

STARLIGHT  
**TRANS LIGHT**

**IRNC INTERNATIONAL NETWORKING 2005-2010**

**Maxine D. Brown**

**Electronic Visualization Laboratory  
UNIVERSITY OF ILLINOIS AT CHICAGO (UIC)  
maxine@uic.edu**

**Thomas A. DeFanti**

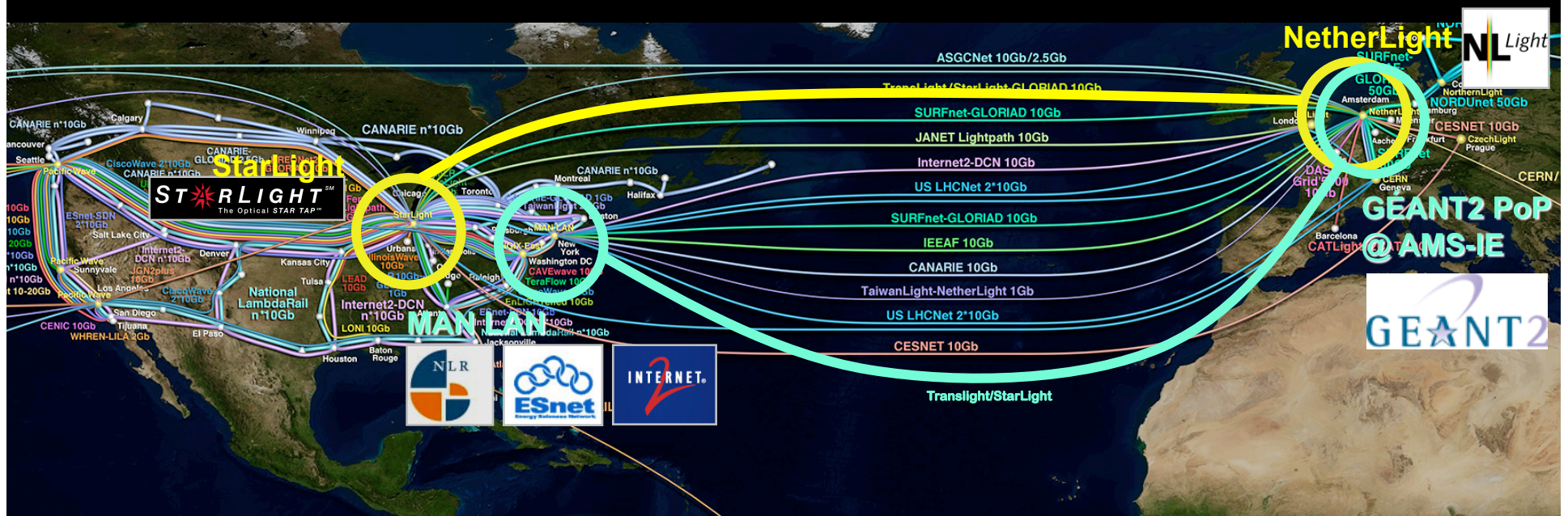
**UIC Electronic Visualization Laboratory  
UCSD Calit2**

**October 15, 2008**

**[www.startap.net/translight](http://www.startap.net/translight)**



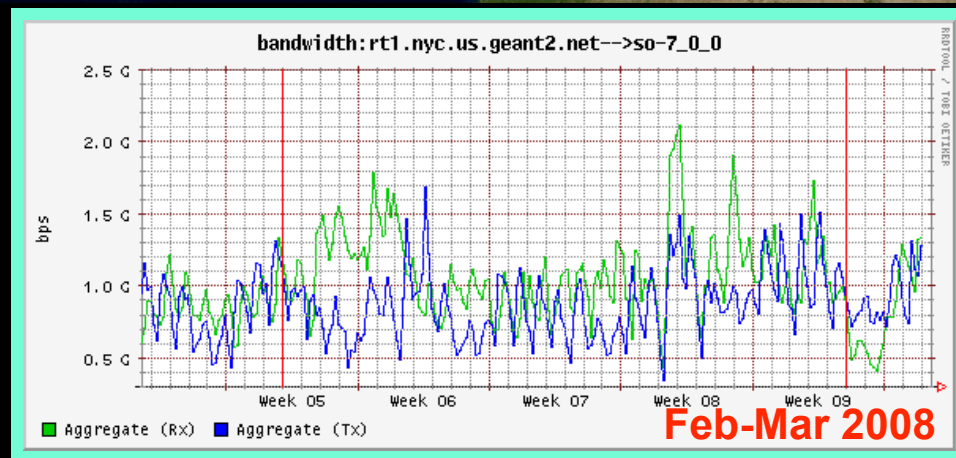
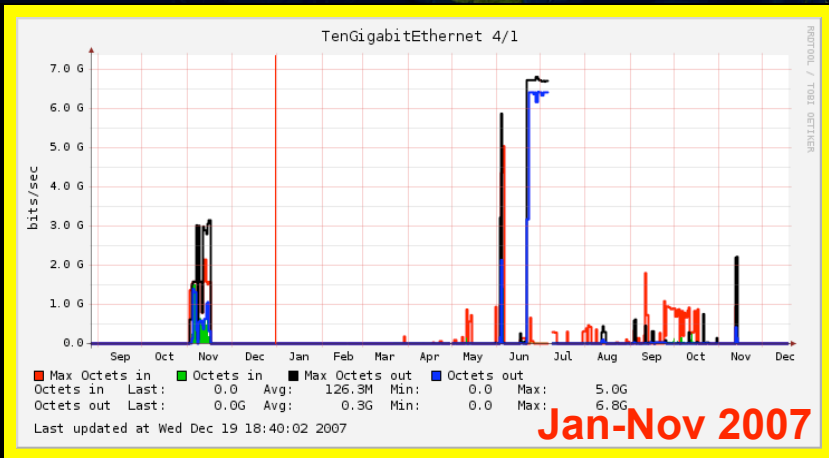
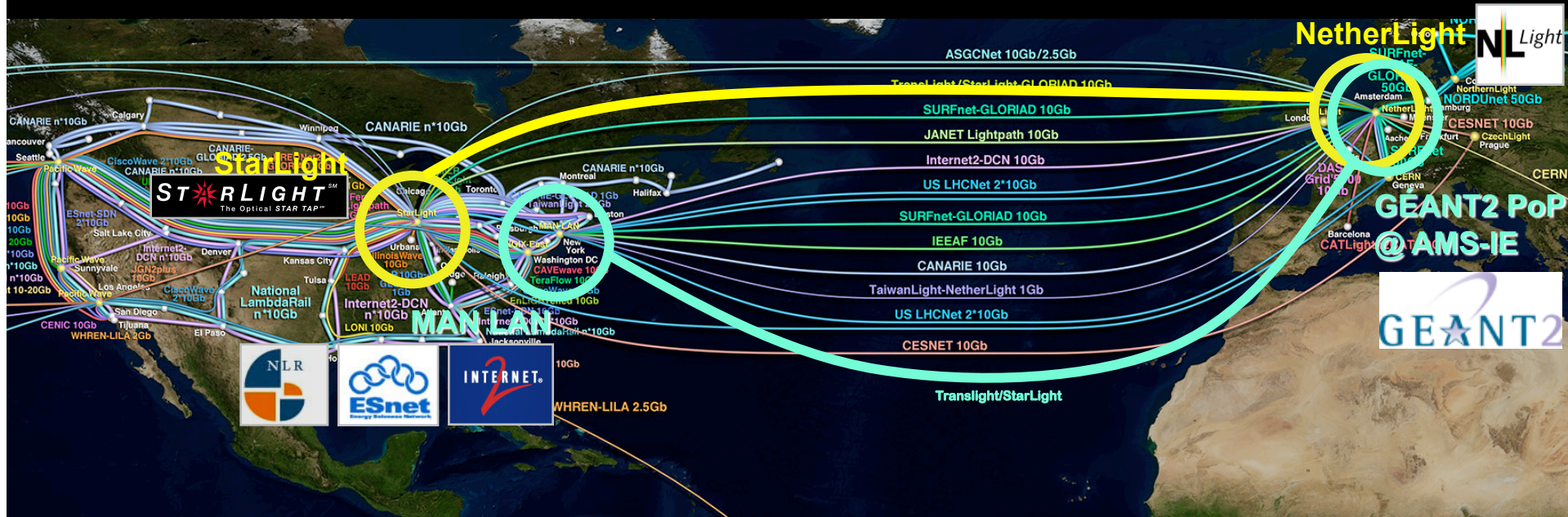
# TransLight/StarLight Funds Two Trans-Atlantic Links



- OC-192 routed connection between MAN LAN in New York City and the Amsterdam Internet Exchange that connects the USA Internet2, ESnet and NLR networks to the pan-European GÉANT2 network
- OC-192 switched connection between NLR and the Regional Optical Networks (RONs) at StarLight and optical connections at NetherLight; part of the Global Lambda Integrated Facility (GLIF) fabric



# TransLight/StarLight Funds Two Trans-Atlantic Links



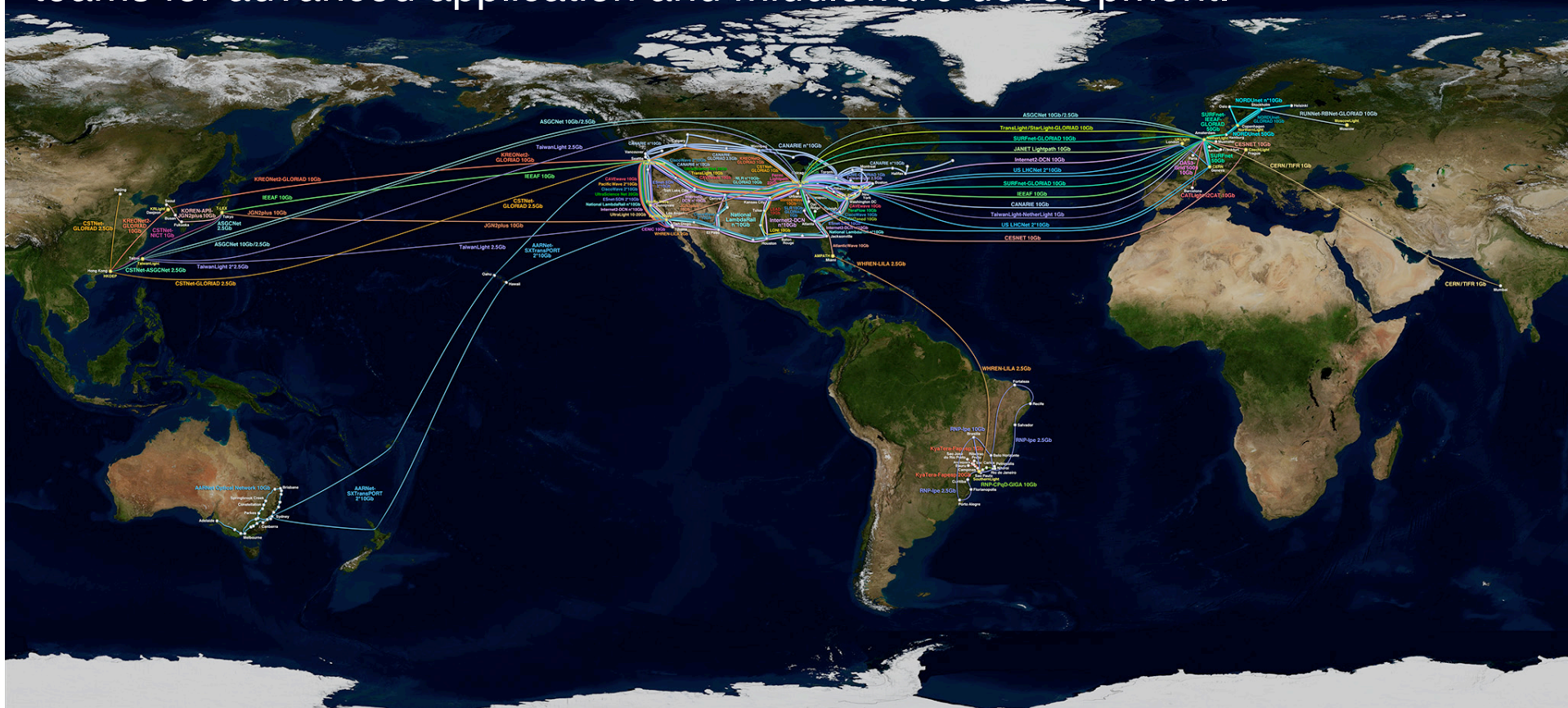
[www.startap.net/translight/pages/measurement.html](http://www.startap.net/translight/pages/measurement.html)





# TransLight/StarLight Participates in the Global Lambda Integrated Facility (GLIF)

GLIF is a consortium of institutions, organizations, consortia and NRENs who share expertise and excess optical network capacity with global research teams for advanced application and middleware development.



GLIF Map 2008: Global Lambda Integrated Facility Visualization by Robert Patterson, NCSA, University of Illinois at Urbana-Champaign Data Compilation by Maxine D. Brown, University of Illinois at Chicago Earth Texture, visibleearth.nasa.gov

www.glif.is



www.glif.is





# TransLight/StarLight Collaborates with Other IRNC Initiatives

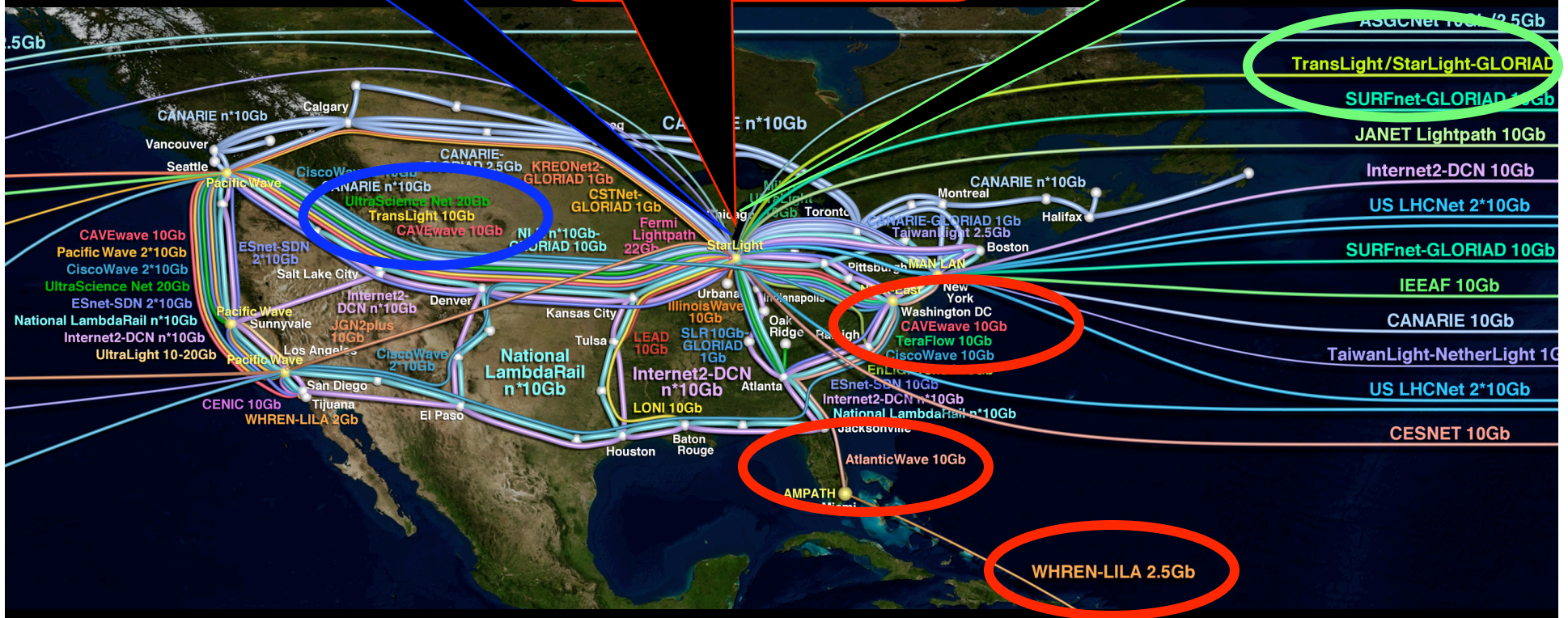
Connect to TransLight/PacificWave in Seattle via TransLight (Cisco Research Wave deployed on NLR)



With US HEP/LHC researchers, do trials to move multi-gigabit traffic between CERN and Brazil (Geneva to Amsterdam; via TransLight/StarLight to Chicago; via CAVEwave to DC; via AtlanticWave to Miami; via WHREN-LILA to Brazil)



Provide GLORIAD with bandwidth to support multi-gigabit US traffic to partners in Russia, Netherlands, Nordic countries





# TransLight/StarLight

## Goals and Objectives

- Develop and leverage today's network infrastructure to meet current and anticipated research needs
  - Provide production links between the US and Europe
  - Support advanced science and engineering network requirements
- Enable scientific researchers and network engineers to engage in system and technology demonstrations and rigorous experimentation

## Accomplishments and Milestones

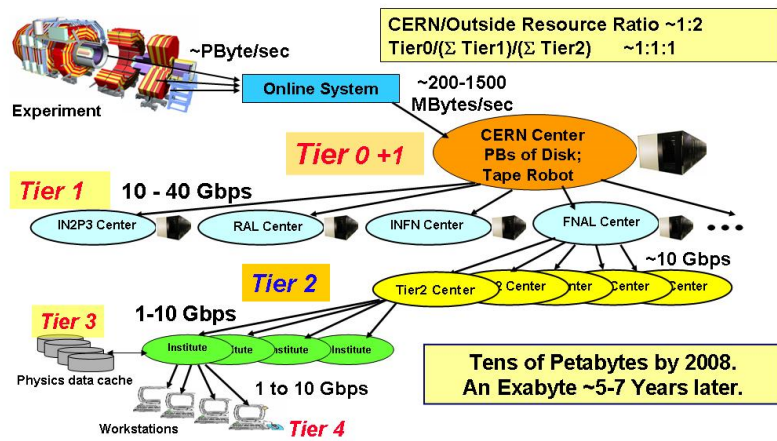
- Identify and support international applications, both production and experimental
- Assure that international network services are similar to and interconnect with those offered by US Research & Education Networks
- Share network engineering tools and best practices
- Prepare documentation
- Participate in conferences :-)

---

# Applications sampling...

# Large Hadron Collider (LHC) and Worldwide LHC Computing Grid (WLCG)

## LHC Data Grid Hierarchy:



**Emerging Vision: A Richly Structured, Global Dynamic System**



*Collaborating LHC Tier1 Centers:*  
Canada, France, Germany, Italy, Netherlands, Nordic countries, Spain, Taiwan, UK, USA

*Collaborating LHC Tier2 Centers:*  
Australia, Austria, Belgium, Brazil, China, Czech Republic, Finland, France, Germany, India, Israel, Italy, Japan, Norway, Pakistan, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Taiwan, UK, Ukraine, US

LHC data is currently transported from CERN over dedicated 10Gbps lightpaths to Tier1 sites across the globe. Traffic from Tier1 centers to Tier2 data analysis centers flows over shared international Research & Education networks.

USLHCNet, funded by Caltech (under a DOE/HEP grant) and CERN, consists of a set of 10Gbps links interconnecting CERN, MAN LAN in New York and StarLight in Chicago, and peers with ESnet, Internet2 and National LambdaRail.

TransLight/StarLight also carries LHC traffic.

[www.cern.ch/LHC/](http://www.cern.ch/LHC/)  
<http://lhcnnet.caltech.edu/>  
<http://lcg.web.cern.ch/LCG>

Data Grid diagram:  
Harvey Newman

their home institutions.





# OptIPuter

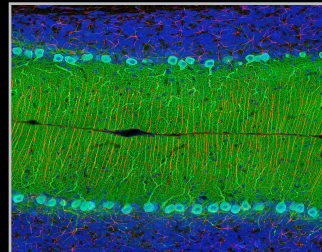
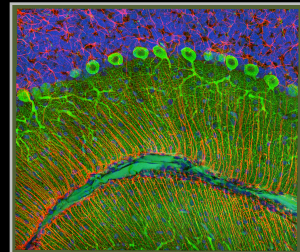
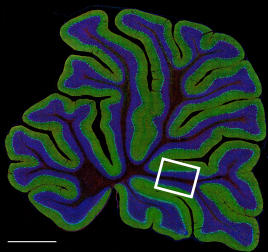
## Enabling Users with Gigabyte Data Objects



- NSF-funded OptIPuter (2002-2008) research initiative was an effort to develop cyberinfrastructure for *real-time collaboration, visualization and analysis of very-large 2D /3D datasets* for geoscience and bioscience
- OptIPuter examined a new model of computing where optical networks were no longer a bottleneck, but the *backplane*, of a global computer:
  - Guaranteed Bandwidth (data movement)
  - Guaranteed Latency (visualization/collaboration, data analysis)
  - Guaranteed Scheduling (remote instruments)

### OptIPuter Partners

- University of California, San Diego
- University of Illinois at Chicago
- University of California, Irvine
- San Diego State University
- University of Southern California
- NCSA
- Northwestern
- Texas A&M
- University of Michigan
- Purdue University
- USGS
- NASA
- CANARIE, Canada
- CRC, Canada
- SARA, Netherlands
- Univ of Amsterdam, Netherlands
- KISTI, Korea
- AIST, Japan



<http://ncmir.ucsd.edu>  
[www.optiputer.net](http://www.optiputer.net)



# OptIPanet Collaboratory Enabling Data-Intensive e-Science



While OptIPuter funding has ended, international user communities continue to want to acquire and/or contribute to OptIPuter developed tools and technologies – to handle the *scalability and complexity of scientific data*, and to *enable collaborations among global virtual organizations*.

GIST, Korea

Michigan



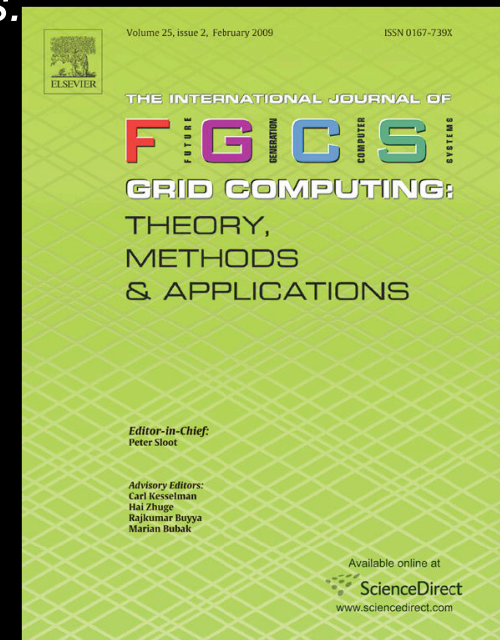
KISTI, Korea

Chicago

SARA, Netherlands



SAGE software, developed by UIC/EVL for OptIPuter, supports global collaborative research, development and education. Shown here, five sites streaming *compressed HD video* (~600Mb per stream) using “SAGE Visualcasting” to replicate streams



“OptIPanet: The OptIPuter global collaboratory” – special section of Future Generations Computer Systems, Volume 25, Issue 2, February 2009



[www.evl.uic.edu/cavern/sage](http://www.evl.uic.edu/cavern/sage)





# e-Very Long Baseline Interferometry (eVLBI) Real-Time Correlation

2008: Africa and the Americas

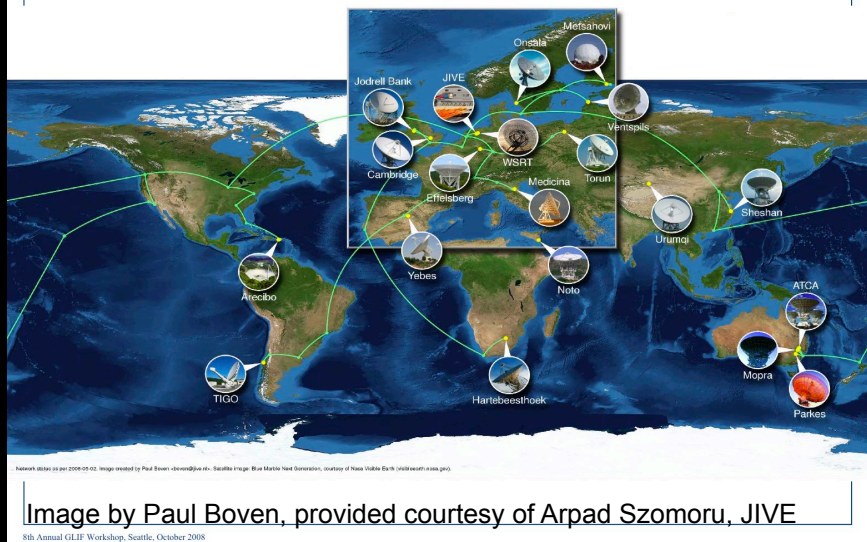


Image: JIVE



## Participating Telescopes:

- Arecibo, Puerto Rico
- Transportable Integrated Geodetic Observatory (TIGO), Chile
- Effelsberg, Germany
- Medicina, Italy
- Westerbork, The Netherlands
- Hartbeesthoek, South Africa
- Onsala, Sweden

On May 22, 2008, EXPReS (Express Production Real-time e-VLBI Service) project members simultaneously linked seven telescopes in Africa, Europe, North America and South America to JIVE, the central data correlator in The Netherlands, simulating a telescope ~11,000 kilometers in diameter. Data was correlated in real time and results were sent to Belgium, as part of a live demonstration at the TERENA Conference 2008.

Data from seven telescopes was routed across numerous networks and exchanges, including: AtlanticWave, AMPATH, Centennial, DFN, GÉANT2, Internet2, SURFnet/NetherLight, NGIX, RedCLARA, Reuna, SANReN, TransLight/StarLight and TENET. Data was transferred from Hartbeesthoek and TIGO at 64Mbps, and at 256Mbps from all other stations. TransLight/StarLight carried Arecibo traffic.

[www.expres-eu.org](http://www.expres-eu.org)

[www.expres-eu.org/TERENA08\\_networking.html](http://www.expres-eu.org/TERENA08_networking.html)

[www.expres-eu.org/TERENA08\\_science.html](http://www.expres-eu.org/TERENA08_science.html)





# Distributed Classroom Instruction

Thomas Sterling of Louisiana State University, Center for Computation and Technology, teaches the class “High-Performance Computing (HPC): Concepts, Methods and Means” – to reverse the trend of too few college graduates entering the HPC workforce as demand increases.

In Spring 2007, he taught the first course in the US to use *uncompressed* high-definition (HD) video streaming (1.5Gb) for distributed classroom instruction.

HPC technologies are both the subject and the enabler of this virtual classroom – enabling the distribution of material at a level of quality over great distances.



## *Participating Institutions:*

- Louisiana State University
- Louisiana Tech University
- University of Arkansas
- MCNC, North Carolina
- Masaryk University, Czech Republic



[www.cct.lsu.edu/csc7600/](http://www.cct.lsu.edu/csc7600/)



# Who Else Uses TransLight/StarLight? You Probably Do!



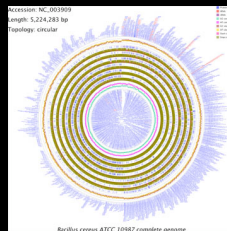
ALMA: Atacama Large Millimeter Array  
[www.alma.nrao.edu](http://www.alma.nrao.edu)



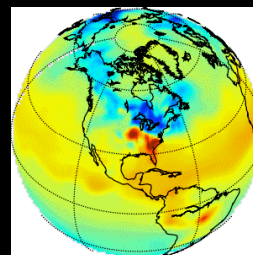
ANDRILL: Antarctic Geological Drilling  
[www.andrill.org](http://www.andrill.org)



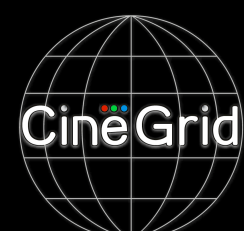
BIRN: Biomedical Informatics Research Network  
[www.nbirn.net](http://www.nbirn.net)



CAMERA metagenomics  
[camera.calit2.net](http://camera.calit2.net)



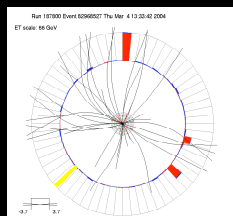
Carbon Tracker  
[www.esrl.noaa.gov/gmd/ccgg/carbontracker](http://www.esrl.noaa.gov/gmd/ccgg/carbontracker)



CineGrid  
[www.cinegrid.org](http://www.cinegrid.org)



Comprehensive Large-Array Stewardship System  
[www.class.noaa.gov](http://www.class.noaa.gov)



D0 (DZero)  
[www-d0.fnal.gov](http://www-d0.fnal.gov)



GEON: Geosciences Network  
[www.geongrid.org](http://www.geongrid.org)



GLEON: Global Lake Ecological Observatory Network  
[www.gleon.org](http://www.gleon.org)



Globus Alliance  
[www.globus.org](http://www.globus.org)



Pacific Rim Applications and Grid Middleware Assembly  
[www.pragma-grid.net](http://www.pragma-grid.net)



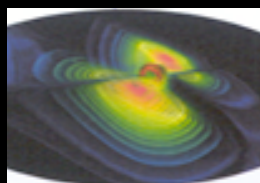
ISS: International Space Station  
[www.nasa.gov/station](http://www.nasa.gov/station)



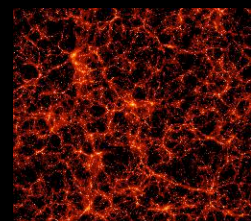
International Wheat Genome Sequencing Consortium  
[www.wheatgenome.org](http://www.wheatgenome.org)



IVOA: International Virtual Observatory  
[www.ivoa.net](http://www.ivoa.net)



LIGO: Laser Interferometer Gravitational Wave Observatory  
[www.ligo.org](http://www.ligo.org)



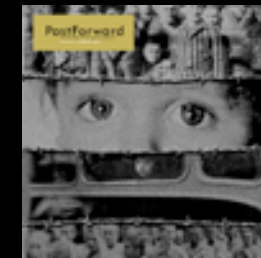
Marenstrum Numerical Cosmology Project  
[astro.ft.uam.es/marenstrum](http://astro.ft.uam.es/marenstrum)



Sloan Digital Sky Survey  
[www.sdss.org](http://www.sdss.org)



TeraGrid  
[www.teragrid.org](http://www.teragrid.org)



USC Shoah Foundation Institute  
[college.usc.edu/vhi/](http://college.usc.edu/vhi/)



---

# Brief History...

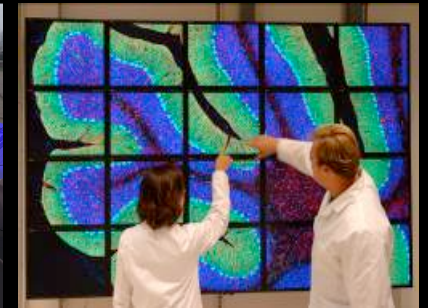
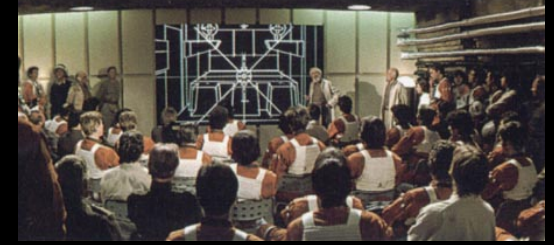
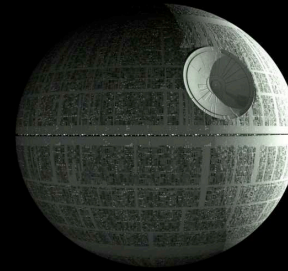


# Electronic Visualization Laboratory

## University of Illinois at Chicago



- Established in 1973
- Directors: Jason Leigh, Tom DeFanti, Dan Sandin (emeritus)
- 10 full-time staff
- Interdisciplinary CS, Art, Biomedical, Communications Departments, working in partnership with universities, research labs, non-profit organizations and industry.
- Currently 15 funded students
- Research in:
  - Advanced Display Instruments
  - Visualization and Simulation, Collaboration, Human-Computer Interaction
  - High-Speed Networking
  - International Network Infrastructure



**Major network user since 1992!**



[www.evl.uic.edu](http://www.evl.uic.edu)

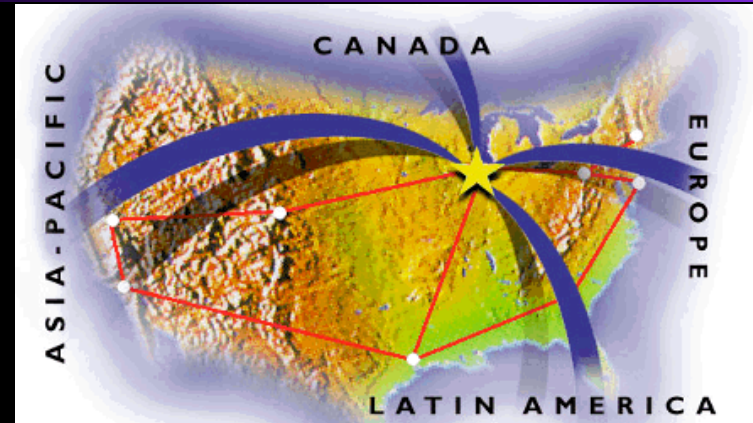


# Electronic Visualization Laboratory

## University of Illinois at Chicago

# STAR TAP<sup>SM</sup>

1997 NSF supported STAR TAP – persistent infrastructure to facilitate the long-term interconnection and interoperability of advanced international networking.



# Euro-Link<sup>SM</sup>

- 1997 NSF announced the High Performance International Internet Services (HPIIS) program – initially funding Euro-Link, TransPAC and MIRnet (now GLORIAD), and ultimately AMPATH.
- 1999 NSF HPIIS award to UIC for Euro-Link – with four charter NRNs: Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden), Netherlands, France and Israel, and CERN joining mid-year as the fifth member



[www.startap.net](http://www.startap.net)

STARLIGHT  
TRANS LIGHT



# StarLight



2001 – present

- StarLight is the largest 1 GE and 10 GE optical exchange for research and education networks
- StarLight is a **research-friendly co-location facility** with space, power and fiber available to university and national/international network collaborators
- StarLight provides an optical infrastructure and **proving ground** for network services optimized for high-performance applications

StarLight is a collaboration of UIC, Northwestern University, Argonne National Laboratory, in partnership with CANARIE/Canada and SURFnet/Netherlands, with support from NSF/OCI and DOE



Northwestern University's  
Chicago downtown campus



[www.startap.net/starlight](http://www.startap.net/starlight)





# EVL Sponsors and Collaborators

- *TransLight/StarLight Partners/Collaborators:* UIC, Northwestern University, Argonne National Laboratory, SURFnet, CANARIE, Internet2, DANTE/GÉANT2, ESnet, National LambdaRail, GLORIAD, TransLight/PacificWave, WHREN-LILA, GLIF
- TransLight/StarLight is made possible by NSF cooperative agreement OCI-0441094 to University of Illinois at Chicago (UIC)
- OptIPuter funded by NSF award OCI-0225642 to UCSD
- StarLight funded by NSF OCI-0229642 to UIC and Northwestern
- Equipment instrumentation development funded by NSF awards CNS-0224306 and CNS-0420477 to UIC
- Additional UIC funding provided by
  - State of Illinois I-WIRE Program, and major UIC cost sharing
  - Northwestern University for facility space, engineering and management
- NSF/OCI and US DoE/Argonne National Laboratory for StarLight and I-WIRE network engineering and design
- Kees Neggers, SURFnet, and Bill St. Arnaud, CANARIE, for networking leadership
- Larry Smarr of Calit2 for I-WIRE and OptIPuter leadership