chicago and Moscow. This link was operational on March 28, 2007, and was first used to exchange SDSS data between NCDM's servers at UIC and StarLight with servers in Moscow. *Note: While the connection is intact between Moscow and StarLight, Russian colleagues discovered in 2009 that it no longer connected to the NCDM server and engineers were in the process of reinstating.*
- **OptIPuter, SAGE and CineGrid...** The UIC Electronic Visualization Laboratory (EVL) has VLANs on TransLight/StarLight to SARA and the University of Amsterdam for OptIPuter, SAGE and CineGrid collaborations. EVL also had a VLAN for OptIPuter research with Moscow, though Russian networks were reconfigured and no request was subsequently made to test connectivity.
- **Korea-NORDUnet Medical Imaging...** NORDUnet has a 1Gbps VLAN *on the SURFnet AMS-CHI link* for a Korea-Norway collaboration between the Department of Gynecologic Oncology, University Hospital, Trondheim, Norway, and YonSei Hospital in Seoul, Korea, who are collaborating on medical imaging. *Note: Though this does not use TransLight/StarLight, it does*

leverage networking investments from SURFnet for international transatlantic connectivity. At StarLight, we created a VLAN over TransLight (the donated Cisco Research Wave between Chicago and Seattle) to carry traffic from Chicago to Seattle, where NORDUnet peers with KREONet2.

- **Korea-CESNET Medical Imaging...** CESNET has a VLAN on TransLight/StarLight for a Korea-Japan-Czech demo done for the APAN 31 conference in 2011 in Hong Kong. Collaborators included Kyushu University in Japan, GIST in Korea and Masaryk Hospital in Ústí nad Labem (MHUL).
- **Arecibo Radio Telescope in Puerto Rico...** A VLAN connects Arecibo in Puerto Rico to JIVE in The Netherlands. The VLAN extends from Atlantic Wave (at AMPATH in Miami), where Arecibo connects, to CAVEwave (in Washington DC), and then over CAVEwave to Chicago and over TransLight/StarLight to NetherLight.
- **HEPGrid (RNP/CLARA) and SPRace (Sao Paulo/ANSP)...** Two VLANs connect Tier2 sites in Brazil to CERN (via WHREN-LILA to AMPATH, then over AtlanticWave to Washington DC, over CAVEwave to Chicago, over TransLight/StarLight to Amsterdam, and then to CERN via SURFnet).
- **FEI (Netherlands) to Rio de Janeiro...** Eindhoven Technical University, in collaboration with FEI, a leading scientific instruments company in The Netherlands that develops electron and ion-beam microscopes and other instruments for nanoscale applications across many industries, requested a VLAN from Amsterdam to Rio over the same topology as the HEPGrid/CERN VLANs provisioned above for a demo at the International Microscopy Conference (IMC17) in Rio de Janeiro (September 19-24, 2010). Alan Verlo worked with NetherLight, RNP and others to provision this VLAN.
- **i2CAT (Barcelona)...** A 1Gbps VLAN is in place for CineGrid activities between the US and Barcelona, via Amsterdam. (*i2CAT has a 10Gbps between Amsterdam and Barcelona.*)
- **ON*VECTOR...** A VLAN, with no bandwidth limits specified, was put in place for Japan/US/Europe ON*VECTOR experiments. UIC and Calit2 work with Keio University, University of Tokyo and NTT Network Innovation Laboratories on the ON*VECTOR project. SARA and University of Amsterdam in The Netherlands are collaborators.
- **CosmoGrid...** A VLAN, with no bandwidth limits specified, was put in place to create a Japan/US/Europe intercontinental supercomputer.
- **LHC/Tier2...** 3Gbps VLANs for Large Hadron Collider (LHC) data for US Tier2 sites are in place (note: TransLight/StarLight already carries LHC traffic between CERN and two Tier2 sites in Brazil). To complement DOE USLHCnet transatlantic bandwidth for US Tier1 sites, Harvey Newman and Artur Barczyk requested a connection between NetherLight and StarLight on the IRNC circuit (a USLHCnet-funded circuit would be used between CERN and NetherLight). This would enable US-based Tier2 sites to get data more efficiently, and not have to access it from Tier1 sites – whether Fermilab, Brookhaven or TRIUMF (in Canada), depending on the data required. From StarLight, lightpath connectivity to Tier2 physics labs at Caltech and University of Michigan is already in place, as both these sites are also part of the US UltraLight project and have VLANs on USLHCnet. In the future, any UltraLight participant, as well as any other Tier2 site, could connect to the TransLight/StarLight circuit via Internet2 and/or NLR, as USLHCnet peers with both of them.
- **USLHCnet / National LambdaRail** – in addition to provisioning VLANs over the IRNC TransLight/StarLight CHI/AMS circuit, network engineer Alan Verlo also worked with Caltech to provision VLANs from USLHCnet to NLR's FrameNet (July 2010).
- **KAUST...** A 1Gbps VLAN over TransLight/StarLight carries R&E traffic between King Abdullah University of Science and Technology (KAUST) in Saudi Arabia and its US partner universities.
- **The Poznan Supercomputing and Networking Center (PSNC)** requested a VLAN (in February 2011) over TransLight/StarLight from NetherLight to StarLight, and then over Internet2-ION to LSU.

(For description of application use, see EAVIV, Section 2.B.2.) (*PSNC has a 40Gbps connection to Hamburg where it peers with SURFnet and gets to NetherLight.*)

- **Masaryk University (Czech Republic)** has a VLAN from the Czech Republic (Brno) over CESNET to NetherLight, then over TransLight/StarLight to StarLight, and then over Internet2-ION to LSU. (For description of application use, see EAVIV, Section 2.B.2.)
- **National University of Mexico (UNAM)** connected via a 1Gbps VLAN over NLR to StarLight (in February 2011), to receive LHC data from CERN.
- **ESnet/GLORIAD...** ESnet and GLORIAD requested a VLAN between their two networks at StarLight in February 2011. Alan Verlo assisted with network engineering.

NOC Operations

StarLight NOC operations are subcontracted to Argonne National Laboratory; see www.startap.net/starlight/ENGINEERING/network_operations.html. SURFnet NOC operations are detailed on their website <http://noc.netherlight.net/>.

2.A.5. Project Governance/Management and Oversight

Throughout the years that TransLight/StarLight managed IRNC transatlantic circuits, the governing structure was simple and based on mutual cooperation among related groups. **Tom DeFanti** is principal investigator and project director of TransLight/StarLight, and is the primary point of contact with our NSF program officer. DeFanti and **Kees Negggers** of SURFnet were stewards of the CHI/AMS link. **Doug Van Houweling** of Internet2 and **Dai Davies** of DANTE were stewards of the NYC/AMS link. StarLight and NetherLight provide network engineering and operations support for the CHI/AMS link; Internet2/MAN LAN and GÉANT2 provided support for the NYC/AMS link.

Kees Negggers of SURFnet has been a key institutional partner of this IRNC award. On behalf of TransLight/StarLight, he negotiated and procured the OC-192 NYC/AMS and CHI/AMS circuits. Tom DeFanti has worked with Kees Negggers and SURFnet since the beginning of the NSF HPIIS program, and UIC has longstanding procedures in place to pay invoices from SURFnet for transoceanic connectivity without charging any overhead to the grant.

DeFanti, in addition to overseeing the annual tendering, payment and installation of the links, has been responsible for assuring annual project milestones are met; coordinating project management and oversight activities with the NSF; serving as the day-to-day project manager; and, serving as a member of the IRNC Program Management Group (of IRNC PIs). **Maxine Brown** is co-principal investigator of TransLight/StarLight and responsible for all documentation, including quarterly and annual reports and web-based materials. Editorial writer **Laura Wolf**, who left UIC, previously assisted Brown with writing and web development as well as coordinating meetings, visits, and participation at major conferences.

Alan Verlo is the TransLight/StarLight network engineer and a member of the StarLight engineering team, and is involved in all network engineering and operations support. For many years, Verlo has also been a member of the SCinet committee, focusing on enabling international SC research demos that have connections in Chicago.

2.B. Research Findings

2.B.1. E-Science Application Organizing and Support

Tom DeFanti and Maxine Brown have been involved with the following organizations and conferences throughout the past year, whose goals are to find and encourage application and middleware development.

- 9th Annual ON*VECTOR Photonics Workshop, sponsored by NTT and hosted by Calit2 at UCSD, February 7-9, 2010. Tom DeFanti and Maxine Brown were co-organizers and members of the Program Committee; Joe Mambretti and Alan Verlo participated.
- ON*VECTOR Terabit LAN Working Group, sponsored by NTT and hosted by Calit2 at UCSD, February 10, 2010. Tom DeFanti and Maxine Brown were co-organizers, with others, and members of the Program Committee; Joe Mambretti and Alan Verlo participated.
- 10th Annual LambdaGrid Workshop, sponsored by GLIF. Maxine Brown served as a member of the Program Committee. Tom DeFanti and Joe Mambretti participated.
- CineGrid@TIFF 2010 (Tokyo International Film Festival) had a one-day CineGrid workshop at the TIFF 2010 conference. Tom DeFanti was one of the organizers, as well as a participant.
- 5th Annual CineGrid International Workshop, sponsored by CineGrid and hosted by Calit2/UCSD, December 12-15, 2010. Tom DeFanti was a co-organizer and member of the Program Committee.

2.B.2. E-Science Application Support (Quantified Science Drivers)

International Applications 2010



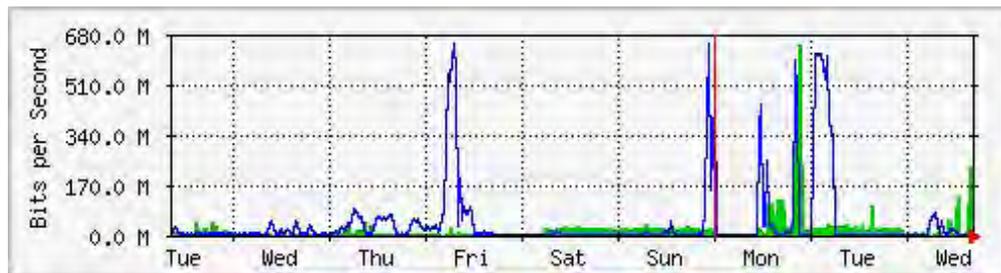
CineGrid: J2K 4K 60P Streaming Evaluation

Collaborators:

- Calit2; UIC/EVL; Pacific Interface; StarLight; US
- NTT Europe
- NTT Network Innovation Laboratories; Keio University; JGN2plus; Japan
- CinePOST; CESNET; Czech Republic

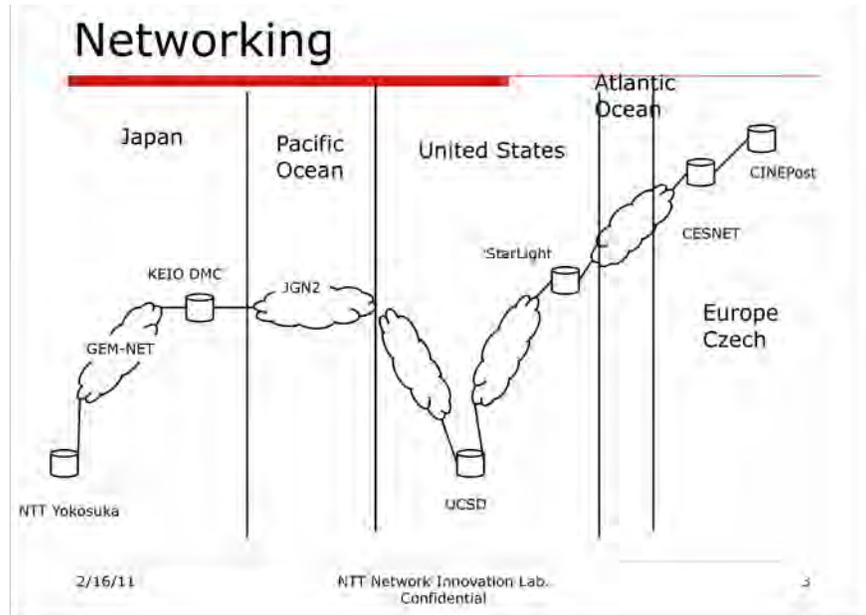
NTT Network Innovation Laboratories (Japan) and CinePOST (Czech Republic) conducted a major CineGrid demonstration, *J2K 4K 60P streaming evaluation*, from April 4-8, 2010. The quality of content streamed from NTT Labs in Yokosuka to CinePOST in the Czech Republic was evaluated by engineers interested in using 4K/60P for football game content distribution, as there is interest in live 4K/60P streaming of the 2014 World Cup games.

Additional demonstrations successfully took place through August 2010, and the professionals said they would consider using 4K technologies in future workflows. Here is the MRTG graph for TransLight/StarLight, taken August 18.



This demonstration used JGN2plus (Tokyo to UCSD), CAVEwave (UCSD to StarLight), the IRNC circuit (StarLight to NetherLight), and then CESNET

(Amsterdam to Prague).



CosmoGrid: The Gravitational Billion Body Problem 2010

<http://modesta.science.uva.nl/Projects/2008/CosmoGrid/>
<http://wiki.2048x2048x2048.org/>

Collaborators:

- Drexel University; Vanderbilt University; StarLight; US
- CANARIE; Canada
- Department of General Sciences and Department of Astronomy, University of Tokyo; National Astronomical Observatory of Japan (NAOJ)/Center for Computational Astrophysics; JGN2plus; SINET3; T-LEX; Japan
- Astronomical Institute ("Anton Pannekoek"), Computational Science and System and Network Engineering Science, University of Amsterdam (UvA); University of Leiden/Leiden Observatory (Sterrewacht Leiden); SARA; SURFnet; The Netherlands
- University of Edinburgh/School of Mathematics; UK
- Ludwig-Maximilians Universität at München; Germany

Researchers in Tokyo and Amsterdam are building an intercontinental supercomputer grid to run cosmological N -body simulations of 10 billion particles. This collaboration began last year, and early progress was reported in previous *TransLight/StarLight* reports. This is an update of 2010 activities.

In December 2009, NAOJ, SINET and JGN2plus began reconfiguring the networks. On February 10, 2010, SINET officially approved use of its network by NAOJ for this experiment so testing could continue.

Given that JGN2plus now terminates in Los Angeles (JGN2plus previously came to StarLight in Chicago), the project uses TransLight/StarLight from Amsterdam to Chicago, then Cisco's C-Wave from Chicago to Los Angeles, where JGN2 connects.

At the GLIF 2010 Workshop, October 13-14, 2010, SARA showed visualizations

from CosmoGrid's simulations of clusters formations after the Big Bang.



Choir to Choir

<http://www.youtube.com/user/ChoirtoChoir#p/a/u/1/k3gDDs58U-w>
<http://visualexchange.net/>

Collaborators:

- Center for Research in Entertainment and Learning (CREL), Calit2/UCSD; Calit2/UC-Irvine (UCI); Visual Exchange Network (VEN); Pangaea Networks; National LambdaRail (NLR); Cisco Wave (C-Wave); StarLight; US
- InTv.co.il; Beit Avi Chai; Bezeq International; Israel



On September 14, 2010, the first of a series of *Choir to Choir* demonstrations was

held at three sites – two choirs (one at UCI and one in Jerusalem) and one conductor (at UCSD). Over the next few months, the goal is to have five Choirs and one Conductor at six separate sites. For this demo, a Men’s Choir at Calit2/UCI and a Woman’s Choir at a theater in Jerusalem sang with the conductor at Calit2/UCSD. They sang together in real time with audiences both in Irvine and Jerusalem. The sound was uncompressed 8-channel audio across the network. Both audiences responded with great enthusiasm.

Using fiber-optic links instead of satellites for large-scale, live events creates new real-time capabilities that allow groups to collaborate cost effectively and enables multiple audiences to engage in new forms of multi-venue participatory media.

Alan Verlo, TransLight/StarLight network engineer, worked with a team to create a lightpath between Israel and San Diego and Irvine. The path originated in Israel over BEZEQ to New York City, then NLR FrameNet from New York to Chicago (StarLight). From Chicago, the path went over CAVEwave and C-Wave (separate east/west paths) to San Diego, and over CENIC to Irvine.



Choir to Choir: Expressions

http://www.youtube.com/user/ChoirtoChoir#p/a/u/0/r96w_xSdrCk
<http://www.calit2.net/newsroom/release.php?id=1778>
<http://visualexchange.net/>

Collaborators:

- Center for Research in Entertainment and Learning (CREL), Calit2/UCSD; Calit2/UC-Irvine (UCI); Visual Exchange Network (VEN); Pangaea Networks; National LambdaRail (NLR); Cisco Wave (C-Wave); StarLight; US
- InTv.co.il; Beit Avi Chai; Bezeq International; Israel

On January 27, 2011, scholars, cultural institutions, and audiences in San Diego and Jerusalem were part of *Expressions*, a ‘co-active’ interactive cultural event marking the United Nations commemoration in honor of the victims of the Holocaust. Simultaneous performers and audience members at both venues communicated with each other over the Internet and determined the sequence of musical tributes.

CREL and Beit Avi Chai in Jerusalem hosted the venues. They worked with Visual Exchange Network and InTv.co.il to introduce the new digital humanities platform.



The program included a keynote address by Yehuda Bauer, Professor of Holocaust

Studies at the Avraham Harman Institute of Contemporary Jewry at the Hebrew University of Jerusalem. The Tel Aviv Soloists Ensemble played two pieces: a string trio and a duet for violin and cello composed by Gideon Klein, a Czech pianist, composer of classical music and organizer of cultural life in the Theresienstadt concentration camp. Soloist Natanel Baram sang from San Diego with the Kol Rina choir performing in Jerusalem (shown in the screen shot above).

During a special co-active segment, as live music was performed by the jazz group HaLev v' HaMayaan, audiences in both cities used handheld devices or laptops to participate, as artwork created by victims of the Holocaust, provided by Yad Vashem, were shared venue-to-venue.

The program was broadcast live on Jewish Life Television (JLTV), the only 24-hour, full-time TV network in the US delivering Jewish-themed programming.

Alan Verlo, TransLight/StarLight network engineer, worked with a team to create a lightpath between Israel and San Diego and Irvine. The path originated in Israel over BEZEQ to New York City, then NLR FrameNet from New York to Chicago (StarLight). From Chicago, the path went over CAVEwave and C-Wave (separate east/west paths) to San Diego, and CENIC to Irvine.



EAVIV

<https://wiki.cct.lsu.edu/eaviv>

<http://www.internet2.edu/presentations/spring10/20100427-applications-hutanu.pdf>

Collaborators:

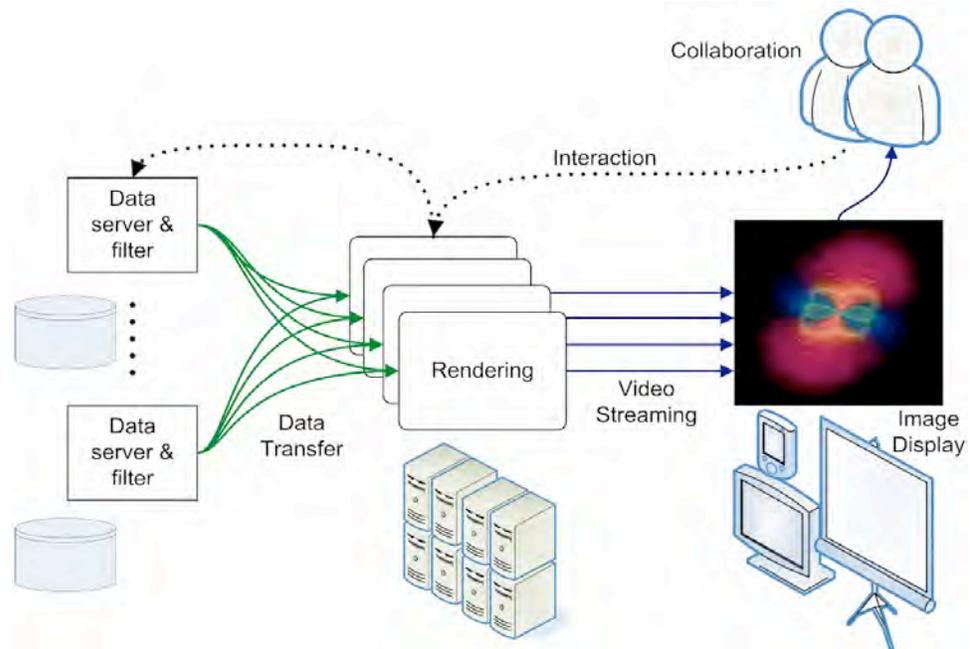
- Louisiana State University (LSU); National Center for Supercomputing Applications (NCSA); Oak Ridge National Laboratory (ORNL); Texas Advanced Computer Center (TACC); Internet2; LONI; OmniPoP; ESnet; US
- Masaryk University; Czech Republic
- Poznan Supercomputing and Networking Center (PSNC); Poland

The NSF EAGER-funded EAVIV project (Strategies for Remote Visualization on a Dynamically Configurable Testbed), is building a research testbed on which to experiment with distributed visualization scenarios on high-speed networks.

It is deployed by LSU, NCSA and Masaryk University, in cooperation with ORNL and TACC, as well network providers (Internet2, LONI, OmniPoP, ESnet). Most recently, PSNC joined the Testbed.

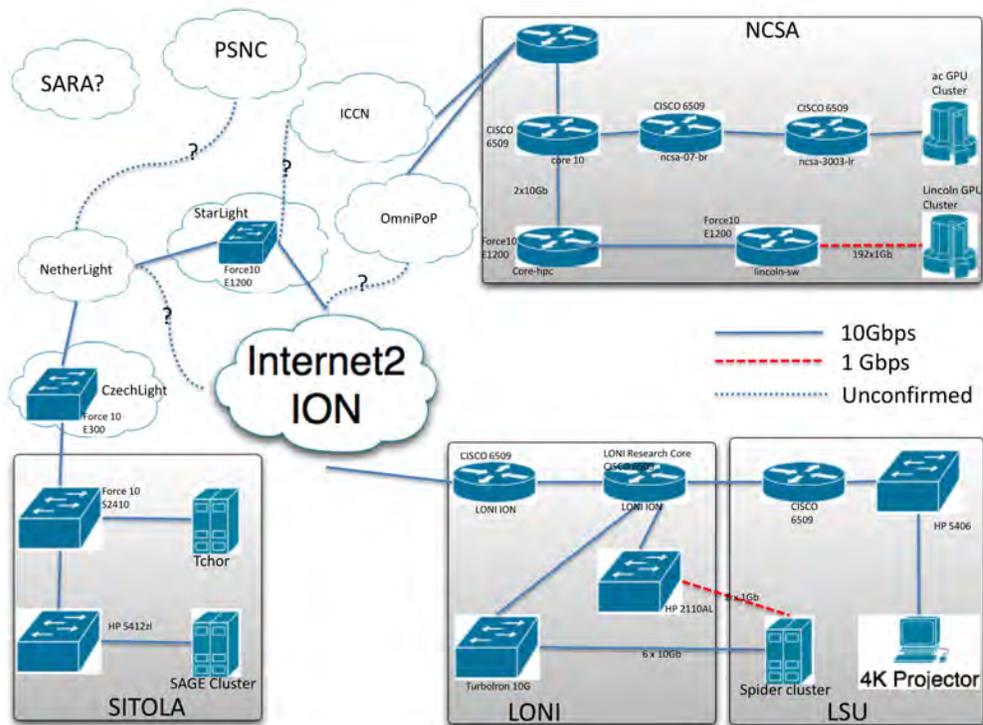
EAVIV develops and tests applications that distribute computing, storage and visualization, and that take advantage of dynamically provisioned optical networks and services. Images are streamed from remote rendering machines using SAGE.

EAVIV uses the IRNC TransLight/StarLight circuit. VLANs have been provisioned at StarLight for interfacing Masaryk University and PSNC to Internet2 ION.



The eaviv Project
<https://wiki.cct.lsu.edu/eaviv/>

Andrei Hutanu (LSU) ahutanu@cct.lsu.edu





FENIUS @ GLIF 2010 and SC10

<http://www.glif.is/publications/press/20101129.html>

<http://www.glif.is/meetings/2010/tech/vollbrecht-dynamicgole.pdf>

<http://code.google.com/p/fenius/>

<http://www.ultralight.org/~azher/idc/Glif2010/>

Collaborators:

- *Participating GOLEs:* CERNLight (Switzerland), CzechLight (Czech Republic), JGNLight (Japan), MAN LAN (US), NetherLight (the Netherlands), NorthernLight (Sweden), PSNCLight (Poland) and StarLight (US)
- *Other participating networks and institutions:* AIST (Japan), CESNET (Czech Republic), Internet2 (US), KDDI (Japan), USLHCnet (US), University of Amsterdam (Netherlands), and University of Essex (UK)

GLIF successfully demonstrated a pilot implementation of an automated lightpath system (*the Automated GOLE Pilot Project*) during SC10 in New Orleans on 15-18 November 2010. This expanded on the system that was first demonstrated at GLIF's 10th Annual Global LambdaGrid Workshop in Geneva on 13 October 2010.

While GLIF has been instrumental in facilitating high-performance applications worldwide, it has been necessary to manually set up lightpaths at each intervening GLIF Open Lightpath Exchange (GOLE). This not only requires significant administrative effort, but it can take several hours to configure each lightpath. There are significant advantages to being able to automatically establish lightpaths.

One obstacle to automating this process is that GOLEs utilize a variety of equipment with different control mechanisms (e.g., Argia/UCLP, DCN/OSCARS, DRAC, G-Lambda), not to mention they fall under different administrative domains. To facilitate dynamic set up, it is necessary to have a standard way of requesting and configuring lightpaths across all GOLEs. It is also necessary to advertise resource availability at each GOLE so that a comprehensive topology can be built up for reachability purposes.

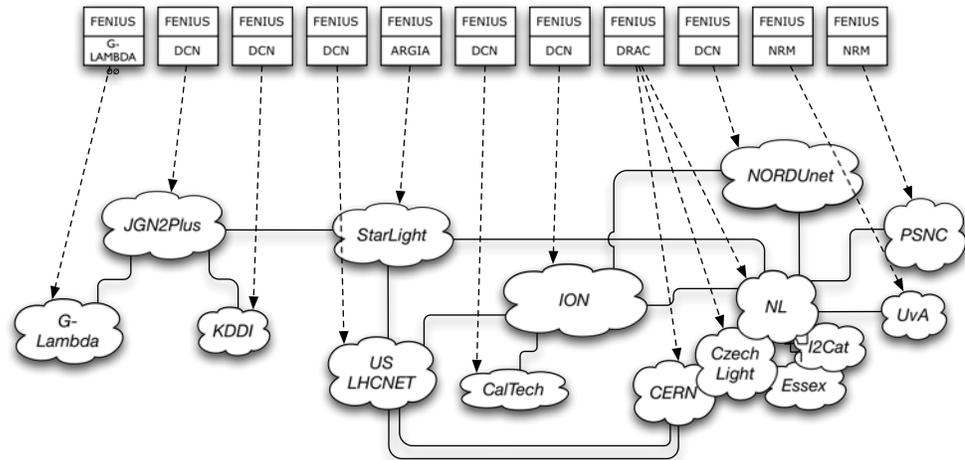


The Automated GOLE Pilot builds on Fenius software developed by ESnet, which is a common API for setting up lightpaths, but translates requests to the different underlying control mechanisms at the GOLEs. This allows lightpaths to be established on demand or reserved in advance for specific periods, along with

dedicated capacity and performance characteristics.

Eight GOLEs participated in the demonstrations, along with three additional sites, including the SC10 venue. Lightpaths were successively brought up and torn down between each location in conjunction with the perfSONAR PinGER service for monitoring and display, providing proof-of-concept and a platform for further development.

GLIF Automated GOLE Logical Topology



The demonstrations represented the initial phase of the pilot project, and there are now two further objectives. The first objective is to work with the Open Grid Forum (OGF) Network Services Interface Working Group to develop a standardized API that can be implemented by GLIF. Complementary to this is the further development of topology distribution and IP layer negotiation protocols, with a view to making these elements more robust. The second objective is to start involving demanding users and application developers who are interested in the capacity and performance offered by dynamic lightpaths, and who would be willing to work with GOLE operators by providing feedback and helping develop best practices.

Below are snapshots, taken by Caltech, for some of the USLHCNet-provided circuits used at GLIF 2010 that were dynamically created from ESnet Fenius (through USLHCNet IDC). *Note that StarLight is part of the overall configuration. When a request is made for a connection between, for example, StarLight and NetherLight, that connection is shown on the displays when it becomes active.*

The screenshot shows the Fenius Web UI for configuring a reservation. It includes sections for:

- 1. First endpoint:** Network: ION / MANLAN, Group: Default, Endpoint: MANLAN_PerfSONAR, VLAN: 1751.
- 2. Last endpoint:** Network: G-lambda, Group: Default, Endpoint: JIST_PerfSONAR.
- 3. Bandwidth:** Bandwidth (Mbps): 500.
- 4. Scheduling:** Times in your timezone (Europe/American), Start: 2010-10-14 11:20:00, Teardown: 2010-10-14 11:25:00.
- 5. Interdomain:** View interdomain path, Network: ds.internet2.edu to ds.internet2.edu.
- 6. Submit!** Request reservation button.

 Below the configuration is an **Interdomain topology** diagram showing connections between various network providers including StarLight, NetherLight, PSNC, UvA, JGN2, ION / MANLAN, USLHCnet, CERNLight, and CzechLight.



perfsONAR powered

Automated-GOLE PingER services

PingER results Last Updated: 13-Oct-10 14:58:49 GMT

GOLEs	StarLight	NetherLight	MANLAN	NorduNet	CERNLight	CzechLight	UvA	PSNC	JGN2 G-Lambda	StarLight USLHCnet	MANLAN USLHCnet	CERNLight USLHCnet	JGN2 G-Lambda USLHCnet
StarLight	Reachable	Reachable	Unreachable	Unreachable	Reachable	Unreachable	Reachable	Reachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable
NetherLight	Reachable	Reachable	Unreachable	Reachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Reachable	Unreachable
MANLAN	Unreachable	Reachable	Reachable	Reachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable
NorduNet	Unreachable	Unreachable	Reachable	Reachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable
CERNLight	Reachable	Unreachable	Reachable	Reachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Reachable	Reachable	Unreachable	Reachable
CzechLight	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable								
UvA	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable							
PSNC	Reachable	Unreachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable						
JGN2	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable
G-Lambda	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable	Reachable	Unreachable	Unreachable	Unreachable	Unreachable	Unreachable

Legend: Reachable (Green circle), Unreachable (Grey circle), Not Available (Red circle with X)



International Microscopy Congress (IMC17)

<http://www.imc-17.com>

<http://www.nc-rj.rnp.br/~leandro.ciuffo/photos/IMC17/> (photos)

Collaborators:

- *Network providers and GOLEs:* RNP, WHREN-LILA, AMPATH, AtlanticWave, MAX, CAVEwave, StarLight, TransLight/StarLight, SURFnet, NetherLight
- FEI; Eindhoven Technical University; The Netherlands

The 17th International Microscopy Congress (IMC17) took place September 19-24, 2010 in Rio de Janeiro, Brazil. FEI, a leading scientific instruments company in The Netherlands, and Eindhoven Technical University successfully did a remote electron microscope demonstration over a lightpath between Amsterdam and Rio.



In the above pictures, the left photo shows the demo itself: Ferry Stavast from FEI company is operating an electron microscope located in Eindhoven. The photo on the right is a detail from RNP's booth at IMC17. RNP had a TV screen showing the GLIF map/video. The wall image illustrated the lightpath from Rio to Eindhoven.

The lightpath was provisioned from Rio to Sao Paulo (RNP Ipê), Sao Paulo to Miami (WHREN-LILA to AMPATH), Miami to Washington DC (AtlanticWave), Washington DC to Chicago (CAVEwave), Chicago to Amsterdam (IRNC TransLight/StarLight), and SURFnet (Amsterdam to Eindhoven).



OptIPortals at CICESE and UNAM

Collaborators:

- Calit2/UCSD; PRAGMA; US
- Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE); Universidad Nacional Autónoma de México (UNAM); CUDI; Mexico

Calit2 in San Diego, and CICESE in Ensenada, collaborate on advanced visualization capabilities. CICESE is also a member of PRAGMA. CICESE has an OptIPortal in place, but it can only support local data given its limited connectivity. The OptIPortal requires multi-gigabit connectivity to support advanced visualization.

The limited development of Mexico's telecommunications market has restricted, until recently, the availability of high-capacity links in the Baja California region. CUDI was recently able to light the fiber on the Mexican side of the Border to enable 10Gbps connectivity between Ensenada and Tijuana. Funds for the lease, last-mile fiber to the campus and equipment were provided by CICESE, UNAM and Calit2.

To benefit from the increased bandwidth on the Mexican side, the project required increasing the capacity of the existing link between Tijuana and CENIC's CalREN-HPR to 10Gbps. *Tom DeFanti at Calit2 has been instrumental in working with IRNC WHREN (now AmLight) and CENIC to upgrade this connection.*

Once operational, CICESE will use the 10Gbps connection to collaborate on remote data sharing with OptIPortal partners and grid computing with PRAGMA partners in application domains such as meteorology, seismology, ocean sciences, microbiology, geophysics, and bioinformatics.

In addition, UNAM has two departments in Ensenada: the Centro de Nanociencias y Nanotecnología (CNyN), which is doing research in neural networks, electronic properties of new materials, nano-materials and nano-structures, and the Instituto de Astronomía, which is working on 3 major international projects: the Taiwan America Occultation Survey, the installation of 1.3 meter optical-infrared robotic telescope for the observation of gamma rays financed by France and China, and a 60 centimeter telescope of the Spanish BOOTES network (Burst Observer and Optical Transient Exploring System) for optical and nIR observation of Gamma rays.

10Gbps capacity between Tijuana and CENIC will enable unprecedented scientific collaborations between Mexican, North American, Asian and European institutions.



SAGE: 9th Annual ON*VECTOR International Photonics Workshop



http://www.sagecommons.org/index.php?option=com_content&view=article&id=87:pragma18&catid=1:latest-news&Itemid=50

Collaborators:

ON*VECTOR (Optical Networked Virtual Environments for Collaborative Trans-Oceanic Research) is a joint project of NTT Network Innovation Laboratories, Keio University's Institute for Digital Media and Content (DMC), the University of Tokyo's Morikawa Laboratory, the University of Illinois at Chicago's (UIC) Electronic Visualization Laboratory (EVL), and the California Institute for Telecommunications and Information Technology (Calit2) at the University of California, San Diego (UCSD), and managed by Pacific Interface Inc (PII).

This year's meeting took place February 7-9, 2010 at Calit2/UCSD. EVL's Ratko Jagodic gave the presentation "Improving SAGE Capabilities for Computer Supported Cooperative Work (CSCW)." EVL's Sungwon Nam worked with NTT Network Innovation Laboratories to stream input from multiple sources to a tiled display at Calit2/UCSD, including high-definition video of people in Japan.



SAGE: SC 2010

http://sc10.supercomputing.org/schedule/event_detail.php?evid=bof121
www.sagecommons.org/index.php?option=com_content&view=article&id=110

Collaborators:

- UIC/EVL; Calit2; SC10; US
- KAUST; Saudi Arabia

EVL organized a successful SAGE Birds-of-a-Feather at SC10 on Tuesday, November 16, 12:15-1:15pm, which brought together over 50 international SAGE users (as shown in photo below).



In addition, EVL did successful SAGE demos in the KAUST booth.



EVL also supported a SARA demo in the Dutch Research booth. Using EVL's latest SAGE User Interface software, SARA showed a collage of different HPC projects it is doing on its tiled display wall. The "screensaver" was a static image, with several movies and other applications as overlays, which were moved and resized to show the capabilities of SAGE.



SAGE: APAN 29

www.computerworld.com.au/article/336056/apan_claims_domestic_world_firsts/?fpid=1

www.aarnet.edu.au/News/2010/02/11/APAN-claims-domestic-and-world-firsts.aspx

Collaborators:

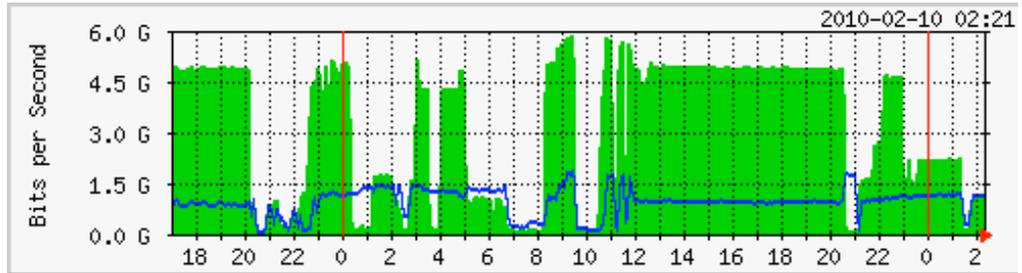
- Texas Advanced Computing Center (TACC); UIC/EVL; US
- University of Queensland; University of Melbourne; AARNet; Australia
- Gwangju Institute of Science and Technology (GIST), Korea

The Asia-Pacific Area Network (APAN) 29th conference was held February 8-11, 2010, in Sydney, Australia, and hosted by AARNet, Australia's Academic and Research Network. It featured two major SAGE demonstrations; it was also Australia's first SAGE Visualcasting demonstration.

Demo participants included the conference site in Sydney, the University of Queensland in Brisbane, University of Melbourne in Victoria, Gwangju Institute of Science and Technology (GIST) in South Korea, and the Texas Advanced Computing Center at University of Texas, Austin, in the US. The goal of these demos was to educate attendees on how network-based delivery of high-definition video and super-high-definition (4K) images and animations could promote global collaboration and advance scientific and engineering research in a variety of disciplines, such as telemedicine, environmental studies, and industrial design. UIC/EVL provided technical support for SAGE. *During prior demos with Australia, UIC/EVL was also involved in network engineering.*



SAGE Visualcasting sustained throughput of over 5Gbps, which was measured from UQ Vislab in Brisbane to the APAN29 conference site at the Hotel InterContinental in Sydney, as seen on the MRTG graph below. Note that TACC was sending DXT compressed 4K animations, utilizing 600Mbps over R&E networks.



2.B.3. Education, Outreach and Broader Participation

EVL and Calit2 do a number of tours for high-school students and undergraduate students to excite them about going to college and to encourage them to pursue careers in science and/or engineering. Tours/demos are also conducted for teachers, campus visitors and company representatives. Most tours consist of an overview presentation of collaborative research, including IRNC/GLIF activities, followed by hands-on demonstrations of advanced, networked visualization technologies. EVL and Calit2 participated in the following broader outreach activities over the past year.



November 13-19, 2010. Dr. Wally Goncharoff, UIC Project Lead the Way (PLTW) Affiliate Professor and a Lecturer in the Electrical and Computer Engineering Department, was accepted into the SC10 Education Program at the suggestion of Maxine Brown. (This is an all-expense four-day intensive SC program that immerses participants in high-performance computing, networking, storage and analysis.) Given that Goncharoff organizes a number of tours for the UIC College of Engineering, notably to EVL, he was interested in understanding more about the HPC work we do.



October 29, 2010. Luc Renambot of EVL participated in the UIC 2010 Frank Armitage Lecture in Biomedical Visualization, which features “visual geniuses” in medical and scientific illustration, animation, imaging and direction. On the last day of the meeting, Renambot hosted 35 attendees at EVL, giving a presentation and demonstrations of the Lab’s research efforts.



October 11, 2010. UIC/EVL hosted high-school students participating in the UIC Computer Science Open House.



October 4 & 6, 2010. EVL gave two tours to computer-science undergraduates enrolled in the UIC COE’s Engineering 100 course. Engineering 100 is a general orientation class for undergraduates. As part of the course, students are divided into groups according to their majors and Teaching Assistants (TAs) in those respective majors provide more specific information about coursework, careers and real-world applications. Computer-science TA Phil Pilosi, who also works part-time at EVL through funds obtained from the NSF Research Experiences for Undergraduates (REU) program, organized the “field trip” to EVL. Approximately 80 incoming computer-science majors visited EVL in two groups, on October 4 and 6, to learn about EVL’s many advanced visualization research and development activities. “The overwhelming response was Wow!,” Pilosi said, “as they learned that computer science can be fun.”



July 21, 2010. Math and science high-school teachers from four midwestern states toured EVL as part of a two-week intensive University of Illinois Summer Training Institute (STI), a continuing education program offered by the Illinois Project Lead The Way (PLTW) initiative. UIC became a PLTW National Affiliate University in 2005, offering Summer Core Training Institute sessions on its Chicago and Urbana-Champaign campuses, sponsoring statewide PLTW conference and professional development activities, coordinating program implementation and recordkeeping, and maintaining the statewide Illinois PLTW program website. PLTW is the largest nonprofit provider of innovative and rigorous Science, Technology, Engineering, and Mathematics (STEM) education programs – for students, parents, volunteers, school principals, and educators.



July 9, 2010. EVL's Maxine Brown and Andy Johnson hosted 20 students from the Chicago State University Minority Engineering program. Johnson's presentation and the subsequent EVL tour was one of several activities planned by Gerald A. Smith of the UIC College of Engineering's Minority Engineering Recruitment & Retention Program (MERRP).



June 23-24, 2010. EVL participated in the UIC Conference for Chicago-area High School CS Teachers (CS4HS), which received major funding from Google, with additional support from the Chicago Computer Science Teachers Association (CSTA), Illinois Computes, and the UIC Computer Science department.



June 21-23, 2010. Maxine Brown attended the NSF Broader Impacts for Research and Discovery Summit (BIRDS), whose goal was to develop guidance materials for the NSF CISE/OCI research communities on how to integrate activities that address the NSF broader impacts review criteria into their research. Working groups met to discuss and document current/future broader impact activities and ways in which infrastructure can be established to make it easier for NSF investigators to improve the broader impacts of their work <<http://toilers.mines.edu/BIRDS/index.html>>.



June 18, 2010. Maxine Brown of EVL hosted a teacher and several of his students from Chicago's Austin Polytechnic High School as part of the University of Illinois Affiliate Project Lead The Way (PLTW) program. Dr. Wally Goncharoff of the UIC College of Engineering organized this PLTW trip and EVL was one of the highlights. After the tour and discussions, the teacher sent an email to Dr. Goncharoff saying, "...the effect of your tour on their imaginations and positive conception of UIC cannot be overstated."



April 30, 2010. EVL hosted 23 journalism students from Northwestern University's Medill School. Their professor, Donna Leff, takes her students to visit a variety of places, with the goal of having the students write articles about subjects they find interesting. This visit subsequently resulted in a story about EVL's unique and advanced classroom, and particularly how UIC physicist David Hofman uses it to teach with colleagues from remote locations <<http://news.medill.northwestern.edu/chicago/news.aspx?id=164805>>

February 15, 2010. UIC/EVL participated in the campus' National Engineers Week, a yearly national event that celebrates the positive contributions engineers make to our quality of life and helps create the future engineering and technology workforce by promoting pre-college interest in math, science and technical literacy. EVL gave an overview presentation of its research, including IRNC/GLIF activities, followed by hands-on demonstrations of its advanced, networked visualization technologies.

February 15, 2010. UIC/EVL hosted high-school students participating in the UIC Computer Science Open House.

2.B.4. Community Partnerships: Meetings and Events

TransLight/StarLight principals have participated in the following meetings and conferences, promoting IRNC efforts. Note that the IRNC #2 TransLight/StarLight award enables us to continue to expand upon experimental networking technologies through the development of several international communication services and advanced applications, leveraging existing collaborations to make significant science impacts.

January 31, 2011. Alan Verlo participated in the JET meeting held at Joint Techs.

January 30 – February 3, 2011. Alan Verlo attended the Winter 2011 ESCC/Internet2 Joint Techs meeting in Clemson, South Carolina.

November 17, 2010. Alan Verlo participated in a JET meeting held at SC10 in New Orleans.

November 13-19, 2010. Calit2, EVL and Northwestern participated in SC10. Alan Verlo was a member of SCinet. Calit2 did NexCAVE and CGLX demonstrations in the KAUST booth. EVL did SAGE demonstrations in the KAUST booth. Northwestern did HPDMnet, iGENI and other demonstrations in the UIC National Center for Data Mining (NCDM) booth. In addition, EVL organized a successful SAGE Birds-of-a-Feather at SC10 on Tuesday, November 16, 12:15-1:15pm, which brought together over 50 international SAGE users.



October 13-14, 2010. Tom DeFanti (Calit2), Maxine Brown (EVL) and Joe Mambretti (NU) participated in the GLIF 10th Annual Global LambdaGrid Workshop, held at CERN in Geneva, Switzerland. Brown is co-chair of the GLIF Research & Applications Working Group, and as part of her session, Tom DeFanti gave the presentation “TransLight/StarLight: The Lightpath is not the Goal, the GOLE is the Goal.” SAGE was one of several international application and middleware experiments mentioned in his presentation. In the same session, Mambretti gave two presentations: “HPDMnet @ GLIF 2010” and “iGENI.” Mambretti also did HPDMnet demos and assisted Poznan Supercomputer Center to showcase their 4K initiative.

September 21, 2010. Alan Verlo participated in a JET meeting.

September 21, 2010. EVL professor Andy Johnson attended the Open Community Meeting: NSF Task Force for Cyberlearning and Workforce Development, in Arlington, VA. He submitted a white paper on EVL’s Cyber-Commons room, a technology-enhanced meeting room on a university campus that supports local and distance collaboration and promotes group-oriented problem solving in formal and informal situations. Accessibility to advanced optical networking is critical to this environment.



August 27, 2010. A delegation from China’s Dalian University of Technology, their president and four others, visited UIC to sign an MOU regarding student exchange with the UIC Chancellor. As part of their day’s activities, they visited EVL, where Maxine Brown provided a brief presentation followed by hands-on demonstrations of EVL’s networked visualization technologies.

August 17, 2010. Alan Verlo participated in a JET meeting.

July 15, 2010. Michael Stanton, Director of Innovation of RNP (Brazilian National Research and Education Network), had previously introduced Brazilian colleagues to SAGE software and tiled display systems; however, this was his first trip to Chicago and he took the opportunity to visit StarLight and EVL, and to better understand EVL technologies and activities so that he can better identify researchers in Brazil to be collaborators.

July 13, 2010. Tom DeFanti, Maxine Brown and Joe Mambretti attended the NSF OCI IRNC Kick-Off meeting in Arlington, VA. DeFanti gave a presentation on our new “TransLight/StarLight” award.

July 13, 2010. Alan Verlo participated in the JET meeting held at Joint Techs.

July 11-15, 2010. Alan Verlo attended the Summer 2010 ESCC/Internet2 Joint Techs in Columbus, OH.

June 24-25, 2010. Maxine Brown participated in the NSF-funded study, Opening Science Gateways to Future Success <<http://www.sciencegateways.org/>>. Specifically, she participated in the “Future Opportunities” focus group, held in Chicago, whose purpose was to identify future opportunities for science and engineering gateways that would warrant funding from NSF. Brown stressed the need for high-resolution “OptIPortal” gateways connected to high-speed networks.

June 15, 2010. Alan Verlo participated in a JET meeting.

June 8, 2010. Luc Renambot of EVL hosted Professor Ramon Fernando da Cunha (Rector) and Professor Paula Casari Cundari (Director of International Affairs Office) from Universidade Feevale in Porto

Alegre, Brazil. They visited UIC to discuss an international partnership, and since one of the academic areas they wanted to pursue was visual arts, UIC organized a tour of EVL.

May 26, 2010. Maxine Brown met with principals of Agilent, including the CTO, who visited UIC to learn about key technology areas. One such area was measurement informatics and the characterization of very-high rate streams and/or volumes of data for processing and display. Brown gave a short presentation on StarLight and EVL networked visualization research.

May 18, 2010. Alan Verlo participated in a JET meeting.

May 13, 2010. Glenn Ricart, NLR Executive Director, visited Joe Mambretti, Linda Winkler and Maxine Brown at StarLight.

May 11-12, 2010. Maxine Brown attended the NLR Spring 2010 All Hands Meeting in Indianapolis.



April 28, 2010. UIC physics professor David Hofman was one of eleven recipients of the 2010 Silver Circle Award, which recognizes the university's best teachers, as selected by a committee of graduating seniors. At the time, Hofman was working in Geneva, Switzerland, with CERN's Large Hadron Collider; however, he didn't let distance get in the way of his teaching responsibilities. With help from EVL, he used EVL's large tiled display in its Cyber-Commons room, plus collaboration software called EVO that is popular among physicists, to continue to teach his students back in Chicago. When Hofman learned he was to receive the Silver Circle Award and that UIC NEWS was sending a photographer to take a picture of him teaching his Physics 594 class, he emailed his students to say, "...this is also an

opportunity to showcase the cutting-edge facilities that EVL has created, to get some good publicity for Physics, and to show how different departments/groups can come together to really offer something unique." The complete UIC NEWS article can be found at <http://www.uic.edu/htbin/cgiwrap/bin/uicnews/articleDetail.cgi?id=14145>. *Though this physics class did not use SAGE, it leverages EVL's investment in tiled displays and high-speed networking to promote high-performance teleconferencing over networks.*

April 20, 2010. Alan Verlo participated in a JET meeting.

April 16, 2010. Tom DeFanti visited Harvey Newman and Julian Bunn at Caltech to discuss USLHCnet, EVO and IRNC.



March 31, 2010. UIC published *Impact* magazine, showcasing UIC's endeavors, "...that have made and will continue to make lasting contributions to Chicago, the nation and the world." One of the articles profiles Maxine Brown for her efforts in helping build StarLight – North America's largest research and education networking hub –located in downtown Chicago. For the article, see <http://www.uic.edu/depts/omc/impact/visionary.html>. This article is based on recognition Brown received in March 2009, when she was selected as one of 10 Global Visionaries and featured in the multi-media public affairs series *Chicago Matters: Beyond Burnham* created by WBEZ

Chicago Public Radio and WTTW Chicago Public Television. The TV interview can be found at http://www.wttw.com/main.taf?p=42,8,80,3&player=LKuixhzDPK&rel=eqYiqJWcf3pSuT7ep2fHgCivZuLI6p_Q. The radio interview can be found at <http://www.chicagopublicradio.org/Content.aspx?audioID=32845>.



March 24-29, 2010. Tom DeFanti and others from UCSD visited Riyadh, Saudi Arabia, to meet with the country's national science agency, the national laboratory King Abdulaziz City for Science and Technology (KACST), and Saudi Telecom Company (STC), to discuss collaborating on the development of information technology systems and advanced communications. At the conclusion of this trip, UCSD signed an initially three-year agreement with KACST and STC. The goal is to give Saudi researchers and industry specialists the opportunity to collaborate

with some of the world's best engineers as they look for solutions that can work in the global context.

March 16, 2010. Alan Verlo participated in a JET meeting.

March 9, 2010. People from Google's Chicago office visited UIC/EVL. Google very much understands the need for broadband high-speed networks and streaming media, as explained in its solicitation for proposals from small towns in the USA, as published on the Google Blog in February 2010

<<http://googleblog.blogspot.com/2010/02/think-big-with-gig-our-experimental.html>>. To quote:

"Imagine sitting in a rural health clinic, streaming three-dimensional medical imaging over the web and discussing a unique condition with a specialist in New York. Or, downloading a high-definition, full-length feature film in less than five minutes. Or, collaborating with classmates around the world while watching live 3-D video of a university lecture. Universal, ultra high-speed Internet access will make all this and more possible. We've urged the FCC to look at new and creative ways to get there in its National Broadband Plan – and today we're announcing an experiment of our own. We're planning to build and test ultra high-speed broadband networks in a small number of trial locations across the United States. We'll deliver Internet speeds more than 100 times faster than what most Americans have access to today with 1 gigabit per second, fiber-to-the-home connections. We plan to offer service at a competitive price to at least 50,000 and potentially up to 500,000 people."

February 10, 2010. Tom DeFanti and Maxine Brown were co-organizers, with others, of the ON*VECTOR Terabit LAN Working Group. Participants included DeFanti, Brown, Alan Verlo and Joe Mambretti.

February 7-9, 2010. Tom DeFanti and Maxine Brown were co-organizers, with others, of the 9th Annual ON*VECTOR Photonics Workshop, sponsored by NTT, and hosted by Calit2 at UCSD. DeFanti, Brown and Alan Verlo attended. Several IRNC national/international collaborators also attended and participated; including: Joe Mambretti, Tajana Rosing, Erik-Jan Bos (SURFnet), Greg Cole (GLORIAD), Jan Gruntorad (CESNET), Lars Fischer (NORDUnet - via VTC), Sebastia Sallent (i2CAT), Michael Stanton (RNP), Brian Tierney (ESnet), and Dave Reese (NLR). EVL's Ratko Jagodic gave the presentation "Improving SAGE Capabilities for Computer Supported Cooperative Work (CSCW)," explaining the new SAGE user-interaction schemes. EVL's Sungwon Nam participated in demonstrations of SAGE and multi-rail aware, flexible data-transfer applications using TLAN technologies.

February 3-4, 2010. Alan Verlo attended a GLIF Technical Working Group meeting, held in conjunction with the Joint Techs Workshop in Salt Lake City, UT. GLIF made progress in some of its Working Groups and created others (see list below). Notably, Alan Verlo is implementing the Dynamic GOLE project for StarLight. The short-term objective is to implement a prototype infrastructure at a few GOLEs (NetherLight, StarLight, MAN LAN, NORDUnet) to enable demos for the GLIF meeting in October 2010 as well as for SC10. The prototype infrastructure would persist for further development for another 12-18 months after that. The long-term objective is to develop implementation and models to enable inter-domain dynamic lightpath control as permanent infrastructure at GOLEs.

- **GNI API Task Force**, headed by Evangelos Chaniotakis (ESnet), is developing a generic network interface (GNI) for making lightpath reservation requests, as well as building a software

framework called Fenius to facilitate translation between GNI and different reservation control systems. The aim is to converge various existing initiatives (e.g., the EU Phosphorus project's Harmony, Japan's G-lambda, GEANT2's IDC), in order to standardize and enhance lightpath resource management.

- **Dynamic GOLE Task Force**, headed by John Vollbrecht (Internet2), is defining common policies and best practices for GLIF Open Lightpath Exchanges (GOLEs), and to investigate how to provision these. The MAN LAN, NetherLight, NorthernLight and StarLight GOLEs will be implementing Fenius to translate bandwidth requests to the underlying control mechanisms such as DRAC and OSCARS. The goal is to make automated GOLE capabilities available for demos in the 4Q 2010.
- **perfSONAR Task Force**, headed by Thomas Tam (CANARIE), is showing the usability and functionality of perfSONAR as a lightpath monitoring tool. While successfully demonstrated at previous Global LambdaGrid Workshops, further enhancements are required to support dynamic circuit configuration and topology services.
- **Global Identifiers Task Force**, headed by Ronald van der Pol (SARA), published a scheme to uniquely name lightpaths, which has been adopted by NetherLight, StarLight and KRLight.
- **Three new task forces were also developed:** (1) the Distributed Topology Exchange Task Force, led by Jeroen van der Ham (UvA), to investigate how to exchange inter-domain topology information based on existing intra-domain solutions; (2) the Resource Allocation Task Force, led by Gigi Karmous-Edwards (NCSU), to focus on how to exchange policy and authorization information; and, (3) the Campus Networking Task Force, led by Ronald van der Pol (SARA) to reach out to campus networkers by determining their needs and requirements, producing information on how to setup and use lightpaths, and encouraging and supporting tests and demos.

February 2, 2010. Alan Verlo attended the JET meeting at the Internet2/ESnet Joint Techs Workshop.

January 31 - February 4, 2010. Alan Verlo attended the Winter 2010 ESCC/Internet2 Joint Techs in Salt Lake City, UT.



January 25 – February 4, 2010. Tom DeFanti and Calit2 and EVL staff traveled to Saudi Arabia to participate in the KAUST Winter Enrichment Program (WEP). WEP is a month-long semester designed for the entire KAUST community to enlarge its intellectual horizons and stretch its collective imaginations. The WEP featured more than 100 courses, workshops, seminars, lectures and recreational events that enriched faculty/student minds and lives. Visualization Workshops took place during a one-week period. In particular, Luc

Renambot of UIC/EVL and Greg Wickham, KAUST, taught the "Streaming Televisualization (SAGE) Workshop," that covered high-resolution visualization displays connected to high-speed networks, remote rendering and parallel pixel streaming with ParaView and SAGE.

2.C. Research Training

National Research & Education Network (NREN) management and engineers from Internet2, ESnet, NLR and DANTE work closely with IRNC management and engineers at UIC and SURFnet, as well as at MAN LAN, StarLight, and NetherLight, to facilitate connectivity and greater advances in global networking than a single-investigator effort can afford. In addition, numerous researchers, middleware developers, network engineers and international NRENs are involved as users of TransLight/StarLight. This global, dedicated community has elected to work together, on a persistent basis, to further the goals of international e-science collaboration.

2.D. Education/Outreach

TransLight/StarLight's primary education and outreach activities include web documentation, articles, and conference presentations and demonstrations. We also provide PowerPoint presentations and other teaching materials to collaborators to give presentations at conferences, government briefings, etc.

EVL has partnered with NCSA and ANL since 1986, with NU/iCAIR since 1994, and with Calit2/UCSD since 2000, in ongoing efforts to develop national/international collaborations at major professional conferences, notably ACM/IEEE Supercomputing (SC), IEEE High Performance Distributed Computing (HPDC), Internet2 Member Meetings and GLIF Workshops. We have participated in European conferences, NORDUnet annual meetings and a UKERNA seminar on optical networking. Our success has been in the development of teams, tools, hardware, system software, and human interface models on an accelerated schedule to enable multi-site collaborations for complex problem solving.

We participate in the annual GLIF workshop and SC conference, and have participated in AAAS 2008 and 2009, to promote the goals of IRNC and TransLight/StarLight. We also organized the iGrid 2005 in San Diego in September 2005 to showcase international advanced applications and middleware developments.

3. Publications and Products

3.A. Journals/Papers

None.

3.B. Books/Publications

Joe Mambretti, Tom DeFanti, Maxine Brown, “StarLight: Next-Generation Communication Services, Exchanges, and Global Facilities” (chapter), *Advances in Computers*, Vol. 80, Marvin V. Zelkowitz (editor), Elsevier, 2010, pp 191 - 207, doi: 10.1016/S0065-2458(10)80005-1

3.C. Internet Dissemination

www.startup.net/translight

3.D. Other Specific Products

Other than the information reported here, we have not developed any other specific product of significance.

4. Contributions

4.A. Contributions within Discipline

TransLight/StarLight, by its very nature, is interdisciplinary. There is clearly a fine team of computer scientists, computational scientists and networking engineers involved with TransLight/StarLight, facilitating greater advances in global networking than single-investigator efforts can afford.

TransLight/StarLight developed its management team in the Chicago area (UIC/EVL), and leverages the efforts of its IRNC partners (particularly TransLight/PacificWave, GLORIAD and WHREN-LILA), and technical and administrative contacts at national NRENs (Internet2, ESnet and NLR) and foreign NRENs (DANTE and SURFnet).

4.B. Contributions to Other Disciplines

Within the Computational Science and the Computer Science communities, TransLight/StarLight efforts help lead 21st century discipline science and computer science innovation. TransLight/StarLight's 10Gbps routed circuit connecting Internet2, NLR, ESnet and GÉANT2 provides greater transatlantic connectivity, and the 10Gbps switched circuit between StarLight and NetherLight provides long-distance, high-bandwidth capability for demanding data-intensive e-science applications.

4.C. Contributions to Human Resource Development

We promote TransLight/StarLight through web documentation, articles, demonstrations and presentations at major networking conferences (e.g., SC, HPDC, Internet2), workshops (GLIF, PFLDNet), scientific conferences (AAAS), as well as PowerPoint presentations and other instructional material. We teach the infrastructure, the grid advancements, the technological innovations and the application advancements that global connectivity enables. In fact, thanks to previous NSF funding of STAR TAP, StarLight and Euro-Link, we have a current mailing list of ~400 <stars@startup.net> individuals, from academia, government and industry, interested in information about international networking developments.

4.D. Contributions to Resources for Research and Education

TransLight/StarLight is a necessary and integral part of application advances and technological innovations for the US Computational Science and Computer Science research and education communities, as well as of major interest to network engineers. In particular, the TransLight/StarLight switched circuit between StarLight and NetherLight is part of the GLIF LambdaGrid fabric and represents a major resource for science and technology.

4.E. Contributions Beyond Science and Engineering

Because of TransLight/StarLight's interest in advanced applications and lightpath provisioning, we often get inquiries from network equipment manufacturers and telecommunication providers about partnering with us to create and showcase a marketplace for wavelength-based network services and products. We look forward to working with these companies and introducing them to the Nation's foremost university and Federal laboratory networking engineers, computer programmers and applications scientists, who are developing and using today's evolving grid technologies. Our users expect us to grow in capacity and sophistication, and we look forward to the engineering challenges ahead.

5. Conference Proceedings

None.

6. Special Requirements

6.A. Objectives and Scope

A brief summary of the work to be performed during the next year of support if changed from the original proposal.

Our scope of work has not changed.

6.B. Special Reporting Requirements

Do special terms and conditions of your award require you to report any specific information that you have not yet reported?

No.

6.C. Animals, Biohazards, Human Subjects

Has there been any significant change in animal care and use, biohazards, or use of human subjects from what was originally approved (or approved later)?

No.

7. Program Plan

The original IRNC program ended, and DeFanti/Brown's follow-on ProNet TransLight/StarLight proposal to provide transatlantic circuits was not renewed. We currently have a small amount of money remaining, and have a no-cost extension, through July 31, 2011, to cover salaries, scale down operations, and document activities and best practices. We also continue to enable international applications by providing network engineering support at StarLight.