STARLIGHT

TR ∆NS LIGHT

TransLight / StarLight

NSF Cooperative Agreement OCI-0441094
www.startap.net/translight

FINAL REPORT February 1, 2011 – July 31, 2011
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Table of Contents

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/GÉANT2, 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
JD Pirtle (15)	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 GÉANT2

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 was SURFnet Chief Technology Officer; he left 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 has done the tenders and procured 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.

(15) JD Pirtle, previously a graduate student and now staff, received a portion of his salary to assist with web documentation.

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," responsible for negotiating, procuring and implementing the TransLight OC-192 circuit(s) between Open Exchanges in the US and in Europe, which UIC pays for upon receipt of an invoice from SURFnet, as has been 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. Under this award, GLORIAD received 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

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 IRNC #1) TransLight/StarLight award was initally funded for the period February 1, 2009 – January 31, 2010. A subsequent supplement and no-cost extension extended this award through July 31, 2011.

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

As this award no longer funds international circuits, remaining 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. In addition, we continue to provide engineering support at StarLight for the CHI/AMS circuit between Chicago and Amsterdam.

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.

- **1st Annual Digital Media Analysis, Search and Management (DMASM) Workshop**, sponsored by NTT Communication Science Laboratory and hosted by Calit2 at UCSD, February 28 – March 1, 2011. Tom DeFanti was a member of the Program Committee.

- **10th Annual ON*VECTOR Photonics Workshop,** sponsored by NTT and hosted by Calit2 at UCSD, March 1-4, 2011. Tom DeFanti and Maxine Brown were co-organizers and members of the Program Committee; Joe Mambretti and Alan Verlo participated.

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

Below is a list of advanced applications that we have either participated in or helped enable (i.e., network engineering). Additional applications in which we were involved overlap with the IRNC #2 TransLight/StarLight award; they are documented in the IRNC #2 TransLight/StarLight Annual Report (July 1, 2010 – June 30, 2011), to be submitted separately.

FENIUS @ APRICOT-APAN 2011

http://www.glif.is/meetings/2011/winter/

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)

Global Lambda Integrated Facility (GLIF) Technical and Control Plane Working Group held a meeting at the APRICOT-APAN 2011 conference in Hong Kong, February 21-25, 2011. At that time, they successfully repeated the FENIUS Automated GOLE Pilot Project demonstration done at the GLIF 2010 LambdaGrid Workshop and at SC10.

Alan Verlo, StarLight network engineer, worked on this project

HDTV and Medical Joint Session (Live Demo of 3D Robot Surgery from the Czech Republic) @ APAN 2011

http://www.apan.net/meetings/HongKong2011/Session/Medical.php
http://www.apan.net/meetings/HongKong2011/

Collaborators:
- Kyushu University; Japan
- GIST; Korea
- Masaryk Hospital in Ústí nad Labem (MHUL), CESNET; Czech Republic

This live demo, taking place at the APAN 2011 meeting in Hong Kong, February 21-25, 2011, was intended for the high-level education for surgeons. MHUL in the Czech Republic connected to the APAN venue in Hong Kong, where Dr. Jan Schraml at MHUL performed a live surgery of a patient with carcinoma of the prostate to demonstrate the advantages of mini-invasive robotic-assisted radical prostatectomy in preserving neurovascular bundles and bladder neck.

Note: The networks involved are CESNET (Prague to Amsterdam), TransLight/ StarLight (Amsterdam to Chicago), CANARIE (Chicago to Seattle), KREONet2 (Seattle to Korea), and then to Hong Kong.

StarLight network engineer Alan Verlo helped configure this network. Below is a

TransLight/StarLight MRTG graph for February 23, 2011 (showing 4Gbps usage).
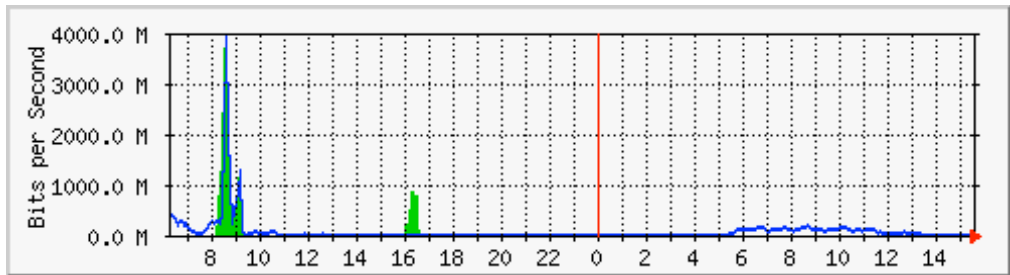

Below are statistics captured by the Czech and Korean NOCs:

TenGigE0/0/0/4 -- CR1.apricot-apan.asia

System: CR1.apricot-apan.asia in
Maintainer: 2011-infra@googlegroups.com
Description: TenGigE0/0/0/4 APAN: KRLight / CESNET 3D Video [to Czech]
ifType: ethernetCsmacd (6)
ifName: TenGigE0/0/0/4
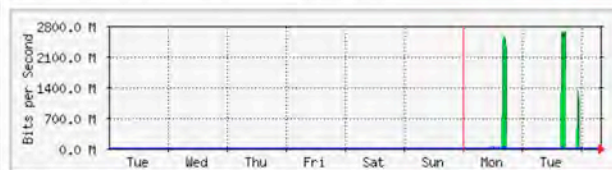Max Speed: 10.0 Gbits/s
Ip: 67.58.60.148 ()

The statistics were last updated **Wednesday, 23 February 2011 at 8:35**,
at which time '**CR1.apricot-apan.asia**' had been up for **2 days, 16:39:55**.

`Daily' Graph (5 Minute Average)
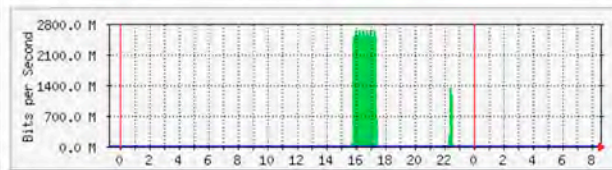
	Max	Average	Current
In	2659.2 Mb/s (26.6%)	128.4 Mb/s (1.3%)	256.0 b/s (0.0%)
Out	24.0 b/s (0.0%)	0.0 b/s (0.0%)	0.0 b/s (0.0%)

`Weekly' Graph (30 Minute Average)

	Max	Average	Current
In	2663.8 Mb/s (26.6%)	115.8 Mb/s (1.2%)	256.0 b/s (0.0%)
Out	78.6 kb/s (0.0%)	240.0 b/s (0.0%)	0.0 b/s (0.0%)

GREEN ### Incoming Traffic in Bits per Second
BLUE ### Outgoing Traffic in Bits per Second
DARK GREEN ### Maximal 5 Minute Incoming Traffic
MAGENTA ### Maximal 5 Minute Outgoing Traffic

MRTG MULTI ROUTER TRAFFIC GRAPHER
2.14.5
Tobias Oetiker <tobi@oetiker.ch>
and Dave Rand <dlr@bungi.com>

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. 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 several broader outreach activities over the past year; some are included here and others are documented in the IRNC #2 TransLight/StarLight Annual Report (July 1, 2010 – June 30, 2011), to be submitted.

April 6, 2011. EVL hosted a local troupe of ~30 Girl Scouts ("Brownies," ages 7-9). They primarily got hands-on demonstrations of the technologies, and thought it the best field trip, ever! Some now want to be professors when they grow up.
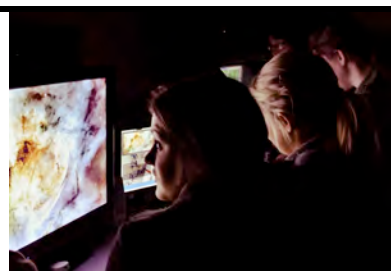
March 1, 2011. EVL hosted 20 high-school girls attending the UIC WISE GEM-SET pre-college outreach program (Women in Science and Engineering Program's Mentoring for Success, a grant funded by the U.S. Department of Education Women's Educational Equity Act WEEA Program).

February 21 2011. EVL had an open house for UIC Engineering Week, and also hosted a Cub Scout troupe from Indiana.

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

TransLight/StarLight principals have participated in the following meetings and conferences, promoting IRNC efforts; some are included here and others are documented in the IRNC #2 TransLight/StarLight Annual Report (July 1, 2010 – June 30, 2011), to be submitted separately.

March 31, 2011. Maxine Brown participated via VTC with Larry Smarr at Calit2/UCSD, who was being visited by Chilean representatives: Harald Beyer (PhD in economics from UCLA, and director of the CEP think tank in Chile); Eugenio Guzmán (Dean of the School of Government of the Universidad del Desarrollo in Chile); Alvaro Fischer (President, Chairman of the Board, Fundacion Chile). During the VTC, Maxine had Calit2 display a draft of the new GLIF map of South America on its OptIPortal.

March 7, 2011. Jason Leigh of EVL hosted Paul Walsh and Roy Sleator of Cork Institute of Technology, Ireland, who visited EVL to learn more about its technologies.

March 2011. Tom DeFanti was in Australia and Singapore, and gave a number of presentations.

- March 9, 2011. Presented "Eliminating the Bottlenecks in Visualization of Large Data and Research Collaboration," at Monash University.
- March 17, 2011. Presented "Eliminating the Bottlenecks in Visualization of Large Data and Research Collaboration," at the CSIRO conference on Computational and Simulation Science in Melbourne.
- March 19, 2011. Invited speaker. Presented "GreenLight Energy Usage Displays" at the Third Workshop on Cloud-Mobile Convergence for Virtual Reality (CMCVR 2011), held in conjunction with IEEE VR 2011 in Singapore < www.cmcvr.org/CMCVR11.html>.
- March 20, 2011. Invited speaker. Presented "The Future of the CAVE" at the JST/CREST Workshop held in conjunction with IEEE VR 2011 in Singapore
- March 24, 2011. Presented "The Future of the CAVE" at University of Queensland.

2.C. Research Training

National Research & Education Network (NREN) management and engineers from Internet2, ESnet, NLR and DANTE work have worked 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 were involved as users of TransLight/StarLight. This global, dedicated community 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 included web documentation, articles, and conference presentations and demonstrations. We also provided 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

None.

3.C. Internet Dissemination

www.startap.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, has been interdisciplinary. There was 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 could afford. TransLight/StarLight developed its management team in the Chicago area (UIC/EVL), and leveraged 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 helped lead 21st century discipline science and computer science innovation. TransLight/StarLight's 10Gbps routed circuit connecting Internet2, NLR, ESnet and GÉANT2 provided greater transatlantic connectivity, and the 10Gbps switched circuit between StarLight and NetherLight provided long-distance, high-bandwidth capability for demanding data-intensive e-science applications.

4.C. Contributions to Human Resource Development

We promoted 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 taught 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@startap.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 has been 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 has been 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 have worked 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.

5. Conference Proceedings

None.