



TransLight / StarLight

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www.startap.net/translight

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Thomas A. DeFanti, Maxine Brown, Alan Verlo
Electronic Visualization Laboratory
University of Illinois at Chicago
851 S. Morgan St., Room 1120
Chicago, IL 60607-7053
tom@uic.edu

Table of Contents

1. Participants	3
1.A. Primary Personnel	3
1.B. Other Senior Personnel (Excluding PI and Co-PI)	3
1.C. Other Organizations That Have Been Involved as Partners	4
1.D. Other Collaborators or Contacts	4
2. Activities and Findings	6
2.A. Research Activities	6
2.A.1. Goals and Objectives	6
2.A.2. Accomplishments and Milestones	6
2.A.3. Infrastructure Topology	7
2.A.4. NYC/AMS Network Operations and Engineering	7
2.A.5. CHI/AMS Network Operations and Engineering	9
2.A.6. Project Governance/Management and Oversight	13
2.A.7. Meeting and Conference Participation	14
2.B. Research Findings	17
2.B.1. IRNC Projects Interactions	17
2.B.2. E-Science Application Identification and Support	18
2.B.3. E-Science Support (Quantified Science Drivers)	18
2.C. Research Training	39
2.D. Education/Outreach	39
3. Publications and Products	40
3.A. Journals/Papers	40
3.B. Books/Publications	40
3.C. Internet Dissemination	40
3.D. Other Specific Products	40
4. Contributions	41
4.A. Contributions within Discipline	41

4.B. Contributions to Other Disciplines	41
4.C. Contributions to Human Resource Development	41
4.D. Contributions to Resources for Research and Education	41
4.E. Contributions Beyond Science and Engineering	41
5. Conference Proceedings	41
6. Special Requirements	42
6.A. Objectives and Scope	42
6.B. Special Reporting Requirements	42
6.C. Animals, Biohazards, Human Subjects	42
7. Program Plan	43

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

- (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 is the TransLight/StarLight budget, accounts payable and equipment procurement person.
- (6) Patrick Hallihan reports to Alan Verlo and is technical support staff.
- (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, until recently, 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 is SURFnet Chief Technology Officer. While not compensated by UIC, he is 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.

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.startup.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. 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 the Internet2-DCN (Dynamic Circuit 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 a 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 NSF International Research Network Connections (IRNC) TransLight/StarLight award is responsible for providing a minimum of OC-192 connectivity between the US and Europe. The goals of the IRNC program in general, and TransLight/StarLight specifically, are 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 continues 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.

2.A.2. Accomplishments and Milestones

In Year 5, TransLight/StarLight continues to fund two international links, 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 GÉANT2 to the US Internet2, NLR and ESnet networks, and an OC-192 switched connection between StarLight in Chicago and NetherLight (co-located at the AMS-IE facility) that is part of the GLIF fabric.

In Year 5, we worked with our IRNC and TransLight/StarLight partners on various activities, to:

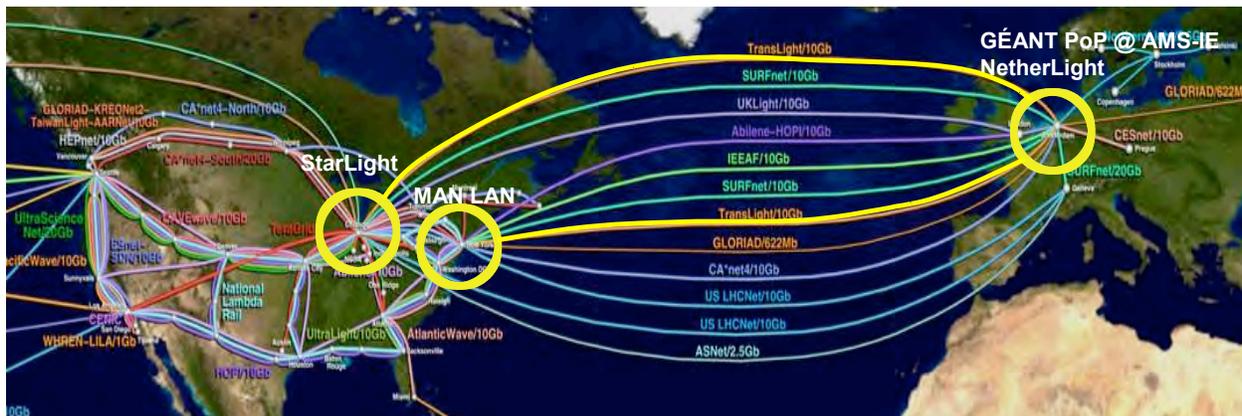
- **Identify and develop production applications on both IRNC circuits**
 - Identify and support science and engineering research and education applications, and provide network engineering assistance to several demanding US/Europe/Asia demonstrations at major events, including research demonstrations at the AAAS 2009 conference in Chicago, IL, February 12-16, 2009; GLIF Workshop in Korea, October 27-28, 2009; and, SC'09 in Portland, OR, November 14-20, 2009.
 - Support the NSF IRNC GLORIAD project with 3x1Gbps VLANs on the CHI/AMS transatlantic circuit
 - Support the NSF IRNC WHREN-LILA project with VLANs on the CHI/AMS transatlantic circuit to (a) carry high-performance eVLBI data from the Arecibo Radio Telescope (Puerto Rico) to JIVE (The Netherlands) for real-time correlation of radio astronomy data, and (b) carry CERN/Large Hadron Collider (LHC) data from Europe to Brazil's Tier2 HEPGrid (RNP/CLARA) and SPRace (Sao Paulo/ANSP) sites for more efficient data distribution.
 - Provision additional VLANs on the CHI/AMS transatlantic circuit for data-intensive applications.
- **Enable state-of-the-art international network services similar to and interconnected with those offered or planned by domestic research networks, including the Internet2 network, NLR and ESnet.**
- **Share network engineering tools and best practices**
 - Learn about cybersecurity best practices of benefit to the IRNC community
 - Participate in JET, Joint Techs, and GLIF Tech Working Group meetings

- Participate in IRNC Measurement Group meetings
- **Documentation and conference presentations**
 - Maintain the TransLight/StarLight website <www.startup.net/translight> (ongoing)
 - Contribute to the GLIF website <www.glif.is> (ongoing)
 - Facilitate the design of a new GLIF world map
 - Give presentations at conferences (e.g., SC, ONT, GLIF, Internet2) (ongoing)

2.A.3. Infrastructure Topology

In Year 5, TransLight/StarLight continued to fund two international links, which were both delivered July 2005:

- **NYC/AMS:** OC-192 routed connection between MAN LAN in New York City and the Amsterdam Internet Exchange (AMS-IE), connecting Internet2, NLR and ESnet networks to GÉANT2.
- **CHI/AMS:** OC-192 switched connection between StarLight in Chicago and NetherLight in Amsterdam (co-located at the AMS-IE facility) that is part of the GLIF LambdaGrid fabric. This is configured as a 10GigE circuit, carved into VLANs, for data-intensive applications.



The GLIF Technical Working Group has defined GLIF Open Lightpath Exchanges, or GOLEs. MAN LAN, StarLight and NetherLight are all GOLEs. The NYC/AMS and CHI/AMS links are, from an operating perspective, treated similarly, as permanent 10Gbps lightpaths that are either handed off to routers (NYC/AMS) or switches (CHI/AMS).

IRNC pays for links only. At MAN LAN, Internet2 pays for the Nortel HDXc, OME and Cisco 6513 switch; GÉANT2 (until October 2008) paid for a router at MAN LAN. At the AMS-IE, SURFnet pays for an HDXc and GÉANT2 pays for a router. At StarLight, CANARIE pays for an HDXc and StarLight provides a Force10 switch. At NetherLight, SURFnet pays for an HDXc and Nortel ERS8600R switch.

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

PoP Connectivity and Peering

TransLight/StarLight peers 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 TransLight/StarLight traffic utilization information for Internet2, NLR and ESnet can be accessed from the TransLight/StarLight website <www.startup.net/translight/pages/measurement.html>. Individual utilization for Internet2 and NLR is also available. ESnet is transitioning from MRTG to an improved service, so graphs are not available. GÉANT2 does not make its statistics publicly available.

<p>Internet2/ESnet/NLR aggregate traffic (maximum ~6Gbps) on IRNC NYC/AMS for the period February 2009 – January 2010.</p>	<p>Device: sw.newy32aoa.manlan.internet2.edu--te10/1</p> <p>7.0 G 6.0 G 5.0 G 4.0 G 3.0 G 2.0 G 1.0 G 0.0</p> <p>Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan</p> <p>Inbound Bits per Second Current: 1.406 Gbps Average: 1.512 Gbps Max: 3.692 Gbps Outbound Bits per Second Current: 2.158 Gbps Average: 1.903 Gbps Max: 6.063 Gbps</p> <p>GEANT2 via OME:1-10-1 -10GE-01519 (Te10/1) Mon Feb 2 22:03:59 2009 UTC -- To -- Tue Feb 2 22:03:59 2010 UTC</p>
<p>Internet2 traffic (maximum ~1.3Gbps) on IRNC NYC/AMS for the period February 2009 – January 2010.</p>	<p>Device: rtr.newy32aoa.net.internet2.edu--xe-2/3/0.102</p> <p>1.4 G 1.2 G 1.0 G 0.8 G 0.6 G 0.4 G 0.2 G</p> <p>Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan</p> <p>Inbound Bits per Second Current: 496.007 Mbps Average: 569.512 Mbps Max: 1.294 Gbps Outbound Bits per Second Current: 161.421 Mbps Average: 187.341 Mbps Max: 739.519 Mbps</p> <p>GEANT AS:20965 (xe-2/3/0,102) Mon Feb 2 22:05:29 2009 UTC -- To -- Tue Feb 2 22:05:29 2010 UTC</p>
<p>NLR traffic (maximum >2Gbps) on IRNC NYC/AMS for the period February 2009 – January 2010.</p>	<p>Device: newy.layer3.nlr.net--tengige0/5/0/4.211</p> <p>2.5 G 2.0 G 1.5 G 1.0 G 0.5 G</p> <p>Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan</p> <p>Inbound Bits per Second Current: 465.328 Mbps Average: 414.605 Mbps Max: 1.833 Gbps Outbound Bits per Second Current: 908.345 Mbps Average: 582.933 Mbps Max: 2.150 Gbps</p> <p>GEANT via MANLAN, AS20965 (TengigE0/5/0/4.211) Mon Feb 2 22:06:32 2009 UTC -- To -- Tue Feb 2 22:06:32 2010 UTC</p>

Routing Policies

The NYC/AMS link is a routed, L3 connection providing connectivity among GÉANT2 in Europe and Internet2, ESnet, NLR and CANARIE at the MAN LAN exchange point. 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, notably:

- Southern and Eastern Europe through SEEREN <www.seeren.org>
- The Mediterranean through EUMEDCONNECT <www.eumedconnect.net>
- Southern and eastern Mediterranean through EUMEDCONNECT2 <www.eumedconnect2.net>
- Latin America through ALICE (America Latina Interconectada Con Europa) <<http://alice.dante.net/>>
- Asia-Pacific region under TEIN2 (Trans-Eurasia Information Network) <www.tein2.net>
- The Asia-Pacific region under the third-generation TEIN3 <www.tein3.net>
- ORIENT, coordinated by DANTE in Europe and CERNET in China <<http://global.dante.net/server/show/nav.1418>>

Security

Internet2 DDoS and Transit security information is located at <<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. Meetings and outcomes were documented at <www.geant2.net/server/show/nav.1227>.

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: Global NOC-NOC Communications

RENOG, the Research & Education Network Operators Group <www.renog.org>, facilitates 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.5. CHI/AMS Network Operations and Engineering

PoP Connectivity and Peering

CHI/AMS...In Chicago, the TransLight/StarLight OC-192 is connected to a CANARIE-owned HDXc box at StarLight and then to StarLight's Force10 switch. From there, it peers with numerous international R&E networks, as well as the Internet2, NLR, ESnet, and regional optical networks.

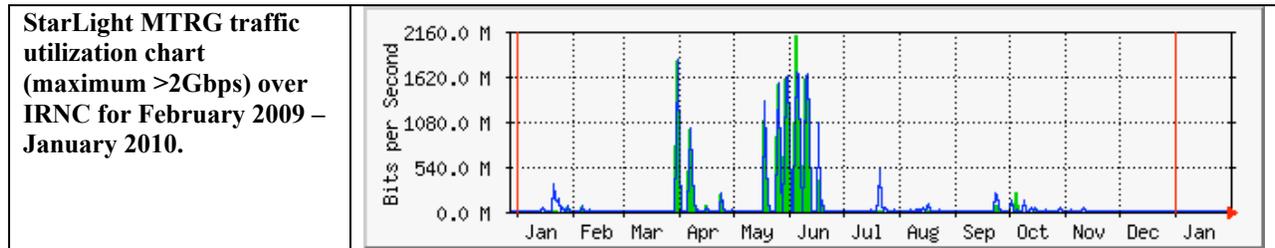
In Amsterdam, the TransLight/StarLight link is connected to a SURFnet-owned HDXc box and Nortel NERS8600R switch at NetherLight.

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

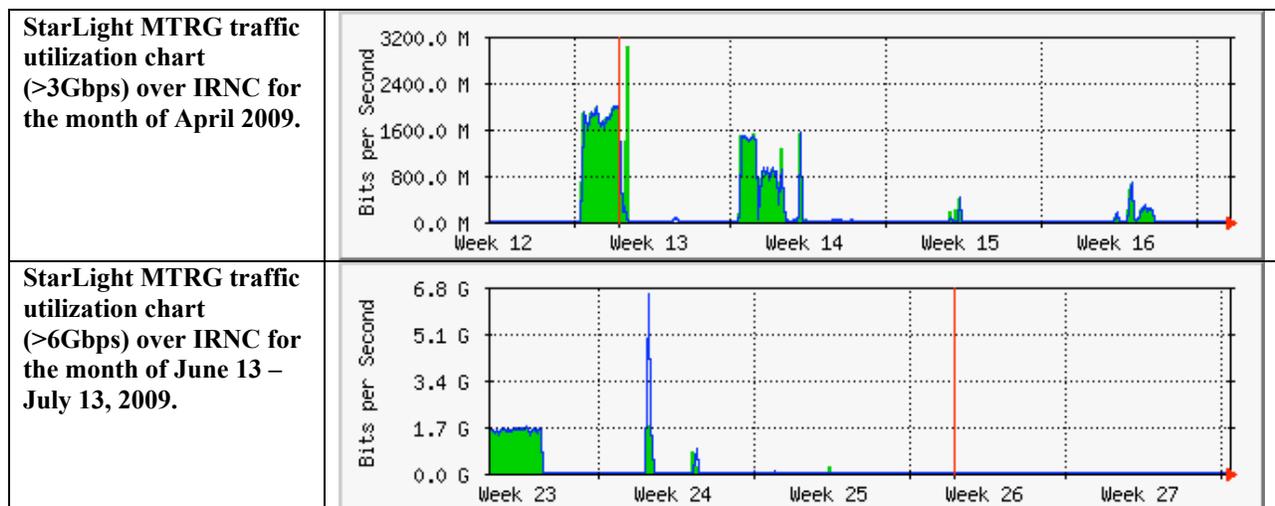
Usage

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.3).



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 in this report.) Below, from MRTG charts captured during specific times over the past year, we see that the TransLight/StarLight CHI/AMS link had bursty traffic requiring up to 6Gbps.



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

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

Engineering

As the fiber market increases, and as technology evolves towards 100Gbps and beyond, the control of dynamic lightpaths becomes increasingly important. TransLight/StarLight network engineer Alan Verlo

and StarLight engineer Linda Winkler participate in GLIF Technical Working Group meetings. Several GLIF task forces focus on dynamic lightpath management and control. TransLight/StarLight is involved in these discussions and will implement best practices as the results of these task forces mature. Given that much of this work involves standardization, the GLIF Technical Working Group works with the Open Grid Forum (OGF), a standards body. GLIF Tech task force documentation can be found at www.glif.is/working-groups/tech/.

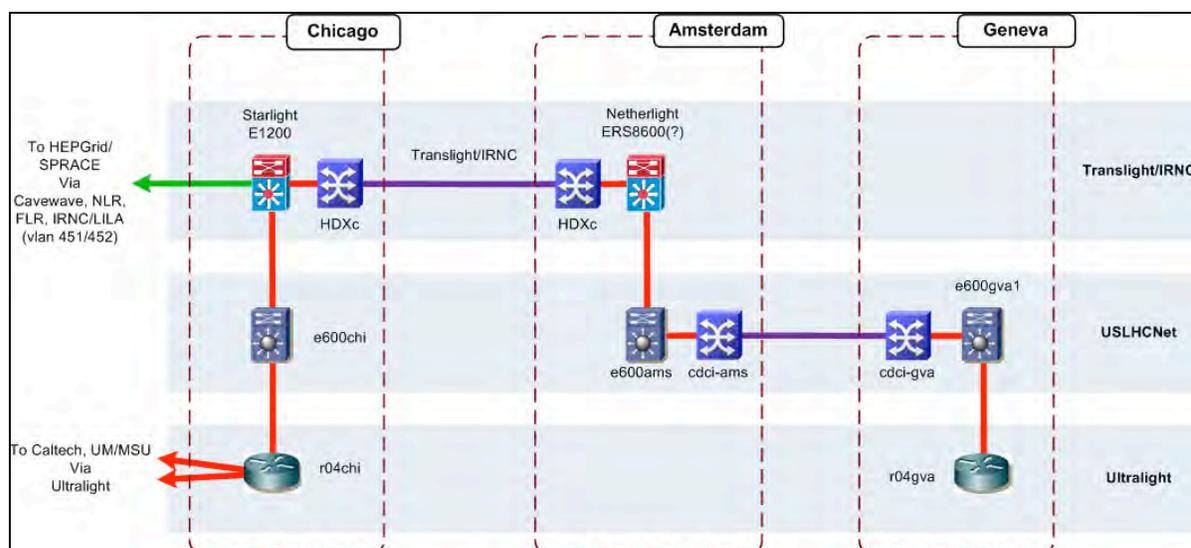
Engineering: LightPath Services

The following VLANs on the TransLight/StarLight CHI/AMS are in place:

- **GLORIAD...**Per discussions with Kevin Thompson at NSF, TransLight/StarLight provides 3 x 1Gbps VLANs on its CHI/AMS link to GLORIAD.
- **NOAA...**A 1Gbps lightpath on the TransLight/StarLight-GLORIAD infrastructure is in place 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 recently discovered that it no longer connects to the NCDM server. Given that the Russians wanted to update their SDSS database in early November, during SC preparations, they relied instead on the regular internet (presumably the TransLight/StarLight NYC/AMS link) and were able to download in several days at rates of 80Mbps during the Moscow workday and up to 170Mbps at night. A lightpath would have enabled them to download in hours. Connections are in the process of being reinstated.*
- **OptIPuter/SAGE...**The UIC Electronic Visualization Laboratory (EVL) has VLANs on TransLight/StarLight to SARA and the University of Amsterdam for OptIPuter/SAGE collaborations. EVL also has a VLAN for OptIPuter research with Moscow.
- **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.*
- **Arecibo Radio Telescope in Puerto Rico...**A VLAN was created to connect Arecibo in Puerto Rico to JIVE in The Netherlands. A VLAN was created from AMPATH, where Arecibo connects, to AtlanticWave to CAVEwave (in Washington DC), and then from CAVEwave to Chicago, 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).
- **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 experiments (See Section 2.B.3, “ON*VECTOR: Synchronized Multi-Lane Streaming Using NTT’s Terabit Network Interface Card (NIC)” description)
- **CosmoGrid**... A VLAN, with no bandwidth limits specified was put in place to create a Japan/US/Europe intercontinental supercomputer (See Section 2.B.3, “CosmoGrid: The Gravitational Billion Body Problem 2009,” for intercontinental supercomputer experiment description)
- **LHC/Tier2**...3Gbps VLANs for Large Hadron Collider (LHC) data for US Tier2 sites, are in place, as illustrated below (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 be connected to the IRNC TransLight/StarLight circuit via Internet2 and/or NLR, as USLHCnet peers with both of them.

To further expedite access, on May 28, 2009, the DOE USLHCnet project selected NLR as a provider of 10Gbps circuits linking US institutions to the LHC. Specifically, NLR will provide two 10Gbps circuits between Chicago and New York, enabling LHC data access and exchange by the US Tier1 facilities Fermilab near Chicago and Brookhaven National Laboratory near New York City. In addition, numerous smaller, Tier2 centers, where most of the data analysis will take place, will also be connected. The US LHC program roadmap calls for introduction of 40-100Gbps technologies when service and cost requirements are met. For information, see <www.nlr.net/release.php?id=44>.



- **KAUST**...A 1Gbps VLAN over TransLight/StarLight has been created. The new \$20,000,000,000 King Abdullah University of Science and Technology (KAUST) in Saudi Arabia, modeled after the best university research and education facilities worldwide and engaging faculty from those facilities, opened in September 2009. To fill its international research mission, KAUST leased a 10Gbps circuit from its campus to the NetherLight exchange, based on requirement

specifications and architectural and engineering advice from TransLight/StarLight¹ and SURFnet. *This link became operational October 20, 2009 (see Section 2.B.3: KAUST Teleconferencing).*

The TransLight/StarLight CHI/AMS circuit now carries R&E traffic from US partner universities to KAUST (via Amsterdam). These universities, who have been awarded an aggregate of more than \$50M/yr for the next 5 years, are: UC Berkeley, Stanford, Texas A&M, Cornell, MIT, Georgia Tech, Penn State, Caltech, UCSD and UIC, plus Woods Hole. To reach specific labs at these institutions, KAUST is also paying for last mile and regional connections as needed to guarantee US/KAUST projects have first-class high-definition videoconferencing as well as data sharing and access to its computing facilities; KAUST installed an IBM Blue Gene/P supercomputer, which is the largest in the world outside of the DOE labs.

TransLight/StarLight inspired this connectivity, helped engineer it, and is making it possible for US researchers to fulfill the requirements of over a quarter of a billion dollars of sponsored research and education funding from KAUST, while minimizing travel requirements. TransLight/StarLight's partnership with KAUST includes ongoing close cooperation with designing and implementing advanced communication services in support of its scientific research. Other countries in the Middle East are certain to engage with KAUST as well, and replicate the networking infrastructure pioneered by TransLight/StarLight and its global partners. In fact, discussions have started about establishing a major open exchange, the Saudi Arabia Light (SALight) at KAUST.

NOC Operations

StarLight NOC operations are subcontracted to Argonne National Laboratory; see www.startup.net/starlight/ENGINEERING/network_operations.html.

SURFnet NOC operations are detailed on their website <http://noc.netherlight.net/>. Active monitoring of NetherLight and its links are done on a 24x7 basis.

2.A.6. Project Governance/Management and Oversight

TransLight/StarLight's governing structure is very simple and based on mutual cooperation among related groups. This structure can evolve, as necessary, to support all critical or significant project activities.

Tom DeFanti is principal investigator and project director of TransLight/StarLight, and is the primary point of contact with our NSF program officer. DeFanti is also steward, with **Kees Negggers** of SURFnet, of the CHI/AMS link, and appointed **Doug Van Houweling** of Internet2 and **Dai Davies** of DANTE as stewards of the NYC/AMS link. StarLight and NetherLight provide network engineering and operations support for the CHI/AMS link; Internet2 and GÉANT2 provide support for the NYC/AMS link.

Kees Negggers of SURFnet is a key institutional partner of this IRNC award. On behalf of TransLight/StarLight, he negotiates and procures the OC-192 NYC/AMS and CHI/AMS links. Tom DeFanti has been working 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, is 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). He also represents TransLight/StarLight at meetings and conferences, as requested.

Maxine Brown is co-principal investigator of TransLight/StarLight and is responsible for all documentation, including quarterly and annual reports and web-based materials. Brown has also given

¹ Tom DeFanti, PI of TransLight/StarLight, is also PI of a KAUST award to UCSD for "Calit2 OptIPresence," October 1, 2008 – September 30, 2012. UIC/EVL receives a subaward.

invited TransLight/StarLight presentations at several meetings and conferences. Editorial writer **Laura Wolf**, who recently 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.A.7. Meeting and Conference Participation

TransLight/StarLight principals have participated in the following meetings and conferences to promote IRNC:

February 2, 2010. Alan Verlo participated in a JET meeting, which was collocated at the Internet2/ESnet Joint Techs Workshop.

January 25 – February 4, 2010. Tom DeFanti, Calit2 and EVL staff traveled to Saudi Arabia to participate in the KAUST Winter Enrichment Program. (Funded by KAUST.)

January 31, 2010 – February 4, 2010. Alan Verlo attended the Internet2/ESnet Joint Techs Workshop in Salt Lake City, as well as the GLIF Technical Working Group Meeting, which was collocated.

December 6-9, 2009. Tom DeFanti attended the CineGrid 2009 Workshop. DeFanti gave a presentation on “Building KAUST Visualization Capabilities.” Jason Leigh and Luc Renambot from UIC/EVL also attended; Leigh gave a presentation on “Building CineGrid Nodes Using SAGE OptIPortals.”

November 18, 2009. Alan Verlo participated in a JET meeting, which was held at the SC09 conference.

November 14-20, 2009. Tom DeFanti, Maxine Brown and Alan Verlo attended SC09. Verlo was a member of the SCinet team. DeFanti participated in the KAUST booth, debuting his new low-cost stereo system NexCAVE, with collaborative demos between the SC site in Portland, and Calit2 in San Diego, as well as conducting video teleconferences with people in San Diego, Chicago and Saudi Arabia.

November 2-6, 2009. Alan Verlo attended the SCinet staging meeting in Portland, OR.

October 30 – November 5, 2009. Tom DeFanti and representatives of EVL went to Japan for meetings with research collaborators at NTT Network Innovations Laboratory. NTT sponsors ON*VECTOR wide-area research experiments that rely on GLIF networks, as well as an annual Photonics Workshop.

October 30, 2009. Prof. Andy Johnson of EVL hosted Celina Pereira of the University of São Paulo’s Faculty of Medicine, Department of Telemedicine, Brazil. Her visit, organized by the Illinois-São Paulo Chapter of Partners of the Americas, enabled EVL to showcase its international networking and research collaborations and explain IRNC partner activities with WHREN-LILA.

October 27-29, 2009. Tom DeFanti and Joe Mambretti attended and participated in the 9th Annual LambdaGrid Workshop sponsored by GLIF in Daejeon, Korea. The GLIF meeting was held October 27-28, followed by a meeting of the GLIF North American (GLIF-NA) Working Group on October 29. Maxine Brown served as a member of the LambdaGrid Workshop Program Committee.

October 20, 2009. Alan Verlo participated in a JET meeting.

October 13, 2009. Maxine Brown was the keynote speaker at the Chicago Community Trust’s 8th Annual Newman Lecture and Dinner. Her talk featured StarLight, and was entitled, “Prototyping Tomorrow’s Computer and Networking Technologies Today.” She was selected because of being honored as a “Global Visionary” by the *2009 Chicago Matters: Beyond Burnham* TV/radio series, organized by Chicago Public Radio and Public Television.

September 16-25, 2009. Tom DeFanti traveled to Saudi Arabia for the opening of KAUST. (Funded by KAUST.)

September 15, 2009. Joe Mambretti participated in a JET meeting.

September 14-15, 2009. Alan Verlo attended the CyberSecurity Summit 2009 for Large Research Facilities, sponsored by EDUCAUSE in Arlington, VA <<http://www.educause.edu/cyb09>>.

August 18, 2009. Alan Verlo participated in a JET meeting.

August 11 – September 15, 2009. Calit2 and EVL staff traveled to Saudi Arabia to help set up the KAUST Visualization Showcase area. (Funding provided by KAUST.)

July 29, 2009. Tom DeFanti hosted Dimitra Simeonidou, Chair of Optical Communications and Head of the Photonic Networks and Networked Media Groups at the University of Essex, UK. They discussed research infrastructure developments in the UK in the fields of networking and high-performance media, as well as the new EU-funded GEYSER collaboration that will implement an IaaS framework over heterogeneous infrastructures (networks, data storage, media devices, content repositories, etc).

July 20, 2009. Alan Verlo participated in a JET meeting, held at the Joint Techs.

July 19-23, 2009. Alan Verlo attended the Summer '09 ESCC/Internet2 Joint Techs, held in Indianapolis, Indiana <<http://events.internet2.edu/2009/jt-indy/index.cfm>>.

June 16, 2009. Alan Verlo participated in a JET meeting.

June 15-20, 2009. Tom DeFanti visited Kees Neggers of SURFnet and Anwar Osseyran of SARA in The Netherlands to discuss IRNC TransLight/StarLight. On June 19, he also participated in a one-day symposium “Networked Visualization for e-Science” organized by the University of Amsterdam, and gave the keynote “UCSD’s Project GreenLight Computation, Visualization, and Networking” <<http://staff.science.uva.nl/~delaat/symp-2009-06-19/>>.

June 11-13, 2009. Tom DeFanti attended the International ACM Symposium on High Performance Distributed Computing (HPDC 2009) in Munich, Germany <www.lrz-muenchen.de/hpdc2009/index.php>, and gave the presentation “OptiPortals for 2015” as part of the panel “How to solve the power wall problem of supercomputing (in 2015).”

June 3, 2009. UIC/EVL hosted several visitors from IMC in Vietnam who were visiting UIC’s Department of Earth and Environmental Sciences to discuss collaborations. IMC is the Institute for Technology Development, Media and Community Assistance, a division of VUSTA, the Vietnamese Union of Science and Technology, both Vietnamese ministerial level entities. Delegates were: Nguyen Duy Ngoc (IMC director), Nguyen Hoang (IMC deputy director), Bui Viet Duc (Head of IMC Education Exchange Division) and Dao Dang Toan (IMC communications assistant).

June 1-5, 2009. Alan Verlo attended a SCInet meeting in Portland, OR.

May 19, 2009. Alan Verlo participated in a JET meeting.

April 21, 2009. Alan Verlo participated in a JET meeting.

April 6, 2009. Joe Mambretti represented TransLight/StarLight at the “Internet2 Meeting on NSF IRNC Program,” held at Georgetown University in Washington DC.

March 24, 2009. Larry Smarr and Tom DeFanti at Calit2/UCSD hosted the NLR All Hands Meeting.

March 20, 2009. Yul Edwards, technology advisor to Illinois’ Congressional representative Danny Davis, visited EVL to learn more about the technologies we use and deploy, including IRNC and StarLight.

March 17, 2009. Alan Verlo participated in a JET meeting.

March 17, 2009. Maxine Brown was selected as one of 15 “global visionaries” for the multi-media series *Chicago Matters: Beyond Burnham*, to explore how the Chicagoland region can thrive in a global era. Chicago Public Radio and PBS are producing this series. The goal was to feature StarLight, and Brown was chosen as a “co-creator and coordinator of the largest digital hub in North America.”

For the WTTW television interview, go to the following website, then scroll down to the end “Starlight” project and click VIEW CLIP:

<<http://www.wttw.com/main.taf?p=42.2.1.1&date=03172009&et=%20-%20Tuesday%2C%20March%2017%2C%202009>>

For the radio show, go to the following website, click on “Audio Slideshow” under Brown’s photo, then hit PLAY: <<http://www.chicagopublicradio.org/Content.aspx?audioID=32845>>

March 10-11, 2009. Mikhail Zhizhin, Head of the Grid laboratories at the Geophysical Center and the Space Research Institute in Moscow, is a long-time collaborator of UIC/EVL, and is involved with networked scientific applications for space physics, remote sensing and climatology with the World Data Centers System under research grants from the Russian Academy of Sciences, NOAA, NASA, EGEE, Microsoft, and the World Bank. He visited EVL and Adler Planetarium (where EVL has an installation in Adler’s Space Visualization Laboratory) to discuss future collaborations.

February 25, 2009. 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 23-24, 2009. Tom DeFanti and Maxine Brown were co-organizers, with others, of the 8th 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; notably: Joe Mambretti, Kees Neggers, John Silvester, Bill St. Arnaud (via VTC), and Dave Reese (NLR).

February 13-15, 2009. EVL participated in the AAAS 2009 conference (American Association for the Advancement of Science), which was held in Chicago. We were in the NSF booth and showcased the IRNC program, as well as several other NSF-funded projects. More specifically, EVL and Northwestern University coordinated the installation of a 1Gbps network between the NSF booth and StarLight, which NSF funded. For further information about the IRNC-related demonstrations, see Section 2.B.3, “AAAS 2009 International High-Definition Video Teleconferencing.”

February 9, 2009. Alan Verlo remotely attended the Collaborative Expedition Workshop #80: “Leveraging SOA: Advancing Cyberinfrastructure Capabilities for High-Performing Distributed Communities.” The GSA’s USA Services/Intergovernmental leads monthly Collaborative Expedition workshops to advance the quality of citizen-government dialogue and collaborations at the crossroads of intergovernmental initiatives, Communities of Practice, Federal IT research and IT user agencies.

February 1-5, 2009. Alan Verlo attended the Winter ‘09 ESCC/Internet2 Joint Techs in College Station, TX. He participated in the JET meeting, held February 2. He also informally met with Matt Zekauskas and Julio Ibarra on IRNC measurement efforts.

2.B. Research Findings

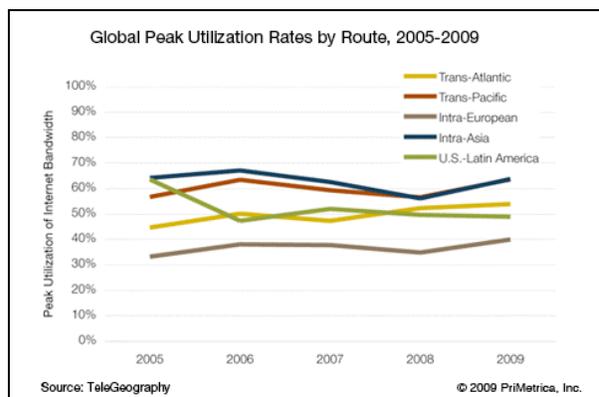
2.B.1. IRNC Projects Interactions

Internet2/ESnet/NLR/GÉANT2 and StarLight/NetherLight Compatibilities

The TransLight/StarLight NYC/AMS routed network seamlessly connects Internet2, ESnet, NLR and GÉANT2, and the switched CHI/AMS switched circuit seamlessly connects StarLight and NetherLight, thereby assuring that international network services conform to those currently offered or planned by domestic research networks.

As an interesting statistic, the research group TeleGeography recently published an article titled “Internet traffic growth not slowed by recession.” This September 14, 2009 article states “international traffic growth accelerated to 79% in 2009, up from 61% in 2008. Growth was fastest in emerging markets, such as Eastern Europe, South Asia, and the Middle East. Traffic from each of these regions grew well over 100% in 2009. However, even more mature markets experienced rapid growth: peak traffic volumes on international links connected to the US and Canada increased 59% in 2009... The need to upgrade Internet backbones in light of traffic growth is not a new development. Since 2007, the annual growth rate of international Internet capacity has exceeded 60%. In 2009, international internet bandwidth increased 64%. In 2009, network operators added 9.4Tbps of new capacity – exceeding the 8.7Tbps in existence just two years earlier.” See the article at

www.telegeography.com/cu/article.php?article_id=30081.



AAAS 2009

IRNC was successfully represented at the AAAS 2009 conference. This was the first time NSF’s booth was networked at a AAAS meeting, so we were able to not only explain the NSF IRNC program, but to show it. NSF provided the additional funding necessary to install a temporary 1Gbps connection from the Hyatt Regency hotel (where AAAS was held) to the StarLight facility. Via high-definition video teleconferencing (VTC), we talked with colleagues from the US (Michigan), Brazil, Czech Republic, Korea, The Netherlands, and Russia. NSF director Arden Bement and former NSF director Rita Colwell happened to be in IRNC’s section of the booth while we were talking with Petr Holub in the Czech Republic, and asked him questions about the high-resolution medical image shown on his tiled display.

The VTC demonstration was complemented by two high-performance networked demos by EVL collaborators Bob Grossman at UIC and Joe Mambretti at Northwestern University. Grossman and Mambretti also very much enjoyed seeing and talking with international colleagues via the VTC, many of whom they also collaborate with. (And, Mambretti was instrumental in working with AT&T to acquire its GigaMAN service between the hotel and StarLight.)

For a detailed description of AAAS 2009 demonstrations, see Section 2.B.3: “AAAS 2009: International High-Definition Video Teleconferencing.”

9th Annual GLIF Global LambdaGrid Workshop

The annual GLIF meeting was held October 27-28, 2009 in Daejeon, South Korea, and hosted by KISTI. Several international demonstrations took place, some of which utilized the TransLight/StarLight switched circuit www.glif.is/meetings/2009/demos/.

- HPMDnet – *iCAIR, KISTI & HPDMNet Consortium*

- perfSONAR – *CANARIE*
- IDC: MAN LAN and NetherLight – *MAN LAN & NetherLight*
- Fast Data Transfer for LHC – *CERN*
- GNI API Fenius interoperability framework – *KISTI, G-lambda, ESnet, & HPDMnet*
- Medical Video Streaming – *NTNU*

SC 2009

Together with our IRNC siblings, we supported scientific and engineering applications at SC09 in Portland, OR, November 14-20, 2009. Alan Verlo participates in SCInet, and one of his primary duties is to support international connections at StarLight, particularly TransLight/StarLight.

2.B.2. E-Science Application Identification and Support

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

- **TransLight/Pacific Wave's Applications group (ongoing)**, organized by John Silvester, stimulates application development. This group meets occasionally via telephone and at conferences. Maxine Brown is a member of this group, representing TransLight/StarLight. This group has provided advice and support to several projects. In particular, Brown was involved in early discussions for the eResearch Australasia Workshop, November 9-13, 2009 <www.eresearch.edu.au/programme-details-2009>.
- **Cyberinfrastructure (CI) Days** <www.cidays.org> is an ongoing effort to educate campuses about what national-scale CI resources are available; it is organized by a consortium of CI providers, including TeraGrid, Educause, Internet2, Open Science Grid, National LambdaRail, SURA and IRNC. Maxine Brown represents IRNC.
- **9th Annual LambdaGrid Workshop, sponsored by GLIF** <www.glif.is/meetings/2009>. Maxine Brown served as a member of the Program Committee.

2.B.3. E-Science Support (Quantified Science Drivers)

For many years, we documented international applications on the StarLight website <www.startap.net/starlight/APPLICATIONS> and, more specifically, US/European applications on the Euro-Link website <www.startap.net/euro-link/APPLICATIONS>. However, as international collaborations become more prevalent, as collaborations expand from two to three to four continents, and as more transoceanic links become operational, it is difficult to identify and document these applications – they are ubiquitous. Of more interest to us, is to identify and serve high-end applications – that is, data-intensive e-science applications requiring advanced networking capabilities – for they are the drivers for new networking tools and services to advance the state-of-the-art of production science.

Below is a list of recent applications (both routed and switched) that we are tracking; more are documented on the TransLight/StarLight website <www.startap.net/translight/pages/applications.html>. Applications utilizing GLIF links are publicized at <www.glif.is/apps>.

US/European Applications 2009



AAAS 2009: International High-Definition Video Teleconferencing

www.evl.uic.edu/core.php?mod=4&type=4&indi=627

Collaborators:

- UIC/EVL; UIC/National Center for Data Mining (NCDM); Northwestern University/International Center for Advanced Internet Research (iCAIR); University of Michigan; TransLight/StarLight; GLORIAD; WHREN-LILA;

TransLight/Pacific Wave; StarLight; US

- SARA; The Netherlands
- Masaryk University; CESNET; Czech Republic
- RNP; Brazil
- KISTI; Korea
- Space Research Institute; Kurchatov Institute; GLORIAD; Russia

The transformative technology of high-performance networking in support of science was prominently featured at the 175th American Association for the Advancement of Science (AAAS) Annual Meeting held February 12-16, 2009, at the Hyatt Regency Chicago. NSF provided the funds to lease a 1Gbps AT&T GigaMAN connection between NSF's booth space at the conference and StarLight, enabling UIC and Northwestern University to showcase the IRNC program.

This network connection was used for H323 video teleconferences between the NSF booth and scientific institutions in the US, Russia, the Netherlands, Korea, the Czech Republic and Brazil. Attendees were able to watch live presentations and question the scientists appearing on a 65-inch LCD display, as if meeting face to face. This network connection also supported additional application demos by UIC National Center for Data Mining and Northwestern University.



UIC/NCDM director Bob Grossman and postdoc Yunhong Gu stand in front of their networked cloud computing demonstration in the NSF booth – with signage overhead that recognizes the IRNC TransLight/StarLight project, UIC and Northwestern University (home of StarLight). Note: while networked, this NCDM demo was not international in scope.



Northwestern/iCAIR director Joe Mambretti sits in front of his HPDMnet demonstration in the NSF booth – with signage overhead that gives recognition to the IRNC program. (For more details on this international networked demonstration, see “HPDMnet @ AAAS 2009” in this report.)



Live teleconferencing between the NSF booth and collaborators from SARA, The Netherlands.



Live teleconferencing between the NSF booth and collaborators from RNP, Rio de Janeiro, Brazil.



NSF director Arden Bement and former director Rita Colwell, in the NSF booth, talk with colleagues at Masaryk U, Czech Republic.



Live teleconferencing between the NSF booth and collaborators at KISTI, Korea.



Live teleconferencing between the NSF booth and collaborators at the Space Research Institute, Russia.



Live teleconferencing between the NSF booth and Dr. Vehlikov and others at the Kurchatov Institute, Russia.



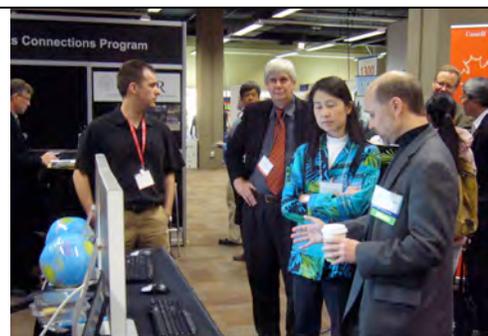
Live teleconferencing between the NSF booth and collaborators at University of Michigan.
Note: While not international, it was networked.



Greg Cole participated in the NSF booth, gave presentations about GLORIAD, and showed his web-based traffic monitoring software.



NSF director Arden Bement and former director Rita Colwell, talk with Bob Grossman and Joe Mambretti in the NSF booth.



NSF CISE assistant director Jeanette Wing talks with Bob Grossman and Joe Mambretti in the NSF booth.



CineGrid: Distributed Color Correction for Cinema 2009

www.cinegrid.org

Collaborators:

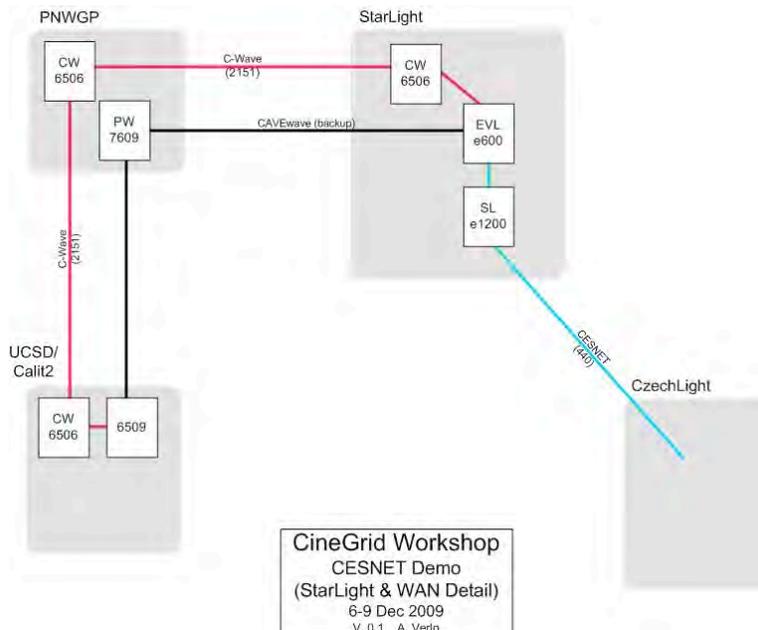
- CESNET; CinePOST; Czech Republic
- Calit2/UCSD; Pacific Interface; StarLight; US

At CineGrid 2009 Workshop in December, the Czech Republic demonstrated distributed color correction for d-cinema post production, by conducting a collaborative session between a film director in the Calit2/UCSD auditorium and a colorist/operator at CinePOST, located at Barrandov Studios in Prague, CZ.

The colorist in Prague used a full-featured, Baselight 4K uncompressed real-time color correction system connected to a Sony SXR projector using 4 x HD-SDI single links. The corrected image was displayed locally on a medium-sized screen in front of the colorist/operator, and was sent over a 10GigE circuit (from Prague to San Diego), decoded and displayed in the Calit2 auditorium using another Sony SXR projector.

So that the director in San Diego saw *the same thing at the same time* as the colorist in Prague, CESNET sent the output of the color rendering system at full quality, 4K uncompressed. This was done using prototype hardware developed and engineered in the Czech Republic using FPGA to encode/transmit 4K over 10GigE uncompressed. This demo transmitted using 4 x single link digital video interfaces (3840x2160 4:2:2 10-bit). According to the development team, the Czech technology has been designed to go up to 8 x HD-SDI in the future.

To enable interactive give-and-take of the creative process between the director and colorist over great distances, the remote sites were also linked by LifeSize high-definition video teleconferencing systems, as well as IM/cellphone back-channels.



Note: While this demonstration did not use TransLight/StarLight, it leveraged Czech Republic investments for international transatlantic connectivity.



CosmoGrid: The Gravitational Billion Body Problem 2009

<http://modesta.science.uva.nl/Projects/2008/CosmoGrid/>

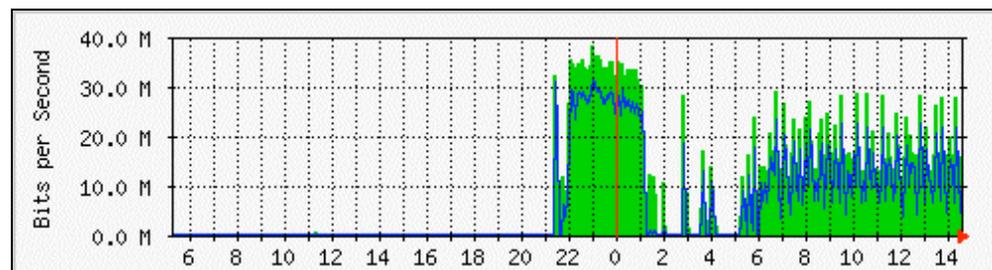
<http://wiki.2048x2048x2048.org/>

Collaborators:

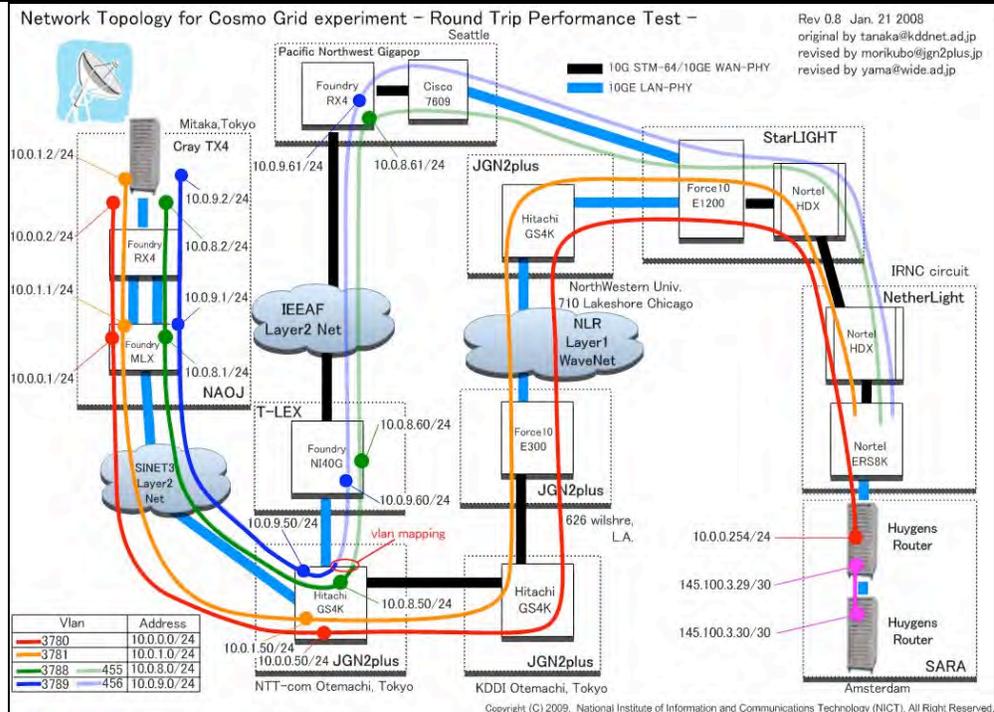
- Drexel University; Vanderbilt University; StarLight; US
- CANARIE; Canada
- Department of General Sciences and Department of Astronomy, University of Tokyo; National Astronomical Observatory of Japan (NAOJ)/Center for Computational Astrophysics; JGN2plus; SINET3; T-LEX; Japan
- Astronomical Institute (“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 2009 activities.

Immediately following SC08, network engineers established a lightpath between NAOJ in Japan and SARA in The Netherlands for further network testing January 15-31, 2009. The scientists successfully ran a $2k^3$ simulation concurrently on the Cray in Tokyo and the Huygens supercomputer in Amsterdam. StarLight’s MRTG traffic utilization graph for January 28, 2009, showed a sustained flow of 30-40Mbps, but overall, the traffic was bursty (with peaks over 500Mbps).



Note in the diagram below that the Tokyo to StarLight path went over the IEEAF link to Seattle, and then over the TransLight Cisco Research Wave to Chicago and then over TransLight/StarLight to Amsterdam.



As of April 14, 2009, the group reached $z=5.28$. Professor Zwart, who heads up this project, moved from UvA to the University of Leiden, where he accepted a position as full professor in Computational Astrophysics. There, he will perform some mid-calculation analysis to see if all is right with the production run, and will also spend time optimizing the code for multi-platform (>2 supercomputers) calculations. At the Dutch Astronomical Conference, held May 13-15 in Rolduc in The Netherlands, he hoped to present a live demo and poster of the CosmoGrid project.

The week of September 16, 2009, the group met in Tokyo to discuss CosmoGrid current progress and future directions. Outcomes:

- After having run the production simulation ($N2048^3$ in a 30Mpc box) for several months in Tokyo, they reached $z=1.5$. They will now re-initiate the Amsterdam-Tokyo connection, but with 256 processors in Tokyo and 512 in Amsterdam. *They are requesting network availability during October-December 2009 timeframe, not including SC09.*
- The group is beginning to think about data analysis and data reduction strategies. They plan to store 110TBytes of data (400 snapshots of 300GBytes each) on tape. Snapshots of $z=1.5$ (and higher) are available.
- A CosmoGrid-II run is planned to study the first dark matter clumps at high redshift. These simulations would be numerically as well as astrophysically challenging. From experience with CosmoGrid, it would be better to use a few processors on many supercomputers rather than many processors on a few supercomputers. They are currently investigating which supercomputers are willing/eligible to contribute to this second endeavor; the goal is 12-24 computers in Europe, the US and Asia.
- A second workshop is being planned in January/March 2010, once simulation data is in hand, to discuss data analysis strategies and the CosmoGrid-II run.

The group submitted the paper “Simulating the universe on an intercontinental grid

of supercomputers” to IEEE Computer for review.

In December 2009, the group started to reconfigure the networks. There have been ongoing problems in Japan connecting NAOJ to Tokyo via SINET, which have not yet been resolved.



EVO Powers Communication for Global Collaborations

www.isgtw.org/?pid=1001833

<http://evo.caltech.edu/>

Collaborators:

The Enabling Virtual Organizations (EVO) “grid” consists of 52 servers deployed at key network locations in 22 countries. Network locations include institutions linked by education and research networks such as JANET in the UK and RENATER in France, and at large laboratories such as CERN in Switzerland and Brookhaven National Laboratory in the US. EVO uses the grid monitoring service MonALISA (Monitoring Agents using a Large Integrated Services Architecture), developed at Caltech, to connect users to the best available server and provide load balancing for the entire system.

EVO, a worldwide network designed for institutions participating in the LHC experiments and other high-energy physics collaborative programs, makes international collaboration easier by providing a reliable and secure system for real-time virtual meetings.

EVO, developed by Caltech, was a winner of the 2009 Internet2 IDEA award for applied advanced networking “at its best.” In 2008 it hosted more than 9,100 virtual LHC collaboration meetings with a total of over 4,200 users. The combined time each user spent in EVO LHC meetings last year totals more than 86,300 hours. Unlike commercial networks, EVO poses no restriction on the number of participants in a meeting. On September 10, 2008, about 1,250 sites around the world participated via EVO in the LHC startup event, with up to 250 sites connected at any given time.



On a related topic, a UIC physics professor who teaches his class with EVO so that remote colleagues (e.g., at CERN, Los Alamos National Laboratory) can lecture to his students, was frustrated that his students were crowded around a small screen and could not see the speakers very well. He came to UIC/EVL, where we plugged the output of the

laptop into EVL’s Cyber-Commons tiled display wall, so the lecturers are now larger than life! The professor is currently at CERN for a month, but continues to teach using EVO for his lectures, displayed on EVL’s wall.



Image from film
“Enquanto a Noite nao
Chega”

FILE Media Arts Festival 2009

www.file.org.br

www.calit2.net/newsroom/release.php?id=1579

www.cinegrid.org

Collaborators:

- Calit2 and Center for Research in Computing and the Arts (CRCA), UCSD; StarLight; CineGrid; US
- Electronic Language International Festival (FILE); RNP; Brazil

The Electronic Language International Festival (FILE 10), one of the world’s leading venues for new media arts, was held in Sao Paulo, Brazil, July 28-August 30, 2009. This year, July 30-31, featured the first 4K digital cinema to premiere simultaneously on three continents: at the festival in Brazil, and streamed in real time over optical networks to both Calit2 at UCSD and to Keio University’s Design Media lab in Tokyo, Japan. The film was by Brazilian director Beto Souza, “Enquanto a Noite nao Chega” (While the Night Doesn’t Come).

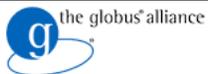
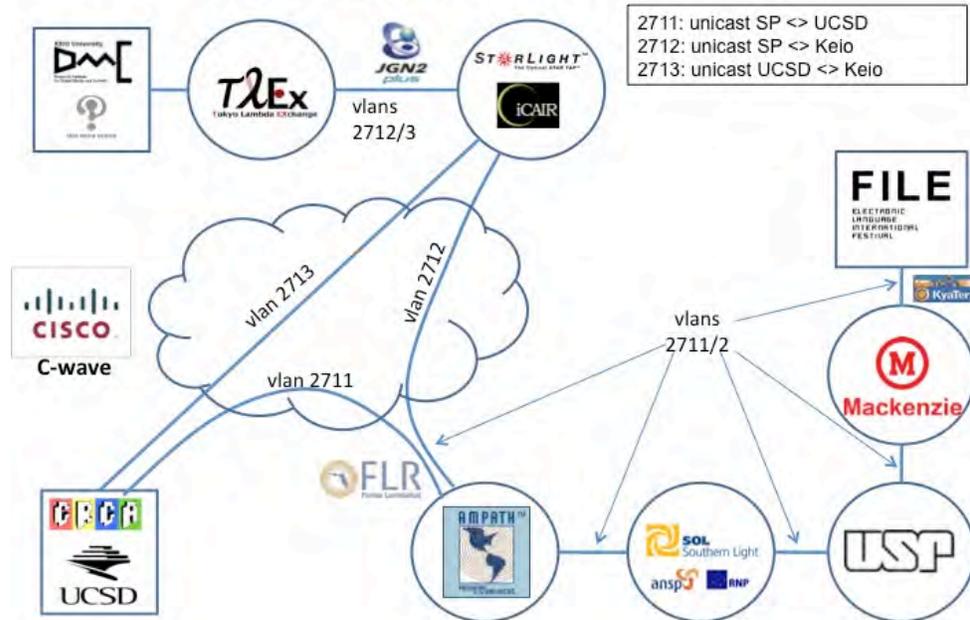


Michael Stanton of the RNP Brazilian network emailed the above photo showing pre-exhibition presentations using the 4K 4-panel screen. Speakers are director Beto Souza (top left), an auditorium view (top right), Keio University (bottom left), and Ramesh Rao at Calit2 (bottom right). The bottom two windows were live videoconference windows, streaming uncompressed HD (about 1.5Gbps).

Below is the network configuration used for this 4K digital cinema demonstration.

Note: While the TransLight/StarLight link was not used, there was much engineering done at StarLight to enable this demonstration. In the future, it will be easy to enable European sites to participate in FILE festivals.

Plan B: unicast VLAN assignments



GLOBUS: WS-VLAM

www.isgtw.org/?pid=1001961
<http://staff.science.uva.nl/~gvlam/wsvlam/>
www.globus.org
www.vl-e.nl

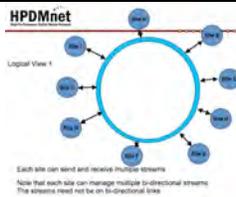
Collaborators:

- The Globus Team; US
- Virtual Laboratory for e-Science (University of Amsterdam, Vrije University, Delft University, AMOLF, NIKHEF, NWO, CWI, TNO); The Netherlands

A new, grid-enabled scientific workflow management system, WS-VLAM (Workflow management System – Virtual Laboratory Abstract Machine), developed by the Virtual Laboratory for e-Science, provides a basic set of tools for building workflows by connecting components to each other based on data dependencies.

The traditional batch processing of grid jobs and workflow execution based on file exchange between the components is not suitable in some scenarios. In contrast, WS-VLAM supports the simultaneous execution of co-allocated processes on the grid, which enables direct data streaming between distributed components, making it highly useful for near real-time distributed applications, such as bio-medical research and online video processing and analysis.

Performance tests indicate that the overhead of WS-VLAM is negligible compared to the standard Globus tool ‘globus-url-copy,’ which uses the GridFTP protocol. It is currently deployed on the Dutch Distributed Supercomputer 3, but WS-VLAM could also be used for any grid (Globus) enabled system.



HPDMnet @ AAAS 2009

www.hpdmnet.org

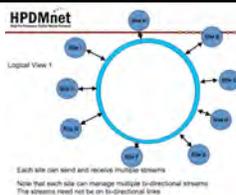
Collaborators:

- CANARIE; Communications Research Centre (CRC); Inocybe; Nortel; Canada
- i2CAT; Barcelona
- StarLight; Northwestern University/International Center for Advanced Internet Research (iCAIR); US
- NetherLight; SARA; SURFnet; University of Amsterdam; The Netherlands

Northwestern University's iCAIR demonstrated its High-Performance Digital Media Network (HPDMnet) by streaming high-resolution digital content from servers in Spain, Canada, the Netherlands and StarLight to displays in the NSF booth at the AAAS 2009 conference, held February 12-16 in Chicago.

HPDMnet is an advanced digital media service that is being designed and developed by an international consortium that has created unique technologies that allow high-performance networks to stream exceptionally high-quality digital media from any source, including cameras, servers, scientific instruments and data repositories. HPDMnet, which is based on a global optical networking facility, can support high-volume digital media streams including individual streams thousands of times larger than those on the "best-effort" Internet.

Below, NSF CISE assistant director Jeanette Wing talks with Joe Mambretti in the NSF booth at AAAS 2009.



HPDMnet @ GLIF 2009

www.hpdmnet.org

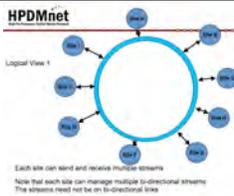
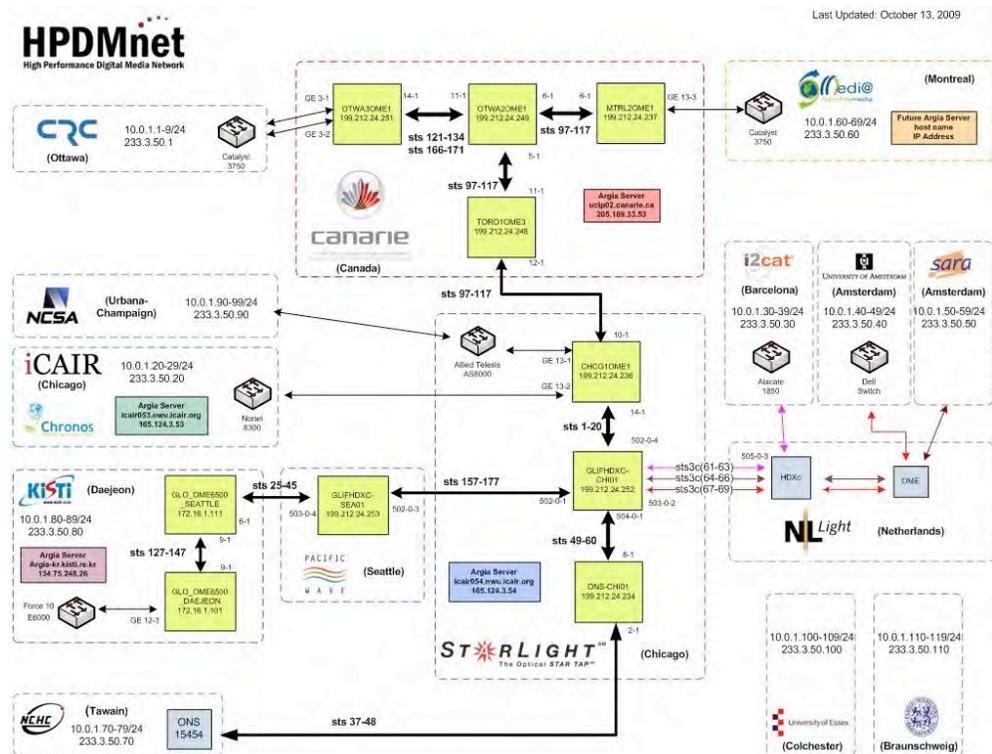
Collaborators:

- CANARIE; Communications Research Centre (CRC); Inocybe; Nortel; Synchronmedia; Laboratory for Multimedia Communication in Telepresence of The Ecole de Technologie Superieure (ETS); Canada
- i2CAT; Barcelona
- Northwestern University/International Center for Advanced Internet Research (iCAIR); National Center for Supercomputing Applications (NCSA) at University of Illinois at Urbana-Champaign; NLR; StarLight; US
- NetherLight; SARA; SURFnet; University of Amsterdam; The Netherlands

- KISTI; KREONet2; Korea
- NCHC; Taiwan
- Networked Media Laboratory, University of Essex; UK
- Technische Universität Braunschweig; Germany

Northwestern University's iCAIR demonstrated its High-Performance Digital Media Network (HPDMnet) by streaming high-resolution digital content from servers in North America (including NCSA) to the GLIF 2009 Workshop, held October 27-28 at KISTI in Daejeon, Korea. The HPDMnet research consortium collaborates on the design, development, and implementation of advanced communication services to support extremely high-resolution digital content.

Note: While transmissions for this particular demo were not sent to/from Europe, past demos have included Europe, and rely on TransLight/StarLight to get there. Network engineering at StarLight facilitates transmission to Asia as well as Europe, as shown in the latest HPDMnet network diagram of all possible connected sites.



HPDMnet @ SC 2009

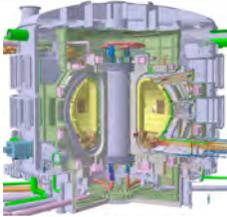
www.hpdmnet.org

Collaborators:

- CANARIE; Communications Research Centre (CRC); Inocybe; Nortel; Synchromedia; Laboratory for Multimedia Communication in Telepresence of The Ecole de Technologie Superieure (ETS); Canada
- i2CAT; Barcelona
- Northwestern University/International Center for Advanced Internet Research (iCAIR); National Center for Supercomputing Applications (NCSA) at University of Illinois at Urbana-Champaign; NLR; StarLight; US
- NetherLight; SARA; SURFnet; University of Amsterdam; The Netherlands

- KISTI; KREONet2; Korea
- NCHC; Taiwan
- Networked Media Laboratory, University of Essex; UK
- Technische Universität Braunschweig; Germany

Members of the HPDMnet Consortium streamed 3D high-resolution visualizations in real time from NCSA, 3D medical imaging streamed from CRC in Canada, a 3D virtual world for nanotechnology science from Northwestern in Chicago, and digital art compositions and live camera streams (showing SAGE on a local tiled display) from Technische Universität Braunschweig in Germany.



ITER Long-Distance Data-Transfer Experiments 2009

www.iter.org

Collaborators:

- University of Tokyo/Data Reservoir project; National Institute of Fusion Science (NIFS); Japan
- StarLight; US
- ITER Institute; Cadarache, France
- *Note: The 7 members of the international ITER project are the People's Republic of China, the European Atomic Energy Community (via EURATOM), the Republic of India, Japan, the Republic of Korea, the Russian Federation and US.*

In June 2009, University of Tokyo's Data Reservoir project and Japan's National Institute of Fusion Science (NIFS) started performing long-distance data transfer experiments between Japan and the ITER Institute in Cadarache, France. This was the first of the series of experiments to establish dedicated network connections for the ITER fusion system.

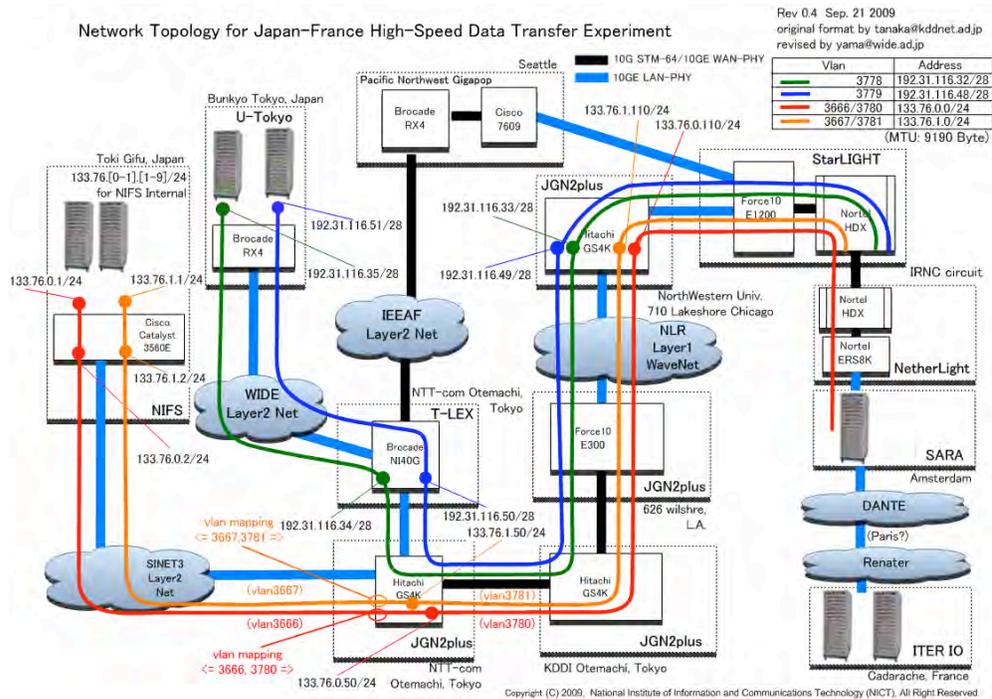
ITER is a large-scale scientific experiment intended to prove the viability of fusion as an energy source, and to collect the data necessary for the design and subsequent operation of the first electricity-producing fusion power plant. Site preparation at Cadarache in Southern France began in January 2007, representing an important first milestone in the 10-year construction process to build ITER.

Beginning June 2009, University of Tokyo's Data Reservoir project and the National Institute of Fusion Science (NIFS) in Japan started performing long-distance data transfer experiments between Japan and the ITER Institute in Cadarache, France. On June 11, 2009, an experiment took place using 1Gbps bandwidth (from Japan to Cadarache via SINET3 to Internet2 to GÉANT2 to RENATER); possible routes were discussed among the various network engineers. Actual bandwidth used was up to 800Mbps, though there was packet loss and the Tokyo/ITER route was not symmetric. After much debugging, errors were fixed.

During September 21-25, 2009, the ITER Data Transfer team conducted data-transfer experiments using 10Gbps from Japan to ITER (Cadarache, France). The objectives of the experiments were to test dynamic control of pacing over the 10Gbps network to reduce packet loss, and to test the feasibility of using small 10Gbps-connected file servers, preferred by scientific users. Results indicate there was considerable packet loss, which the researchers are now investigating.

The network path used in September was SINET (Gifu, where NIFS is located, to Tokyo), JGN2plus (Tokyo to Chicago/StarLight), TransLight/StarLight (Chicago to Amsterdam/NetherLight), GÉANT2 (Amsterdam to Paris), and RENATER (Paris

to Cadarache). A network diagram appears below.



KAUST High-Definition Video Teleconferencing 2009

www.kaust.edu.sa/

www.calit2.net/newsroom/release.php?id=1599

Collaborators:

- KAUST Visualization Team; Saudi Arabia
- Calit2/UCSD; UIC/EVL; US

On October 20, 2009, the new KAUST 10Gbps circuit from Saudi Arabia to NetherLight (Amsterdam) was used for a 3-way high-definition video-teleconference (VTC) among collaborators at KAUST, UCSD and UIC. KAUST data went over a 1Gbps VLAN from KAUST to NetherLight to Chicago via TransLight/StarLight, and then on to UCSD/Calit2 over CAVEwave. The photo below shows the Calit2 meeting room, with images of EVL participants displayed on the left VTC unit and images of KAUST participants displayed on the right.





Large Hadron Collider: Worldwide LHC Computing Grid: STEP'09

www.hpcwire.com/industry/academia/STEP09-Demonstrates-LHC-Readiness-49631242.html

<http://press.web.cern.ch/press/PressReleases/Releases2009/PR11.09E.html>

<http://leg.web.cern.ch/LCG/>

Collaborators:

WLCG combines the IT power of more than 140 computer centers, the result of collaborations among 33 countries.

On July 1, 2009, in preparation for the restart of the Large Hadron Collider (LHC), the Worldwide LHC Computing Grid (WLCG) was used in its first production demonstration involving all key elements – from data taking to analysis. Records of all sorts were established: data taking throughput, data import and export rates between the various Grid sites, as well as huge numbers of analysis, simulation and reprocessing jobs – ATLAS alone ran close to 1M analysis jobs and achieved 6GB/s of Grid traffic, the equivalent of a DVD worth of data a second, sustained over long periods.

This result is particularly timely as it coincides with the transition of grids into long-term sustainable e-infrastructures, clearly of fundamental importance to projects of the lifetime of the LHC. With the restart of the LHC only months away, one can expect a large increase in the number of grid users: from several hundred users today to several thousand when data taking and analysis commences. This can only happen through the significant streamlining of operations and simplification of end-users' interactions with the grid. *Scale Testing for the Experiment Programme '09 (STEP'09)* included massive-scale testing of end-user analysis scenarios, including “community-support” infrastructures, whereby the community is trained and largely self-supporting, backed by a core group of grid and application experts.



Large Hadron Collider: Moving Towards Terabit/Sec Transfers of Scientific Datasets @ SC09

http://media.caltech.edu/press_releases/13309

<http://supercomputing.caltech.edu/>

http://supercomputing.caltech.edu/BWCPressReleaseV8_hbn112509.pdf

Collaborators:

- Caltech/Center for Advanced Computing Research (CACR); U Michigan; Fermi National Accelerator Laboratory (Fermilab); Brookhaven National Laboratory; University of California, San Diego; University of Florida; Florida International University (FIU); US
- CERN
- National University of Sciences & Technology (NUST)/School of Electrical Engineering and Computer Science; Pakistan
- Rio de Janeiro State University (UERJ); University of São Paulo (USP); São Paulo State University (UNESP)/São Paulo Regional Analysis Center (SPRACE); Brazil
- National Institute of Chemical Physics and Biophysics (Estonia)
- Kyungpook National University; Korea

The High-Energy Physics team demonstrated storage-to-storage data transfer over wide-area networks from two racks of servers and a network switch-router on the

SC09 exhibit floor. The demonstration achieved a bidirectional peak throughput of 119Gbps and a data flow of more than 110Gbps that could be sustained indefinitely among clusters of servers on the show floor and at Caltech, Michigan, San Diego, Florida, Fermilab, Brookhaven, CERN, Brazil, Korea, and Estonia.

Following the SC09 Bandwidth Challenge, the team continued its tests and established a world-record data transfer between the Northern and Southern hemispheres, sustaining 8.26Gbps in each direction on a 10Gbps link connecting São Paulo and Miami.

By setting new records for sustained data transfer among storage systems over continental and transoceanic distances using simulated LHC datasets, the HEP team demonstrated its readiness to enter a new era in the use of state-of-the-art cyberinfrastructure to enable physics discoveries at the high-energy frontier, while demonstrating some of the groundbreaking tools and systems they have developed to enable a global collaboration of thousands of scientists located at 350 universities and laboratories in more than 100 countries to make the next round of physics discoveries.

Note: While this demonstration did not use TransLight/StarLight, it leveraged DOE LHCnet investments for international transatlantic connectivity.



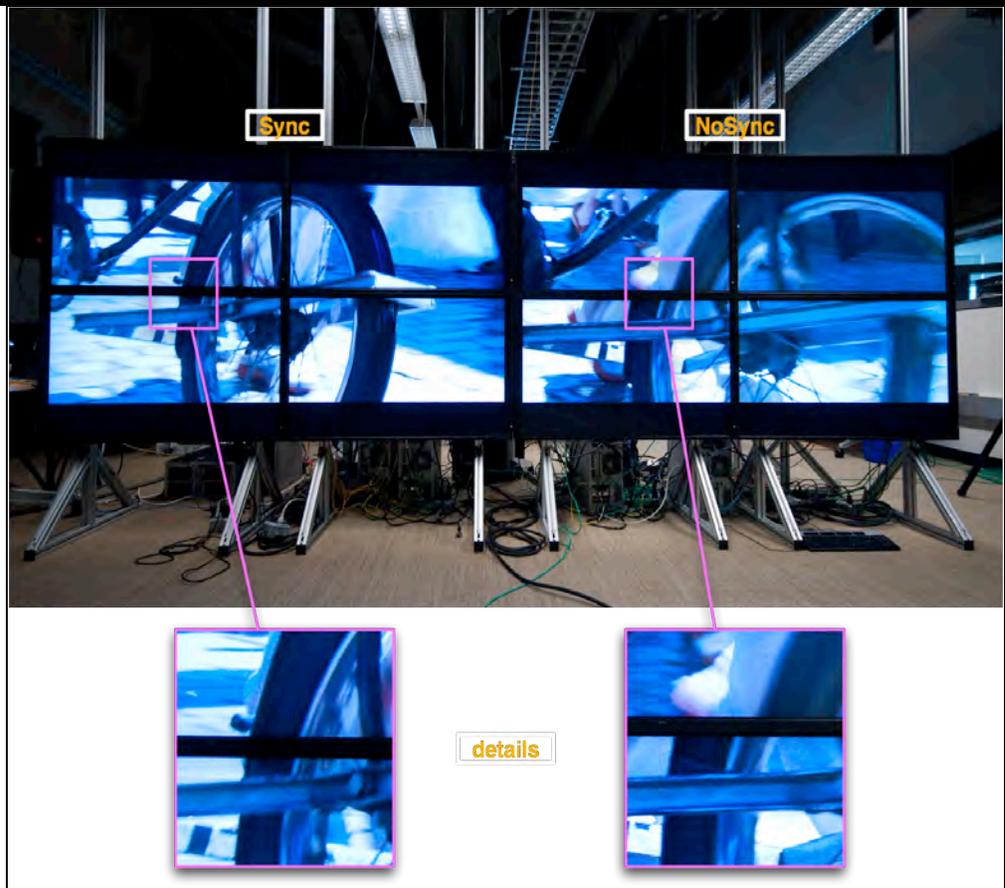
ON*VECTOR: Synchronized Multi-Lane Streaming Using NTT's Terabit Network Interface Card (NIC)

Collaborators:

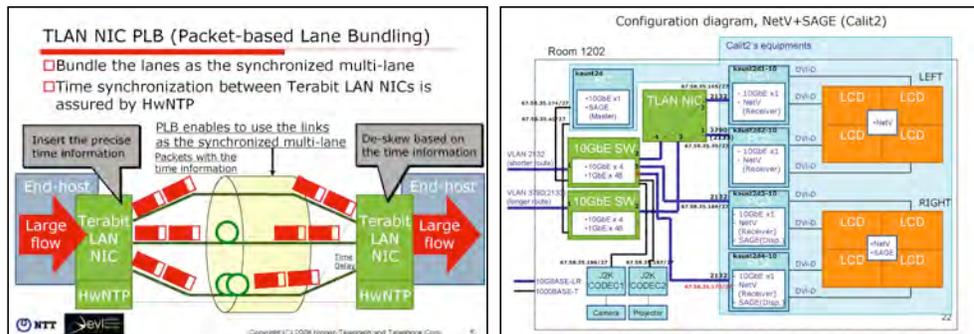
- NTT Network Innovation Laboratories; Keio University/Institute for Digital Media and Content; Japan
- UIC/EVL; Calit2/UCSD; StarLight; IEEAF; US
- CzechLight; CESNET; Czech Republic
- NetherLight; SURFnet; The Netherlands

*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).*

On February 24, 2009, members of the ON*VECTOR team did an experiment that required a diverse 10Gbps path from Japan to San Diego via Europe, which included the IRNC TransLight/StarLight link (network diagram appears below). The goal was to demonstrate NTT research hardware, a Terabit Local Area Network (TLAN) NIC, which synchronizes tiled display animations so that the frames display correctly, regardless of the network paths taken.



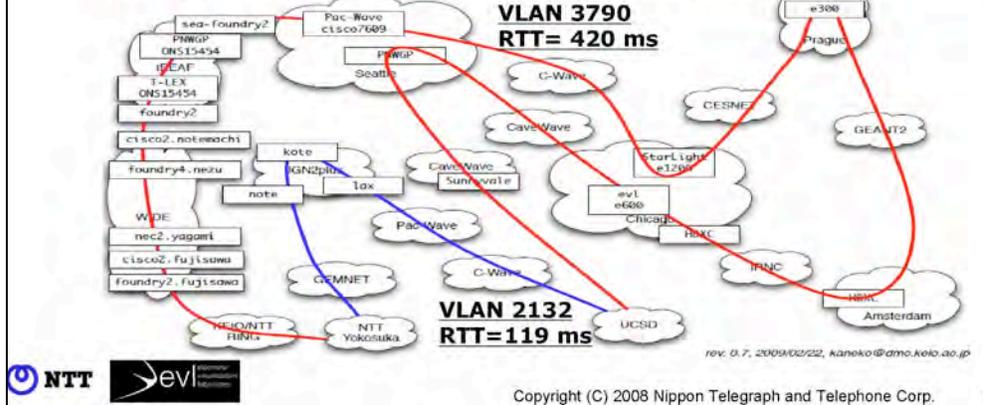
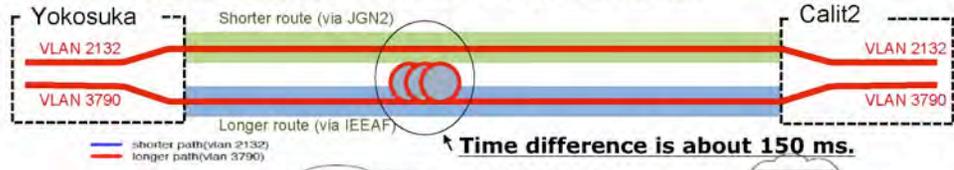
NTT's TLAN NIC Packet-based Lane Bundling (PLB) and EVL's SAGE and NetV (MultiRail-aware networked video) were used to stream tiled images in parallel over two transpacific 10Gbps routes. The photo above shows the same 2x2 animations being sent simultaneously – the 2x2 animation on the left used the TLAN NIC PLB to compensate for a 150ms propagation delay difference; the 2x2 animation on the right did not use it. Below is an illustration of the overall experiment, followed by a schematic of how the equipment was put together.



For the demonstration at the annual ON*VECTOR Photonics Workshop, as shown in the illustration below, two 10Gbps paths were used (a short path, shown in BLUE, and a long path, in RED).

Network configuration

Two VLANs in two different 10G physical routes



Copyright (C) 2008 Nippon Telegraph and Telephone Corp.

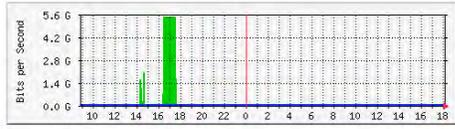
The following MRTG graphs are from February 26.

<p>System: SL-E1200 in Maintainer: Description: TenGigabitEthernet-2/2 CiscoWave 6506 at 750/iCair ifType: ethernetCsmacd (6) ifName: TenGigabitEthernet 2/2 Max Speed: 1250.0 MBytes/s</p> <p>The statistics were last updated Thursday, 26 February 2009 at 18:04, at which time 'SL-E1200' had been up for 133 days, 13:37:05.</p> <p>'Daily' Graph (5 Minute Average)</p> <p>Max In: 5536.6 Mb/s (55.4%) Average In: 565.6 Mb/s (5.7%) Current In: 16.6 kb/s (0.0%) Max Out: 3482.2 Mb/s (34.8%) Average Out: 227.1 Mb/s (2.3%) Current Out: 2384.0 b/s (0.0%)</p> <p>'Weekly' Graph (30 Minute Average)</p> <p>Max In: 7548.6 Mb/s (75.5%) Average In: 593.1 Mb/s (5.9%) Current In: 16.4 kb/s (0.0%) Max Out: 2689.0 Mb/s (26.9%) Average Out: 211.4 Mb/s (2.1%) Current Out: 2520.0 b/s (0.0%)</p> <p>Bandwidth usage from Pacific Wave in Seattle to StarLight over "TransLight," the Cisco Research Wave that is deployed on NLR</p>	<p>System: SL-E1200 in Maintainer: Description: TenGigabitEthernet-10/2 CESNET ifType: ethernetCsmacd (6) ifName: TenGigabitEthernet 10/2 Max Speed: 1250.0 MBytes/s</p> <p>The statistics were last updated Thursday, 26 February 2009 at 18:04, at which time 'SL-E1200' had been up for 133 days, 13:37:06.</p> <p>'Daily' Graph (5 Minute Average)</p> <p>Max In: 963.6 Mb/s (9.6%) Average In: 23.2 Mb/s (0.2%) Current In: 2792.0 b/s (0.0%) Max Out: 5540.8 Mb/s (55.4%) Average Out: 275.3 Mb/s (2.8%) Current Out: 304.5 kb/s (0.0%)</p> <p>'Weekly' Graph (30 Minute Average)</p> <p>Max In: 333.4 Mb/s (3.3%) Average In: 4032.3 kb/s (0.0%) Current In: 2960.0 b/s (0.0%) Max Out: 5441.8 Mb/s (54.4%) Average Out: 276.6 Mb/s (2.8%) Current Out: 308.2 kb/s (0.0%)</p> <p>Bandwidth from StarLight to Prague over CESNET</p>
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System: evl-e600 in
 Maintainer:
 Description: TenGigabitEthernet-2/3 TransLight/StarLight IRNC
 ifType: ethernetCsmacd (6)
 ifName: TenGigabitEthernet 2/3
 Max Speed: 10.0 Gbits/s

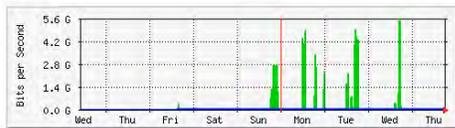
The statistics were last updated **Thursday, 26 February 2009 at 18:10**, at which time 'evl-e600' had been up for **148 days, 19:36:39**.

'Daily' Graph (5 Minute Average)



	Max	Average	Current
In	5462.0 Mb/s (54.6%)	195.5 Mb/s (2.0%)	2208.0 b/s (0.0%)
Out	8712.0 b/s (0.0%)	3816.0 b/s (0.0%)	3680.0 b/s (0.0%)

'Weekly' Graph (30 Minute Average)



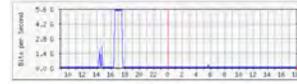
	Max	Average	Current
In	5443.8 Mb/s (54.4%)	287.0 Mb/s (2.9%)	2384.0 b/s (0.0%)
Out	15.8 Mb/s (0.2%)	85.5 kb/s (0.0%)	3608.0 b/s (0.0%)

Bandwidth from NetherLight in Amsterdam to StarLight over the TransLight/StarLight IRNC circuit

System: evl-e600 in
 Maintainer:
 Description: TenGigabitEthernet-1/0 CAVEwave to UCSD (NLR-STAR-SEAT-10GE-6 and NLR-SEAT-SAND-10GE-7)
 ifType: ethernetCsmacd (6)
 ifName: TenGigabitEthernet 1/0
 Max Speed: 10.0 Gbits/s

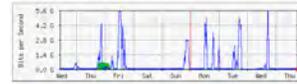
The statistics were last updated **Thursday, 26 February 2009 at 18:10**, at which time 'evl-e600' had been up for **148 days, 19:36:39**.

'Daily' Graph (5 Minute Average)



	Max	Average	Current
In	209.8 Mb/s (2.1%)	531.8 kb/s (0.0%)	8792.0 b/s (0.0%)
Out	5482.0 Mb/s (54.6%)	196.0 Mb/s (2.0%)	3248.0 b/s (0.0%)

'Weekly' Graph (30 Minute Average)



	Max	Average	Current
In	457.5 Mb/s (4.6%)	32.2 Mb/s (0.3%)	4076.0 b/s (0.0%)
Out	5446.9 Mb/s (54.5%)	381.8 Mb/s (3.8%)	3280.0 b/s (0.0%)

Bandwidth from StarLight to UCSD over CAVEwave



SAGE Visualcasting @ SC09

www.tacc.utexas.edu/news/feature-stories/2009/supercomputing-09/

Collaborators:

- Texas Advanced Computing Center (TACC), Dell Computer, US
- University of Queensland, Australia
- SARA, The Netherlands



At SC09, the TACC booth featured *Colt*, a 36-Megapixel tiled display wall powered by a Dell graphics cluster, which enables viewing of very large datasets at high

resolution. Colt was used to display interactive large-scale visualizations computed on and streamed from TACC's *Longhorn*, located at its Austin facility, which is the largest, hardware-accelerated visualization cluster in the world.

SAGE demonstrated Longhorn's large-scale remote visualization and collaboration capabilities. Using SAGE and the TeraGrid's 10Gbps network, visualizations coming off Longhorn were displayed on the Colt wall in the TACC booth on the show floor. In addition, the University of Queensland in Australia streamed uncompressed and DXT-compressed full-HD live camera feeds and visualization streams to the TACC booth using SAGE over AARNet, Pacific Wave, and NLR PacketNet. These streams are also forwarded to the Dell booth and to SARA in the Dutch Research Consortium booth on the show floor.



SAGE Visualcasting: Total Solar Eclipse July 22, 2009

www.astronomy2009.org

<http://eclipse.gsfc.nasa.gov/SEmono/TSE2009/TSE2009.html>

http://en.wikipedia.org/wiki/Solar_eclipse_of_July_22,_2009

Collaborators:

- UIC/EVL; University of Michigan; StarLight; US
- Keio University; JGN2plus; Japan
- SARA; The Netherlands

The total solar eclipse that took place on Wednesday, July 22, 2009 was visible from a narrow corridor through northern India, eastern Nepal, northern Bangladesh, Bhutan, the northern tip of Myanmar, central China and the Pacific Ocean, including the Ryukyu Islands, Marshall Islands and Kiribati.

Within the context of the International Year of Astronomy 2009, researchers at Keio University in Japan coordinated groups to capture the total solar eclipse. HD video (motion-picture XD-CAM) was captured and transmitted in real time from Wuhan and Shanghai, in China, and from Amami, Japan (southern islands), back to Keio University in Tokyo. High-resolution still images were also recorded and transmitted in real time from each location (Nikon D3 with fish-eye lens).

From Keio, HD video was streamed using SAGE streaming software to a SAGE Bridge cluster at StarLight in Chicago (Keio selected and switched the various input streams). SAGE Visualcasting then replicated the HD video streams for viewing at UIC/EVL in Chicago, University of Michigan in Ann Arbor, and SARA in Amsterdam. Uncompressed YUV422 video at ~ 20 fps, with audio, requires a sustained bandwidth of 800Mbps.

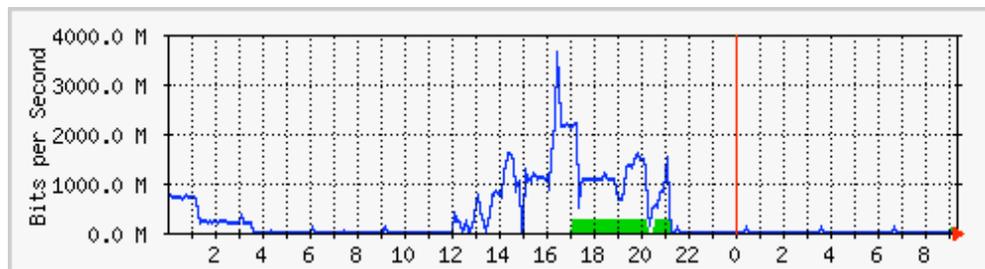
In addition, Keio sent digital still images to a SAGE Bridge cluster at UIC/EVL using Keio's virtual file-system cache, which uses Fuse, where Visualcasting was then used to replicate the still images to displays at UIC/EVL, Michigan and SARA. Images were backed up on EVL's storage system. Uncompressed RGB images at ~1 fps requires a sustained bandwidth of 500Mbps.

Keio also arranged to have the event shown on several dome theaters in Japan and to transmit an Internet video stream as well.

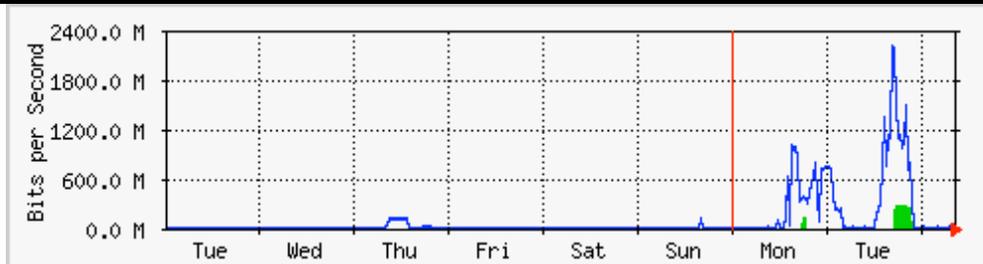


Above is a picture of UIC/EVL's tiled display wall. The fish-eye lens photos sent from Tokyo are displayed in the upper left. The HD video streamed from Tokyo to StarLight, where it is replicated and forwarded to EVL, appears in the lower left. Video feedback of people at SARA viewing the photos and video, being streamed to EVL from Amsterdam in real time, appears in the upper right. (Feedback from Michigan was displayed on a Lifesize teleconferencing system elsewhere in the EVL laboratory.) The following day, Paul Wielinga of SARA sent email stating: "We enjoyed a fantastic eclipse-night with our audience last Wednesday morning...It is always amazing to realize that we are able to view, live, high-resolution images from the other side of the earth as if it is next door... We will get used to this idea, but it still seems a miracle, certainly for most of the people who attended the show."

The TransLight/StarLight CHI/AMS MRTG, for transmitting HD video and still images to SARA in Amsterdam, on the evening of July 21, 2009:



TransLight/StarLight CHI/AMS MRTG for the week of July 15-22, 2009:



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), and Internet2 and GLIF meetings. 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 and SC conferences, 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.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@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 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 current IRNC program soon comes to an end, and NSF is in the process of reviewing proposals for the follow-on IRNC program for the next five years. Because new awards would not be made before the current IRNC ends, NSF OCI wished to provide supplements, equivalent to two months of a project's annual costs, through at least March 31, 2010, to bridge the time period before the new program becomes effective.

The TransLight/StarLight team submitted a request for a supplement in the amount of \$167,000, which was awarded. The current award now terminates July 31, 2010, so the team can continue to support and/or provide guidance and documentation to the new IRNC awardees on transatlantic network services.