

GLORIAD/Taj: Update



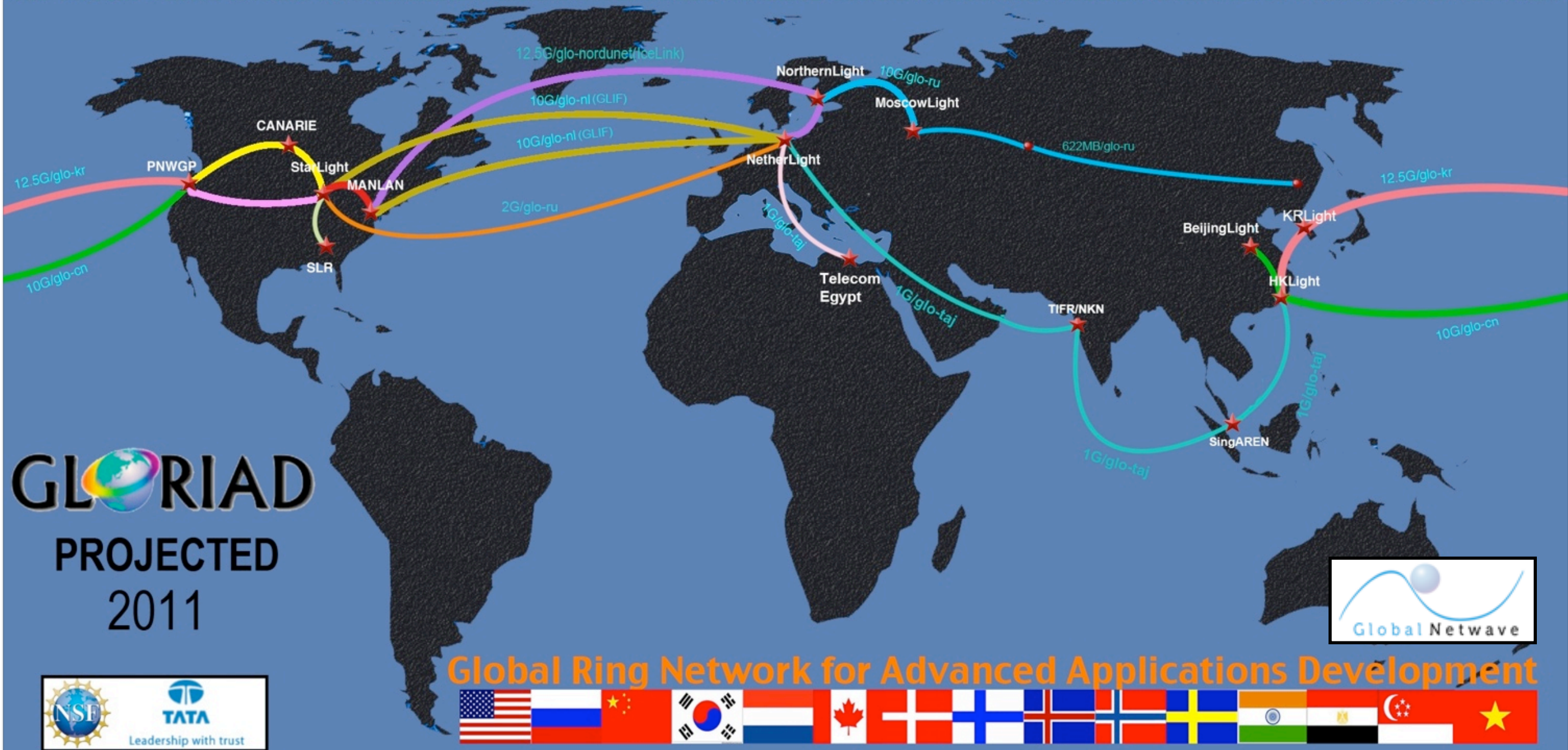
Greg Cole
Principal Investigator
US GLORIAD
gcole@gloriad.org

Co-Chair (Global project): Kees Negggers

Co-PIs (NSF project): Dongkyun Kim, Jerry Sobieski, Jun Li

Global Ring Network for Advanced Applications Development (GLORIAD)

USA-RUSSIA-CHINA-KOREA-NETHERLANDS-CANADA-DENMARK-FINLAND-ICELAND-NORWAY-SWEDEN-INDIA-EGYPT-SINGAPORE-VIETNAM

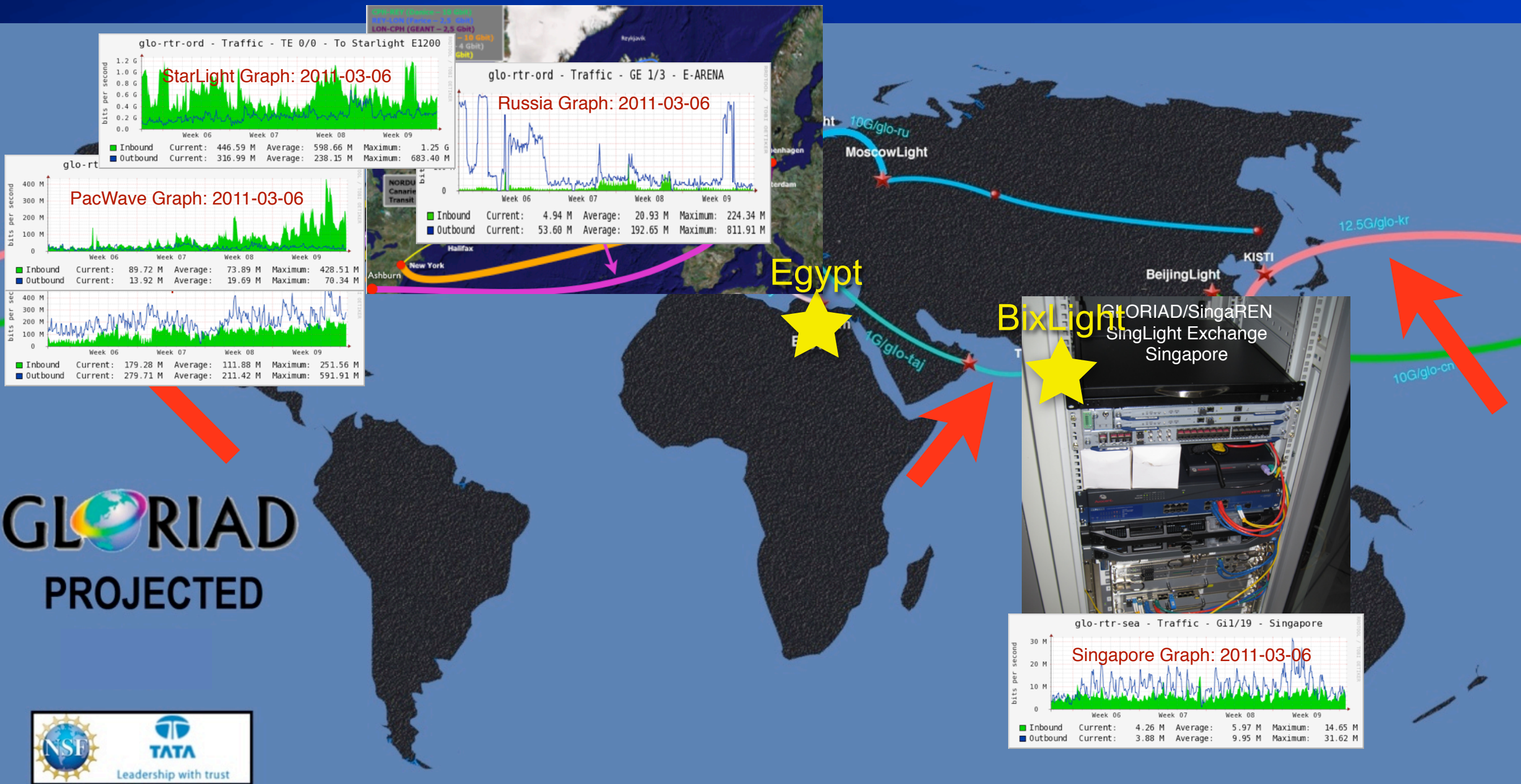


Partners: SURFnet, NORDUnet, CSTnet (China), e-ARENA (Russia), KISTI (Korea), CANARIE (Canada), SingaREN, ENSTInet (Egypt), Tata Inst / Fund Rsrch/Bangalore Science Community, NLR/Internet2/NLR/NASA/FedNets, CERN/LHC

Sponsors: US NSF (\$18.5M 1998-2015), Tata (\$6M), USAID (\$7.5M 2011-2015) all Intl partners (~\$220M 1998-2015)

History: 1994 Friends and Partners; 1996 Civic Networking; 1997 US-Russia MIRnet; 2004 GLORIAD; 2009 GLORIAD/Taj; 2011 GLORIAD/Africa

Transition from 2009 to 2011



Thank you GLORIAD/Taj-U.S. Team



Susie Baker
Research Leader



Predrag Radulovic
Chief Network Engineer



Anita Colliatie
Assistant Director



Kim Summerfield
Program Manager



Lyn Prowse-Bishop
Executive Assistant



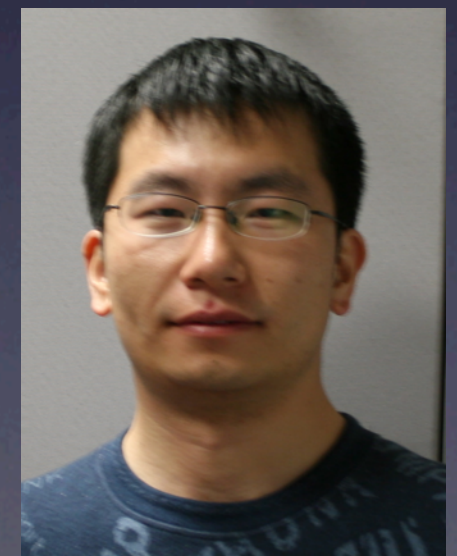
Harika Tandra
Software Engineer



Greg Cole
Principal Investigator



Hui Li
Visiting Engineer, CNIC



Zhang Lei
Visiting Engineer, CNIC

Thank you GLORIAD/Taj-U.S. Team

Graduate Research Assistants



Naveen Vallabhaneni



Ashwini Chegus



Nate Freeman



Kartheek Bodanki



Anuradha Bulusu



Krishna Chaitanya

Update

- 🌐 Infrastructure
- 🌐 Measurement/Monitoring
- 🌐 dvNOC
- 🌐 Social Media/Zeeba

Infrastructure Update

- Korea-China-US Circuit upgraded to 12.5G (2010)
- China-US circuit upgraded to 10G (2010)
- US-Russia circuit upgraded to 1G (2010)
- New US-Nordic 10G link added to IceLink (operational August 2011)
- First Egypt/Africa-Amsterdam-US R&E to be operational September 20, 2011
- New circuit from Bangalore-Singapore-Hong Kong-Seattle awaiting local connect in Bangalore



GLORIAD AFRICA

GLORIAD–Africa:
Connecting Science and Education
across the Continent and
around the Globe

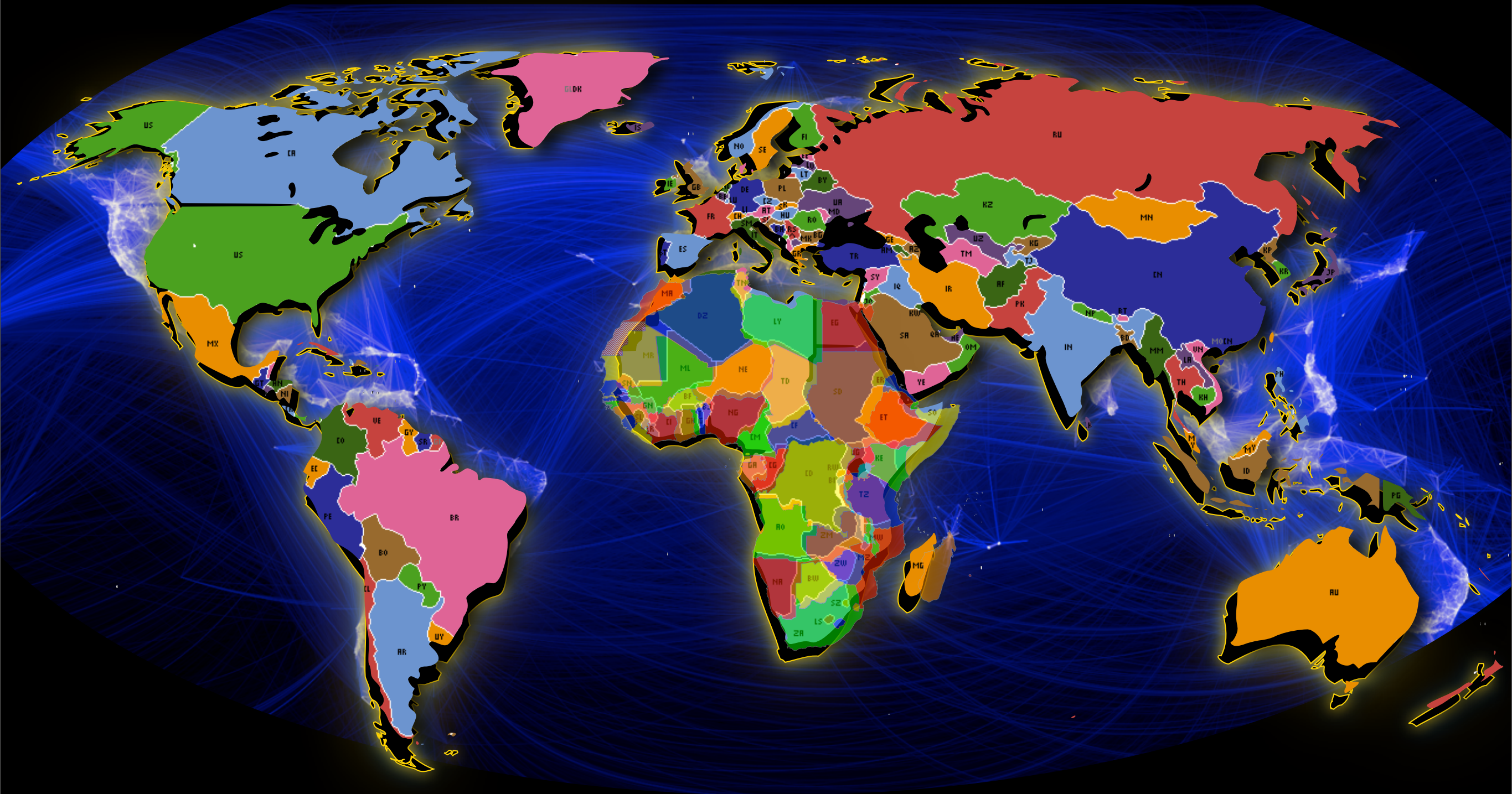
A Egypt–US Science and
Education Cyberinfrastructure
Program and Facility in
Cairo, Egypt

Towards a Knowledge-Enabled & Community-Empowered Continent



GLORIAD in Africa

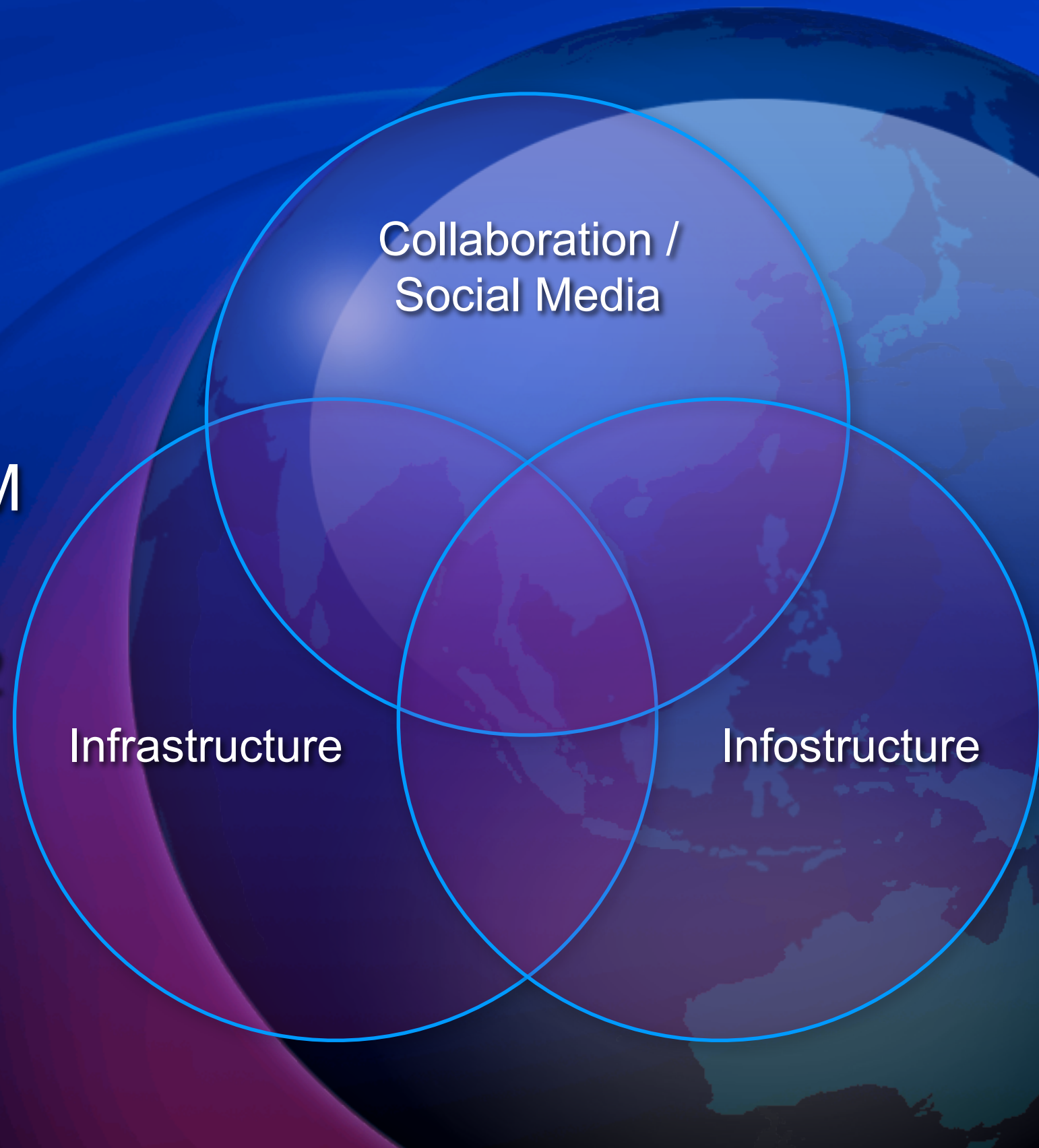
Towards a Knowledge-Enabled and Community-Empowered Continent



See: <http://www.facebook.com/notes/facebook-engineering/visualizing-friendships/469716398919>

GLORIAD in Africa Program Emphasis

- Began 9/1/2011
- \$3.5M for 2 years
(being mod'd to \$7.5M
for 5 years)
- 5 new (FTE) staff (1/2
Graduate student)
starting 9/19/2011



Measurement/Monitoring Update



Picture of GLORIAD/Taj new “nprobe” network measurement device. Hardware: Dell PowerEdge R410 Server - 8 core intel processor, 10GE Intel Fiber Card. Network utilization and performance measurement box - at 10G line speed designed to improve and extend open source nprobe netflow emitter software, emit extended netflow records including detailed information of packet retransmissions.



The two screenshots above illustrate data generated from the Taj project’s new “nprobe” boxes deployed in Chicago and Seattle. The first illustrates top flows on the network; the second illustrates large flows suffering from poor performance (i.e., high packet retransmits). This data was formerly generated from GLORIAD’s packeteer system.



FermiLab (Chicago)

Fermi National Accelerator Laboratory advances the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified researchers to conduct basic research at the frontiers of high energy physics and related disciplines.

Host name

*.fnal.gov

Country

United States

Country Code

US

Region

Illinois

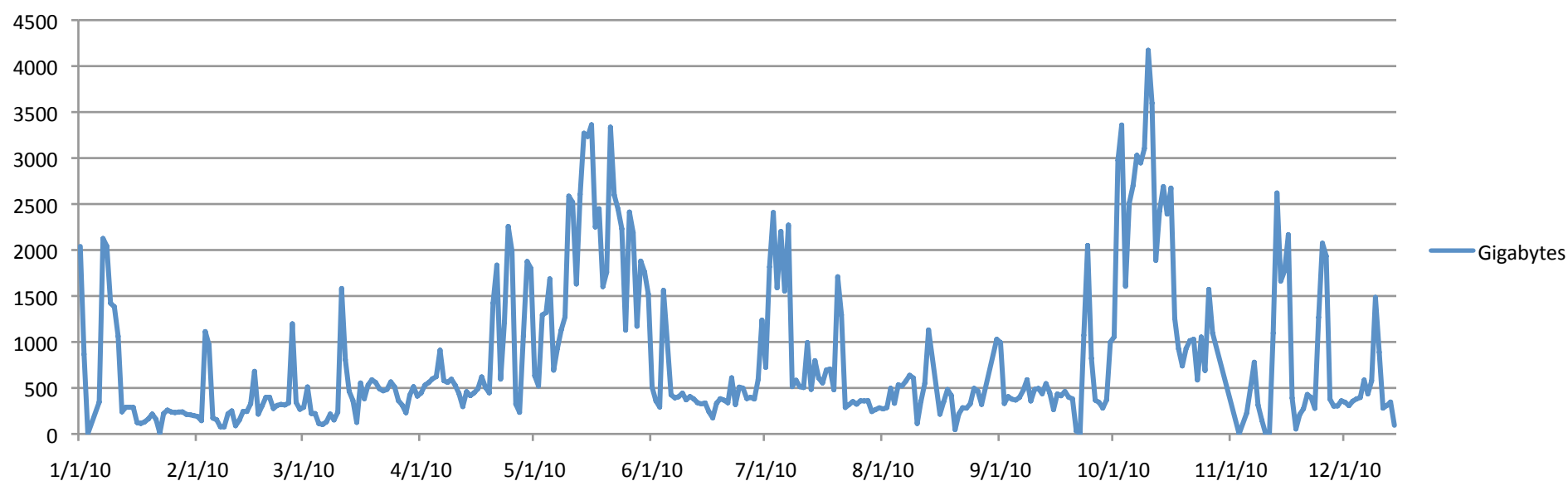
City

Batavia

#1 largest provider of
data across
GLORIAD (~270
Terabytes in 2010)

See: <http://www.fnal.gov/>

Gigabytes Tranferred per Day



The background of the entire page is a large, stylized image of Earth from space, showing continents and clouds. At the top, there is a horizontal banner with a blue background. On the left side of the banner, the word "MODIS" is written in large, white, bold, sans-serif capital letters. On the right side of the banner, the word "Web" is written in large, white, bold, sans-serif capital letters. The banner is flanked by satellite imagery of Earth's surface.

MODIS

Web

USGS MODIS Repository of Earth Satellite Imagery

MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths (see MODIS Technical Specifications). These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere. **MODIS is playing a vital role in the development of validated, global, interactive Earth system models able to predict global change accurately enough to assist policy makers in making sound decisions concerning the protection of our environment.**

Host name

e4ftl01.cr.usgs.gov

Country

United States

Country Code

US

Region

South Dakota

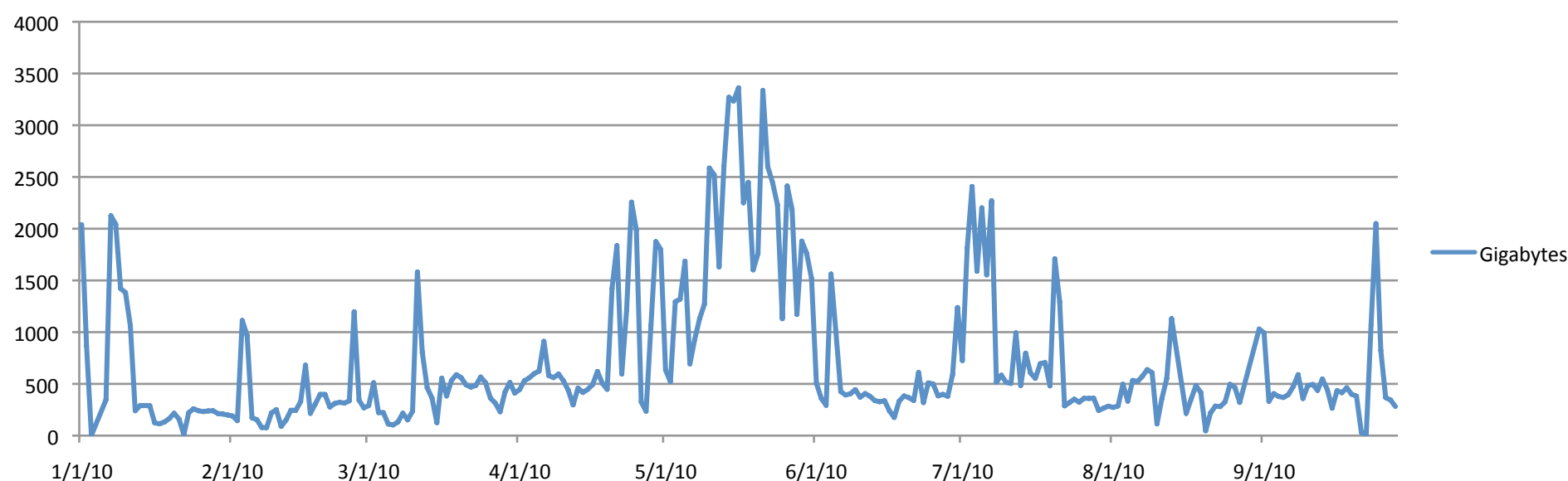
City

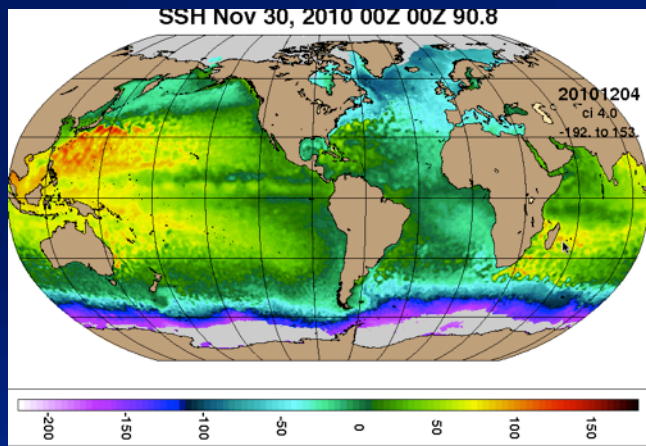
Sioux Falls

#2 largest provider of
data across
GLORIAD (~75
Terabytes in 2010)

See: <http://modis.gsfc.nasa.gov/>

Gigabytes Tranferred per Day





Hycom National Ocean Partnership Program

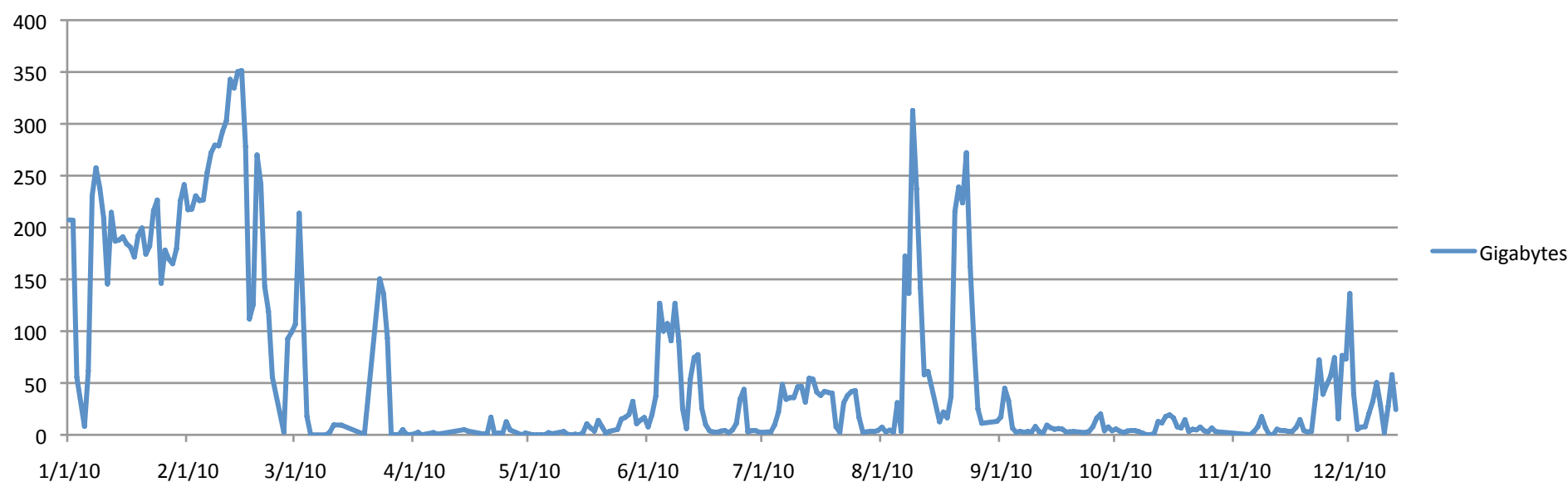
The HYCOM consortium is a multi-institutional effort sponsored by the National Ocean Partnership Program (NOPP), as part of the U. S. Global Ocean Data Assimilation Experiment (GODAE), to develop and evaluate a data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called HYbrid Coordinate Ocean Model or HYCOM).

Host name
tds.hycom.org
Country
United States
Country Code
US
Region
Florida
City
Tallahassee

#3 largest provider of
data across
GLORIAD (~21
Terabytes in 2010)

See: <http://www.hycom.org/>

Gigabytes Tranferred per Day



National Center for Atmospheric Research

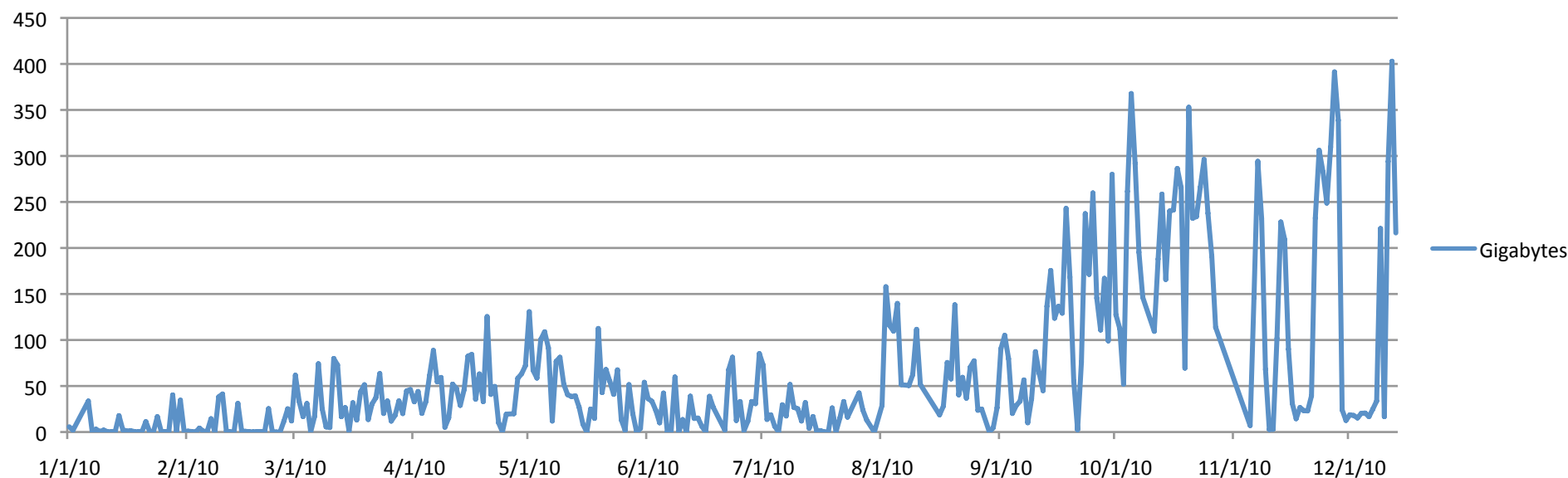
The National Center for Atmospheric Research (NCAR) is a federally funded research and development center devoted to service, research and education in the atmospheric and related sciences. NCAR's mission is to understand the behavior of the atmosphere and related physical, biological and social systems; to support, enhance and extend the capabilities of the university community and the broader scientific community – nationally and internationally; and to foster transfer of knowledge and technology for the betterment of life on Earth. The National Science Foundation is NCAR's primary sponsor, with significant additional support provided by other U.S. government agencies, other national governments and the private sector.

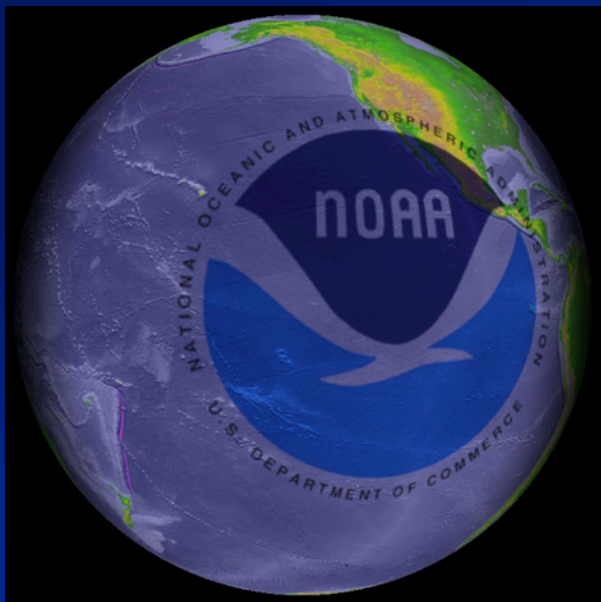
See: <http://www.ucar.edu/>

Host name
dsspub.ucar.edu
Country
United States
Country Code
US
Region
Colorado
City
Boulder

#4 largest provider of
data across
GLORIAD (~20
Terabytes in 2010)

Gigabytes Tranferred per Day





Climate Diagnostics Center (NOAA)

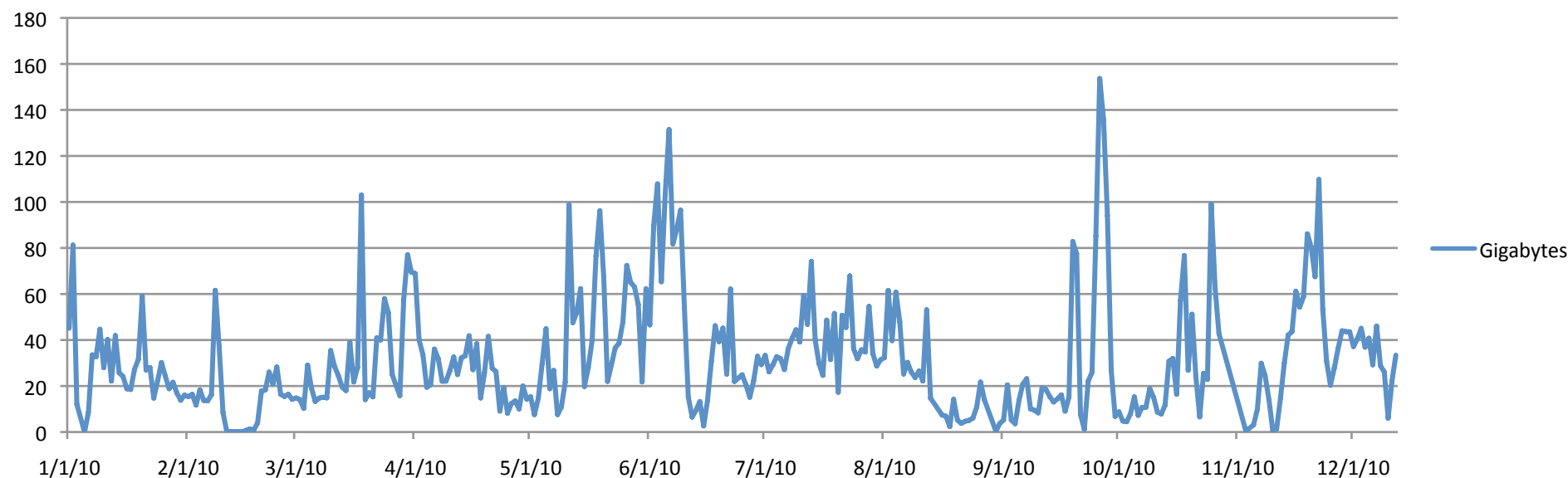
The Climate Diagnostics Center (CDC) in Boulder, Colorado advances understanding and predictions of climate variability through a vigorous research program, emphasizing state-of-the-art diagnostic techniques, directed at identifying the causes and potential predictability of important climate phenomena. Examples of phenomena that are foci for CDC research include major droughts and floods, the El Niño - Southern Oscillation and its global impacts, and decadal to centennial climate variations. CDC also performs extensive intercomparisons of observational and climate model data, an activity which is essential to improving NOAA's climate models and forecasts. CDC is also a major participant in the Western Water Research Initiative.

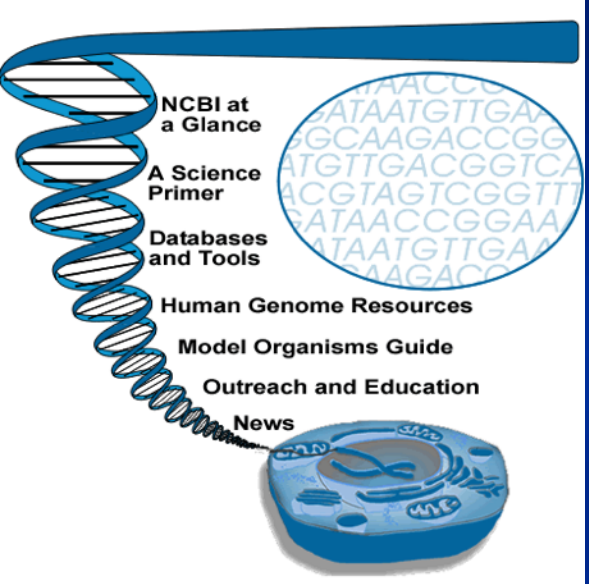
Host name
ftp.cdc.noaa.gov
Country
United States
Country Code
US
Region
Colorado
City
Boulder

#8 largest provider of
data across
GLORIAD (~11
Terabytes in 2010)

See: http://www.research.noaa.gov/climate/climate_cdc.html

Gigabytes Tranferred per Day





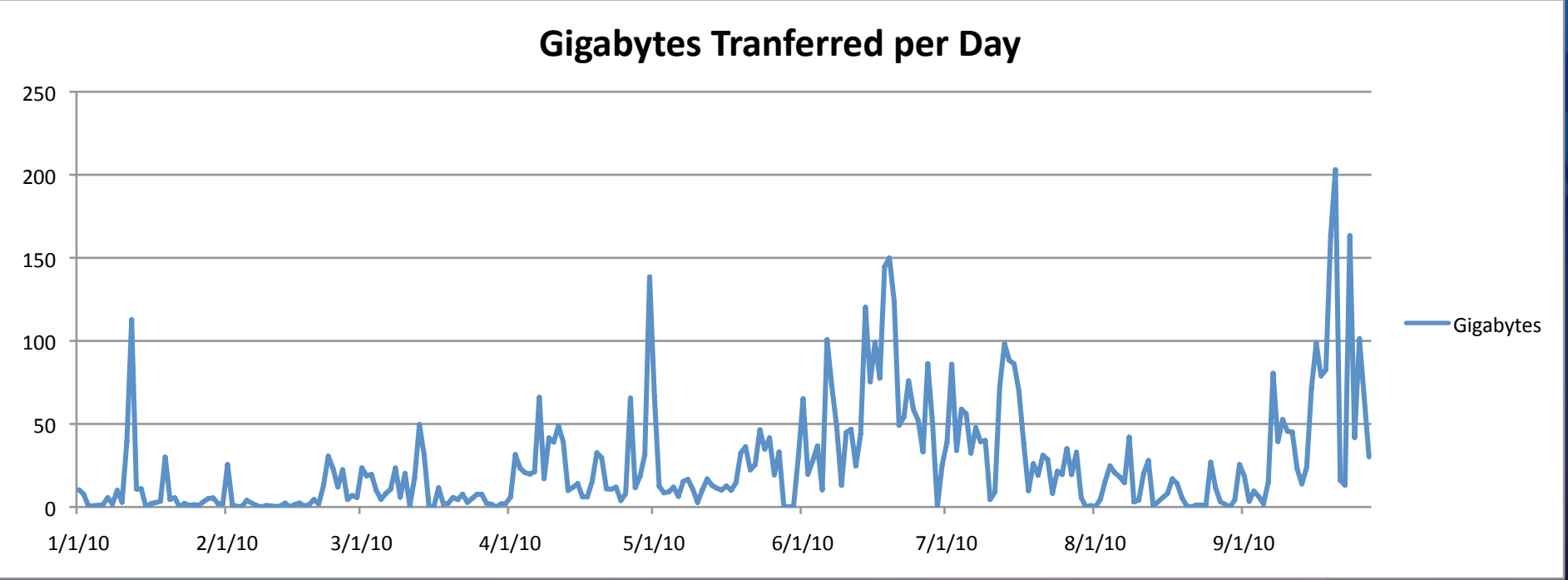
National Center for Biotechnology Information (NCBI)

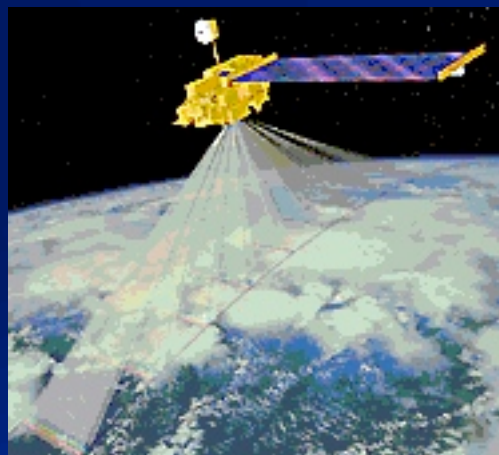
The National Center for Biotechnology Information advances science and health by providing access to biomedical and genomic information. Popular database resources include: [BLAST](#), [Bookshelf](#), [Gene](#), [Genome](#), [Nucleotide](#), [OMIM](#), [Protein](#), [PubChem](#), [PubMed](#), [PubMed Central](#), [SNP](#)

Host name
ftp.wip.ncbi.nlm.nih.gov
Country
United States
Country Code
US
Region
Maryland
City
Bethesda

12th largest provider
of data across
GLORIAD (~9
Terabytes in 2010)

See: <http://www.ncbi.nlm.nih.gov/>





Atmospheric Science Data Center, NASA

Multi-angle Imaging SpectroRadiometer (MISR)

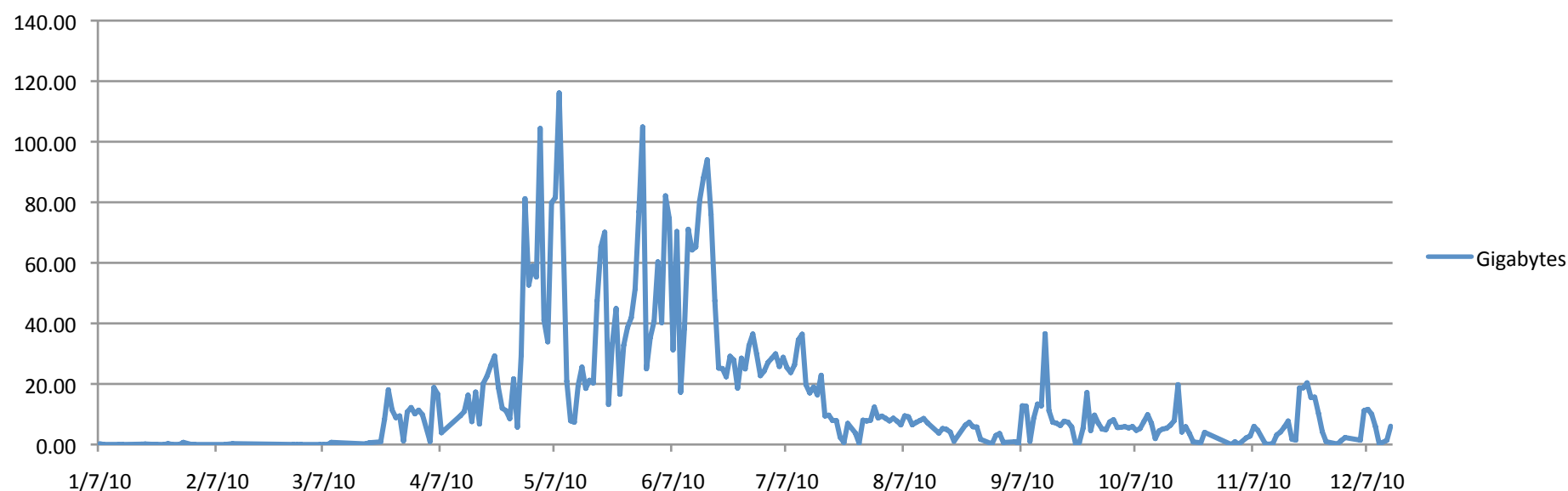
23rd largest provider
of data across
GLORIAD (~5
Terabytes in 2010)

MISR provides new types of information for scientists studying Earth's climate, such as the regional and global distribution of different types of atmospheric particles and clouds on climate. The change in reflection at different view angles combined with stereoscopic techniques enables construction of 3-D models and estimation of the total amount of sunlight reflected by Earth's diverse environments.

See: http://eosweb.larc.nasa.gov/GUIDE/campaign_documents/misr_ov2.html

Host name
l4ftl01.larc.nasa.gov
Country
United States
Country Code
US
Region
Virginia
City
Hampton

Gigabytes Tranferred per Day



Operational Monitoring

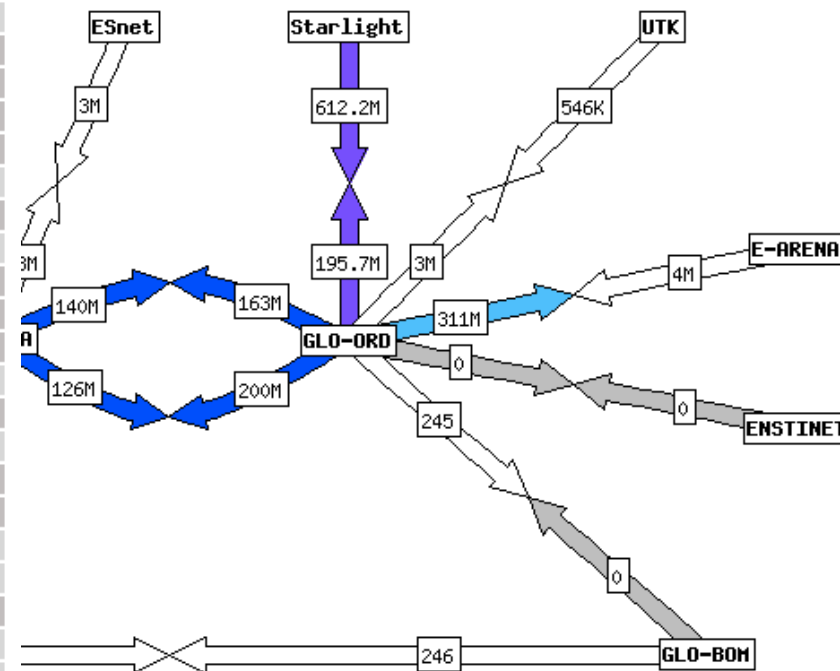
Nagios Availability Report: 12-31-2010 23:00:00 to 08-31-2011 10:38:23

Host	% Time Up	% Time Down	% Time Unreachable	% Time Undetermined
aarnet-rtr-lax	99.991% (99.991%)	0.009% (0.009%)	0.000% (0.000%)	0.000%
aarnet-rtr-sea	99.988% (99.988%)	0.012% (0.012%)	0.000% (0.000%)	0.000%
asnet-rtr	99.968% (99.968%)	0.032% (0.032%)	0.000% (0.000%)	0.000%
calren-rtr-svl	99.989% (99.989%)	0.011% (0.011%)	0.000% (0.000%)	0.000%
canet-rtr-ywg	99.223% (99.223%)	0.777% (0.777%)	0.000% (0.000%)	0.000%
canet-rtr-yyz	99.018% (99.018%)	0.982% (0.982%)	0.000% (0.000%)	0.000%
canet-rtr-yyz	99.969% (99.969%)	0.031% (0.031%)	0.000% (0.000%)	0.000%
cstnet-rtr-hkg	99.929% (99.929%)	0.071% (0.071%)	0.000% (0.000%)	0.000%
cudi-rtr	79.825% (79.825%)	20.175% (20.175%)	0.000% (0.000%)	0.000%
earena-rtr-ams	98.375% (98.375%)	1.625% (1.625%)	0.000% (0.000%)	0.000%
enstinet-rtr	0.000% (0.000%)	100.000% (100.000%)	0.000% (0.000%)	0.000%
esnet-rtr-ord	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
esnet-rtr-sea	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
glo-rtr-ord-lo0	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
glo-rtr-sea-lo0	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
glo-rtr-sin-lo0	87.126% (99.920%)	0.070% (0.080%)	0.000% (0.000%)	12.804%
internet2-rtr-ord	99.992% (99.992%)	0.008% (0.008%)	0.000% (0.000%)	0.000%
karen-rtr	99.985% (99.985%)	0.015% (0.015%)	0.000% (0.000%)	0.000%
kreonet2-rtr-sea	99.865% (99.865%)	0.135% (0.135%)	0.000% (0.000%)	0.000%
kreonet2-sea-primary	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
los-nettos-rtr-lax	99.992% (99.992%)	0.008% (0.008%)	0.000% (0.000%)	0.000%
nasa-nisn-rtr-ord	99.967% (99.967%)	0.033% (0.033%)	0.000% (0.000%)	0.000%
nlr-rtr-ord	99.964% (99.964%)	0.036% (0.036%)	0.000% (0.000%)	0.000%
nlr-rtr-sea	72.760% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	27.240%
nus-rtr-lax	99.991% (99.991%)	0.009% (0.009%)	0.000% (0.000%)	0.000%
pnwg-rtr-sea	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
singaren-rtr	87.126% (99.920%)	0.070% (0.080%)	0.000% (0.000%)	12.804%
slr-rtr-atl	99.817% (99.817%)	0.183% (0.183%)	0.000% (0.000%)	0.000%
starlight-rtr-ord	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
twaren-rtr	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
utk-rtr-tys	99.906% (99.906%)	0.094% (0.094%)	0.000% (0.000%)	0.000%



is are EST/EDT.

GLORIAD Network Weathermap



Created: Sep 12 2011 14:10:35

Update

- Infrastructure
- Measurement/Monitoring
- dvNOC
- Social Media/Zeeba

Why dvNOC?

- Inadequacies in performance of our general purpose shared IP services
- Challenges in cooperatively managing international links and services
- Difficulties in establishing more advanced services for our customers and in troubleshooting performance for those customers

Distributed Virtual Network Operations Center (dvNOC)

- Our proposed pathway towards building and operating in a decentralized, collaborative fashion a global integrated R&E network fabric where the focus is on users and their applications and on ensuring quality end-to-end performance
- We need this for our GLORIAD operations; we hope it is useful more broadly.

Distributed Virtual Network Operations Center (dvNOC)

- Addresses need for all levels of cyberinfrastructure operators *and users* to collaborate on decentralized, distributed and reliable operations of links and services
- Consensus-driven approach to common standards, tools and software
- Focus on customer-based performance
- Enormous development effort on part of US, Chinese, Korean, Dutch and Nordic GLORIAD teams (and we hope, soon, other GLIF partner communities)

A Global, Better Integrated Network Fabric Needed

- User applications include: building, campus, regional/national + international links and services
- Good performance means all are working well – and together (either
- Expectations for quality performance are growing
- Must support both traditional “shared IP” service and more advanced lightpath service

Distributed Virtual Network Operations Center (dvNOC)

- A community-driven, open-source software development effort
- Effort to establish commonly accepted standards for describing cyberinfrastructure elements - equipment, links, services and personnel
- Effort to define metrics for describing how those elements are performing, moving from traditional focus on circuits / links to focus on global fabric and user-based performance
- Integrates with another effort we're undertaking to document the reality and benefits of use of global R&E infrastructure - suitable for community education, sponsor reporting and efforts to sustain and improve public investment
- A community-building effort

dvNOC Development

- Inclusion in initial GLORIAD proposal to NSF in 2004 (for dNOC)
- Discussion at GLORIAD technical meeting in 2005 (Calgary, Canada)
- Substantial Work by KISTI's Dr. Dongkyun Kim on vision and definition in 2005-2006 (and on-going since)
- Work by US and China partners (Chunjing, Jiangning, Xiaodan, Gang, Tong Li) in 2007-2008 on metrics infrastructure and first version of a dvNOC application framework
 - Current version at: <http://viz.gloriad.org/dvnoc/dvnoc.html> developed using Flash/Flex technology (and integrating with GLORIAD metric systems via web services)
 - New version being developed as “web app” (no flash) and incorporating social media technology (working with SURFnet's SURFconext project/people)

dvNOC - Functional Elements

vNOC

User/Control/Data Interfaces with Web Service

vRES

vMAN

vLIGHT

vCON

Network Resource Repository

Layered Network Monitoring/
Management
System

Dynamic Lightpath
Provisioning
System

dNOC

Management / Measurement Protocols

Physical Nodes (Router, Switch, OXC, ...)

To be Useful, dvNOC must:

- Address real network operational issues
- Facilitate dialog and information sharing among operations teams
- Allow for authenticated access to different levels of information
- Be based entirely on open standards and open-source software
- Be community-driven and broadly inclusive of other efforts
- Enable management of all levels of network service (L1/L2/L3)
- Support operations at campus/regional/national/international levels
- Be rooted in solid metrics/data

Other dvNOC Challenges

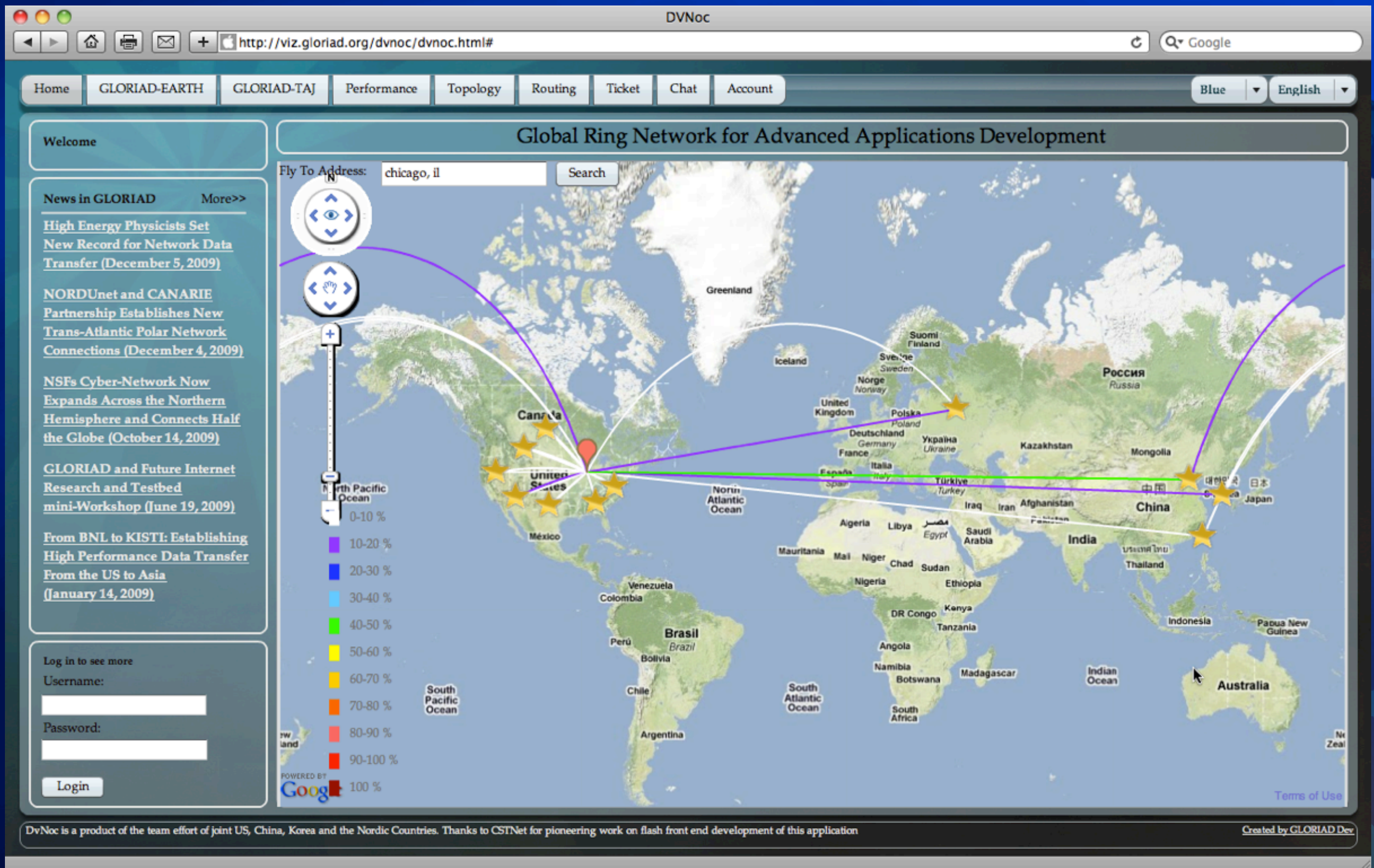
- Schema/database definition of network elements (equipment, services, personnel)
- Web-services definition
- Security/authentication model
- Integration with other operations/performance/metric approaches (such as GLIF/GOLEs, perfSonar, MonAlisa)
- Complete operational version of dvNOC framework
- Community buy-in and use

Note: GLORIAD/GLIF provides good prototype/development community. Value will be in broader buy-in.

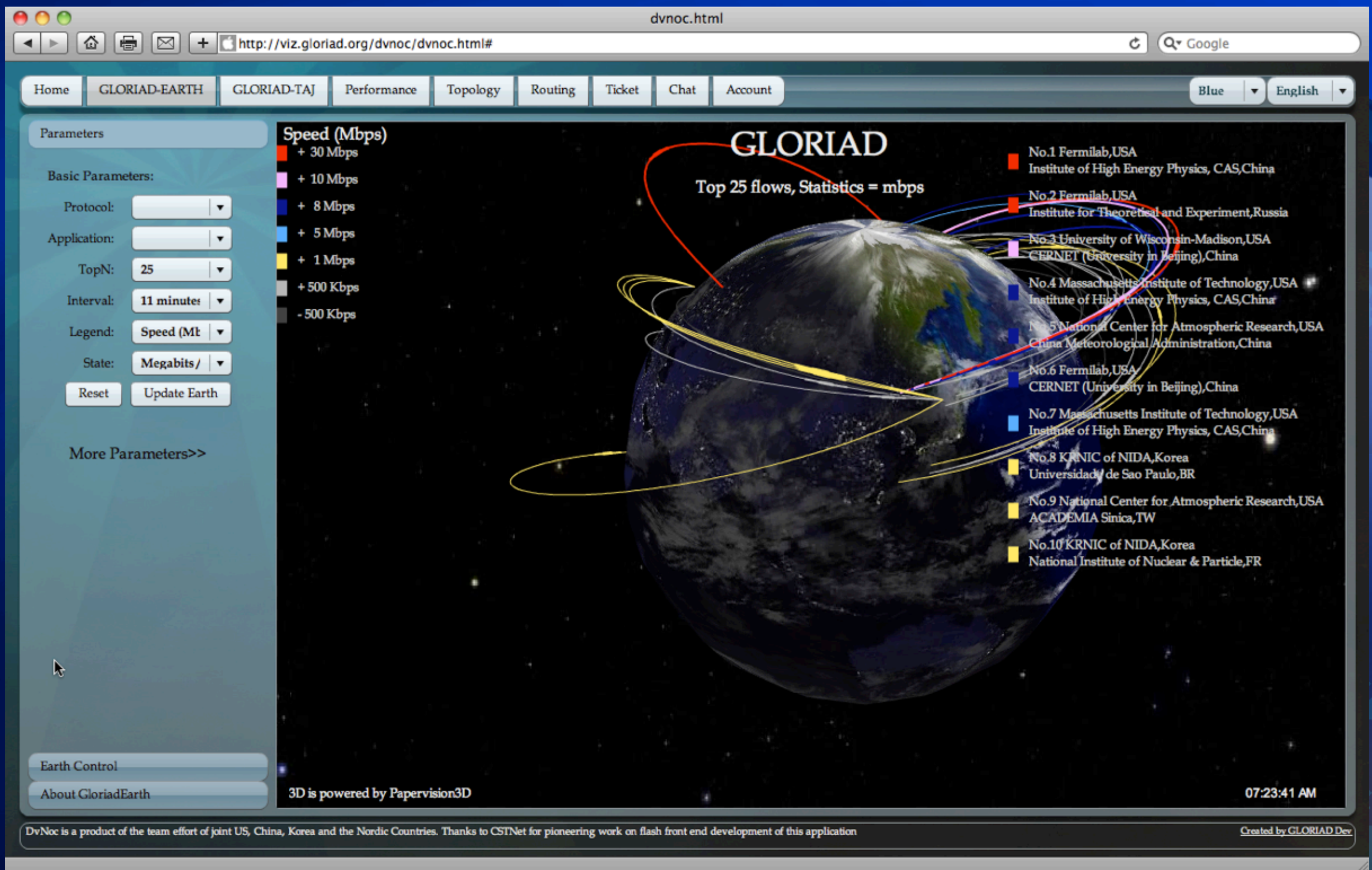
Summary dvNOC thoughts

- An integrated, well-performing global R&E network requires *something like* dvNOC (i.e., sharing operational data and facilitating dialog at all levels of network operations)
- This is an enormously challenging problem - socially, 'network politically', technically
- Benefits should scale far beyond GLORIAD and GLIF

dvNOC



dvNOC



dvNOC

dvnoc.html

http://viz.gloriad.org/dvnoc/dvnoc.html#

Google

HomeGLORIAD-EARTHGLORIAD-TAJPerformanceTopologyRoutingTicketChatAccount

BlueEnglish

Parameters

Basic Parameters:

Protocol:

Application:

TopN:

Interval:

Legend:

State:

ResetUpdate Earth

More Parameters>>>

Discipline

Helioseismology

Interdisciplinary

Geophysical Sciences

Linguistics

Biological Sciences

Political Sciences

Unknown

Title: Grazing and Iron Controls of Diatom Blooms in the Arabian Sea

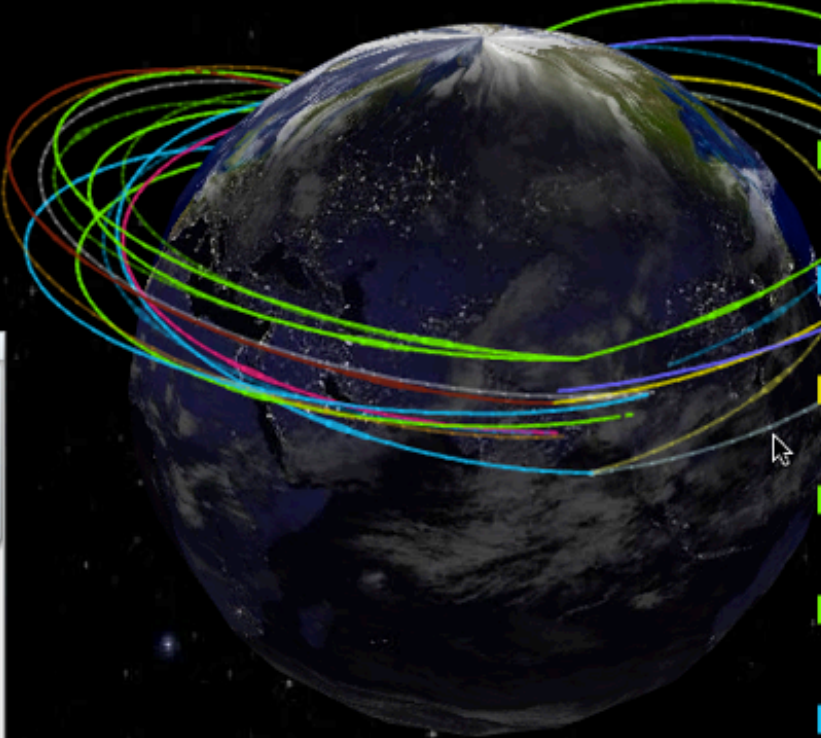
The Arabian Sea is important in global C and N budgets because of its high rates of annual primary production, its extensive zone of oxygen depletion and denitrification, and its expected strong response to global warming via ocean-atmosphere feedback to monsoon winds and upwelling intensity, especially the Oman Upwelling, driven by the SW Monsoon. In 2007, one of the investigators found that a large region of the central and southern Arabian Sea was Fe-limited during the SW Monsoon, consistent with

Earth Control

About GloriadEarth

GLORIAD-TAJ

US-India projects funded by NSF



No.1 National Solar Observatory,US
Udaipur Solar Observatory,IN

No.2 Center for Bits and Atoms (CBA), MIT,US
Consortium of Science and Technology
Institutions across India,IN

No.3 Central Washington University,US
Research in Monsoon regions of Northwestern
India,IN

No.4 Cornell University,US
Linguistics workshop,IN

No.5 University of Miami,US
Indian Institute of Technology Kharagpur
(IITK),IN

No.6 University of California-Los Angeles,US
Gendered Empowerment of Community
Organizations,IN

No.7 North Carolina State University,US
International Workshop on Sustainable
Development Strategy,IN

No.8 University of Miami Rosenstiel School of
Marine&Atmospheric Sci,US
South West Monsoon region,IN

No.9 University of Massachusetts Boston,US
University of Agricultural Sciences,
Bangalore,IN

No.10 University of Arkansas,US
Indira Gandhi Institute of Development
Research (IGIDR),IN

07:27:44 AM

DvNoc is a product of the team effort of joint US, China, Korea and the Nordic Countries. Thanks to CSTNet for pioneering work on flash front end development of this application

Created by GLORIAD Dev

Update

- Infrastructure
- Measurement/Monitoring
- dvNOC
- Social Media/Zeeba

Zeeba (.net)

Launched February 17, 2010 with our Indian partners at the Observer Research Foundation in Mumbai India Zeeba is designed to explore how to best use social media tools to address global science, education and health collaboration via modern cyberinfrastructure. It is offered as a community building tool to connect scientists, educators, students and cyberinfrastructure builders - and meant to explore how we can use increasingly powerful and complex cyberinfrastructure globally to better engage and work together.

Zeeba (.net)

This is not a science/education do-all/be-all social web site (there are others out there doing that such as the excellent [ResearchGate](#)) - our intended niche (because we work in this area) is the intersection of science/education/health and cyberinfrastructure.

Zeeba (.net)

- Those of us who work on GLORIAD (the project home of Zeeba) have a ringside seat to observe how cyberinfrastructure is being used creatively by some of the world's best hearts and minds to explore, discover, test, teach and train.
- There is often a technical "disconnect" between those who'd like to collaborate globally and the often difficult technical requirements for doing so.
- We intend to encourage the sharing of stories - successful and otherwise - to both inspire others and, importantly, point towards the necessary "how to" information.



CONNECTING THE WORLD OF SCIENCE AND EDUCATION

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BLOGS

DISCOVERIES

FILES

FRIENDS

GROUPS

JOURNAL SEARCH

MEMBERS

PAGES

Frontpage archive

About Zeeba

Zeeba is a social media site for science and education.

Blog Speak



What the cloud *really* means for science

...
Susie Baker 82 days ago



Undersea cable networks-observatories can play critical role in climate change and sea level rises

[There have been several good articles lately about the challenge of rising sea levels due to climate change. This is a very poorly understood area as mentioned by the IPCC, as ice sheet dynamics, especially in the Western Antarctic Ice ...

Susie Baker 75 days ago

Featured Stories



More on Apple software SIM and implications for R&E/community networks

[There has been a lot of traffic in the blogosphere about the recent rumours of Apple producing a software SIM. I have collected together here a number of useful pointers and commentaries on the subject. As I mentioned before software ...

Susie Baker 75 days ago



The power of 'convergence'

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[Around the world there are a number of initiatives on developing new collaborative tools and generic portal services for various research communities that allows the seamless integration of commercial cloud services and ...

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From the Net



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By ERIK OLSEN
Published: November 15, 2010

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A Web-based Information Portal to Biological Macromolecular Structures

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SCEC's "M8" earthquake simulation breaks computational records, promises



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RCSB Protein Data Bank



November 16, 2010 by Susie Baker

data bank, dataset, visualization, animation, protein, biology

A Web-based Information Portal to Biological Macromolecular Structures

Show Welcome Message

The PDB archive contains information about experimentally-determined structures of proteins, nucleic acids, and complex assemblies. As a member of the [wwPDB](#), the RCSB PDB curates and annotates PDB data according to agreed upon standards.

The RCSB PDB also provides a variety of tools and resources. Users can perform simple and advanced searches based on annotations relating to sequence, structure and function. These molecules are visualized, downloaded, and analyzed by users who range from students to specialized scientists.

Click to go directly to the RCSB PDB portal: <http://www.rcsb.org/pdb/home/home.do>

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Surround-screen projection-based virtual reality: The design and implementation of the CAVE

Authors


Carolina Cruz-neira; Daniel J. Sandin; Thomas A. Defanti

Abstract

Abstract Several common systems satisfy some but not all of the VR This paper describes the CAVE (CAVE Automatic Virtual Environment) virtual reality/scientific visualization system in detail and demonstrates that projection technology applied to virtual-reality goals achieves a system that matches the quality of workstation screens in terms of resolution, color, and flicker-free stereo. In addition, this format helps reduce the effect of common tracking and system latency errors. The off-axis perspective projection techniques we use are shown to be simple and straightforward. Our techniques for doing multi-screen stereo vision are enumerated, and design barriers, past and current, are described. Advantages and disadvantages of the projection paradigm are discussed, with an analysis of the effect of tracking noise and delay on the user. Successive refinement, a necessary tool for scientific visualization, is developed in the virtual reality context. The use of the CAVE as a one-to-many presentation

Year

2009

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Zeeba (.net) Next Steps

- Work with SURFnet's SURFconext project to retool/rethink architecture and services and to partner on future development
- Redesign (as part of overall GLORIAD web presence redesign)
- Populate/curate/promote

GLORIAD Planning Site

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Distributed Virtual Network Operations Center (dvNOC)

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GLORIAD and Taj Next Steps

- Egypt Link and Egypt Starlight/Netherlight facility (and partnership on new USAID-funded GLORIAD in Africa project)
- India BixLight (link and Starlight/Netherlight facility)
- Work with Singapore partners on SingLight (and new partners in SE Asia such as VinaREN)
- US-Russia “Refresh” (and 10G upgrade)
- Improve North American services/capacity for GLORIAD/GLIF partners (especially Seattle-Chicago)
- NIS deployment
- LHCONe deployment/support
- Continued/accelerated development of new dvNOC and Zeeba programs
- Improvements to measurement/monitoring infrastructures (including new work on security)
- Improve planning and integration with GLIF
- **Green GLORIAD**