GLORIAD As a Facility for Supporting LHCONE Services

LHCONE-LHCOPN Workshop
Stockholm, Sweden
May 3-4, 2012

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Director, Mettropolitan Rsearch and
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GLORIAD

A cooperative R&E network ringing the northern hemisphere linking scientists, educators and students in Russia, USA, China, Korea, Netherlands, Canada, the Nordic countries – and India, Egypt, Singapore – and others with specialized network services; co-funded, co-managed by all international partners

Collaborative International Program to Develop/Deploy advanced Cyberinfrastructure between partnering countries (and others) as effort to expand science, education and cultural cooperation and exchange

Follow-on to NSF-/Russian MinSci-Funded MIRnet and NaukaNet programs (Total NSF $18.5M, 1998-2015; International: ~$240). Part of broader NSF Program called International Research Network Connections.

NSF Sponsorship

Organization Chart

National Science Foundation

- Office of the Director & Staff Offices
- NSF Director / Deputy Director
- National Science Board Chair / Vice Chair
- Office of Inspector General
- Directorate for Biological Sciences
- Directorate for Computer & Information Science & Engineering
- Directorate for Education and Human Resources
- Directorate for Engineering
- Directorate for Geosciences
- Directorate for Mathematical and Physical Sciences
- Directorate for Social, Behavioral and Economic Sciences
- Office of Cyberinfrastructure
- Office of International Science and Engineering
- Office of Polar Programs
- Office of Budget, Finance and Award Management
- Office of Information and Resource Management

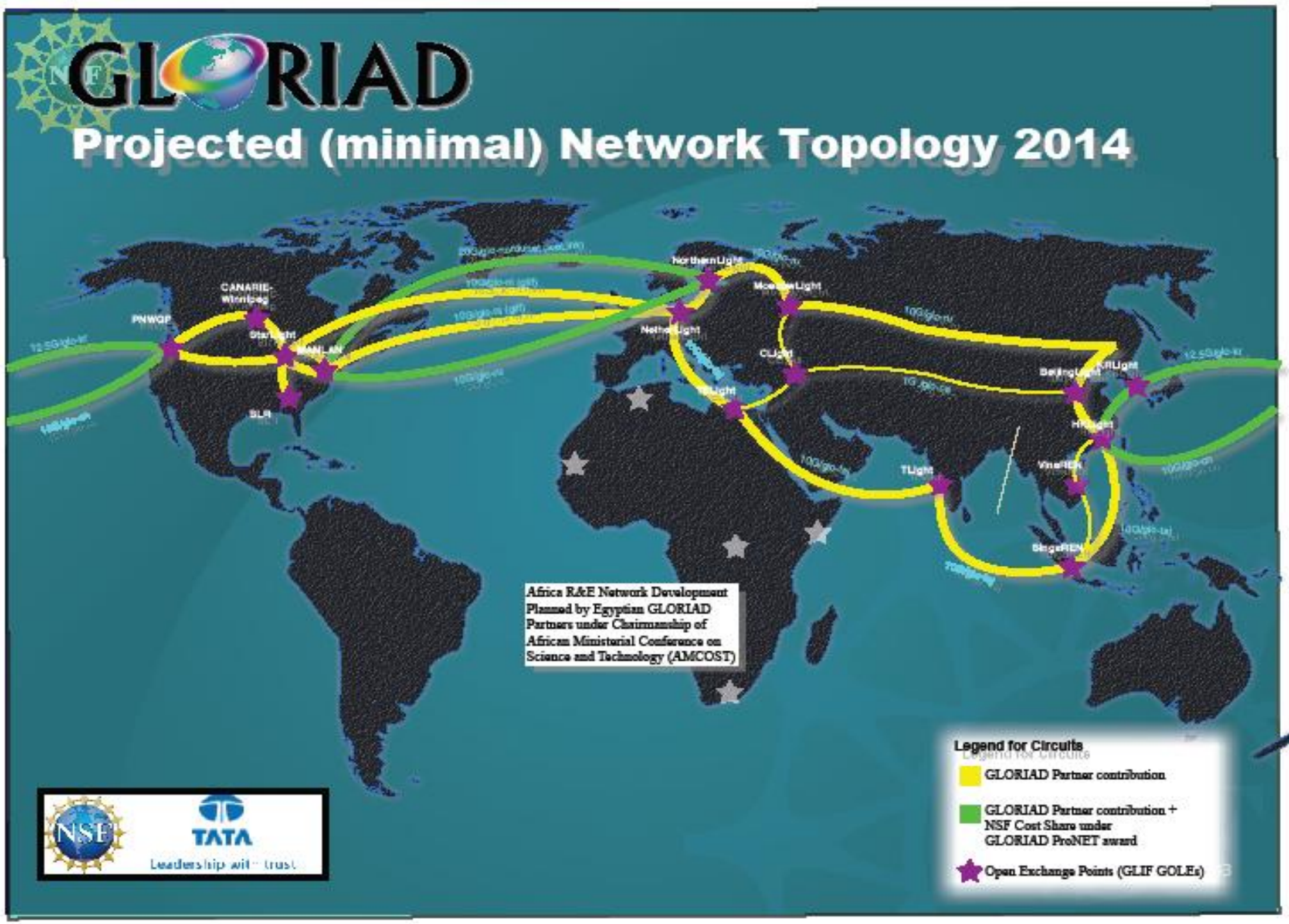
TATA

المصرية للاتصالات
Telecom Egypt

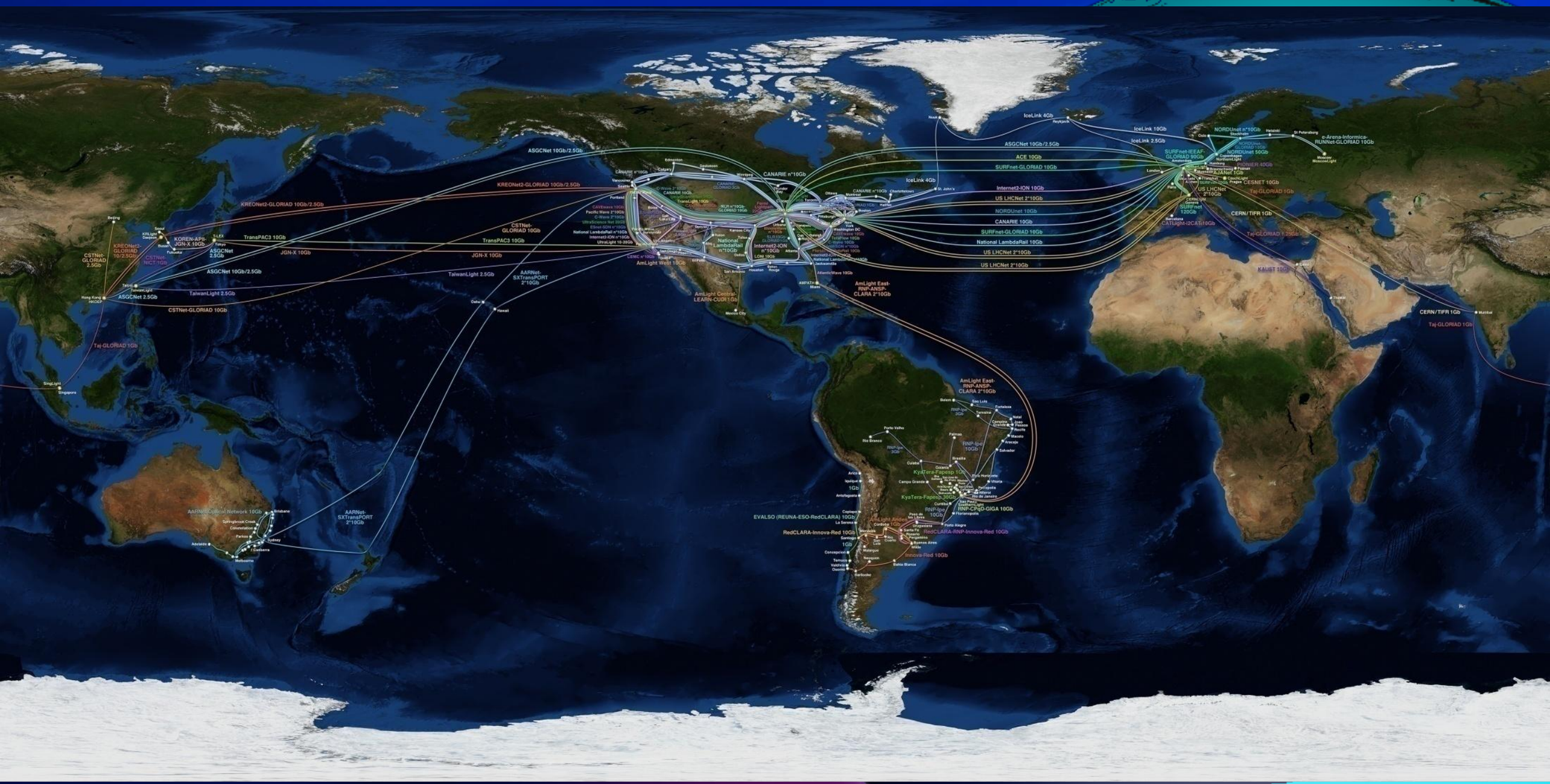
Follow-on to NSF-/Russian MinSci-Funded MIRnet and NaukaNet programs
(Total NSF $18.5M, 1998-2015; International: ~$240M)

GLORIAD

Projected (minimal) Network Topology 2014



Global Lambda Integrated Facility



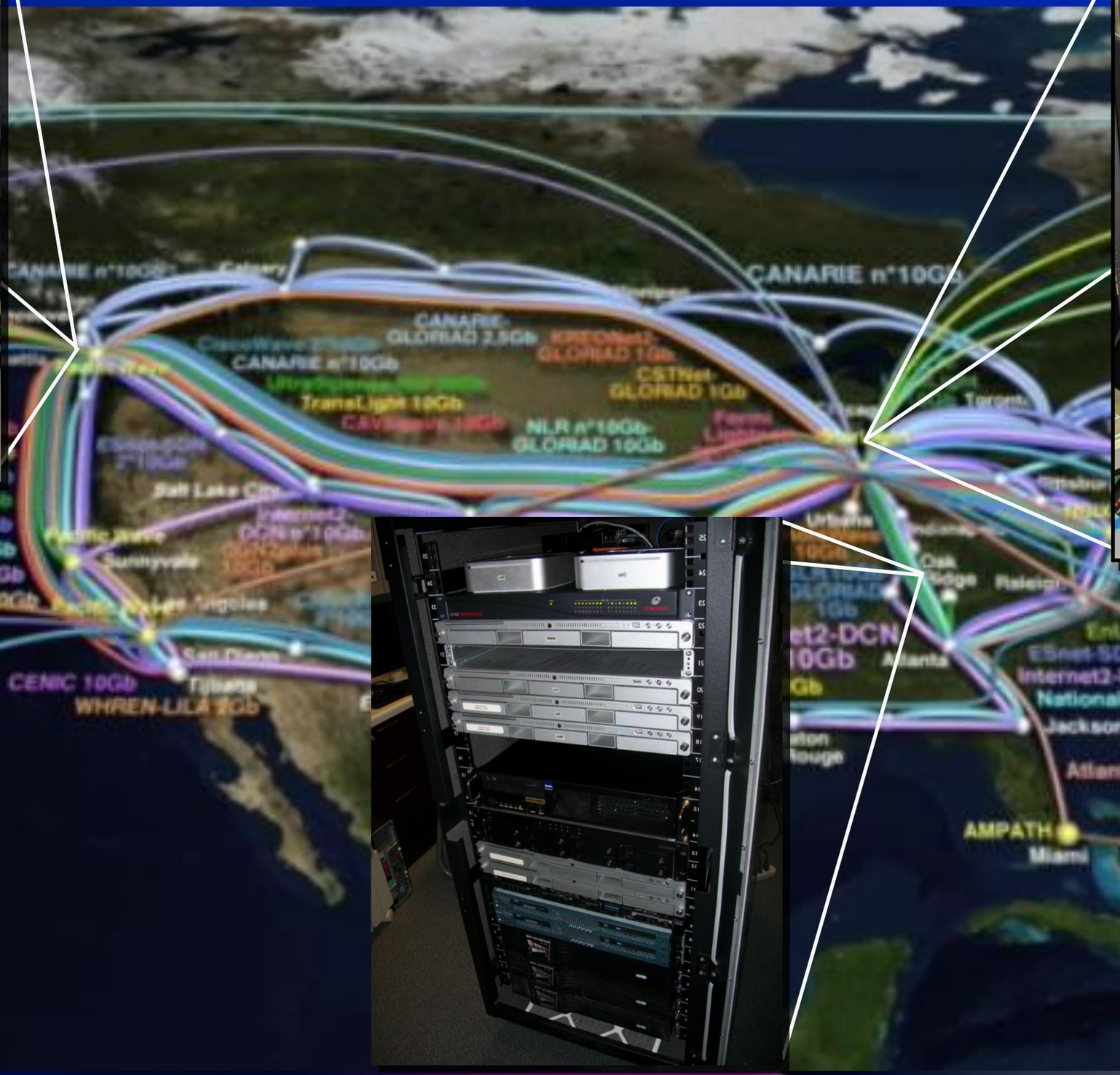
Visualization courtesy of Bob Patterson, NCSA; data compilation by Maxine Brown, UIC.

www.glif.is

Global Ring Network for Advanced Applications Development (GLORIAD)

- 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 (~$240M 1998-2015)
- History: 1994 US-Russia Friends and Partners; 1996 US-Russia Civic Networking; 1997 US-Russia MIRnet; 2004 GLORIAD; 2009 GLORIAD/Taj; 2011 GLORIAD/Africa

GLORIAD-US Operations



StarLight / Chicago:
Key GLORIAD Partner

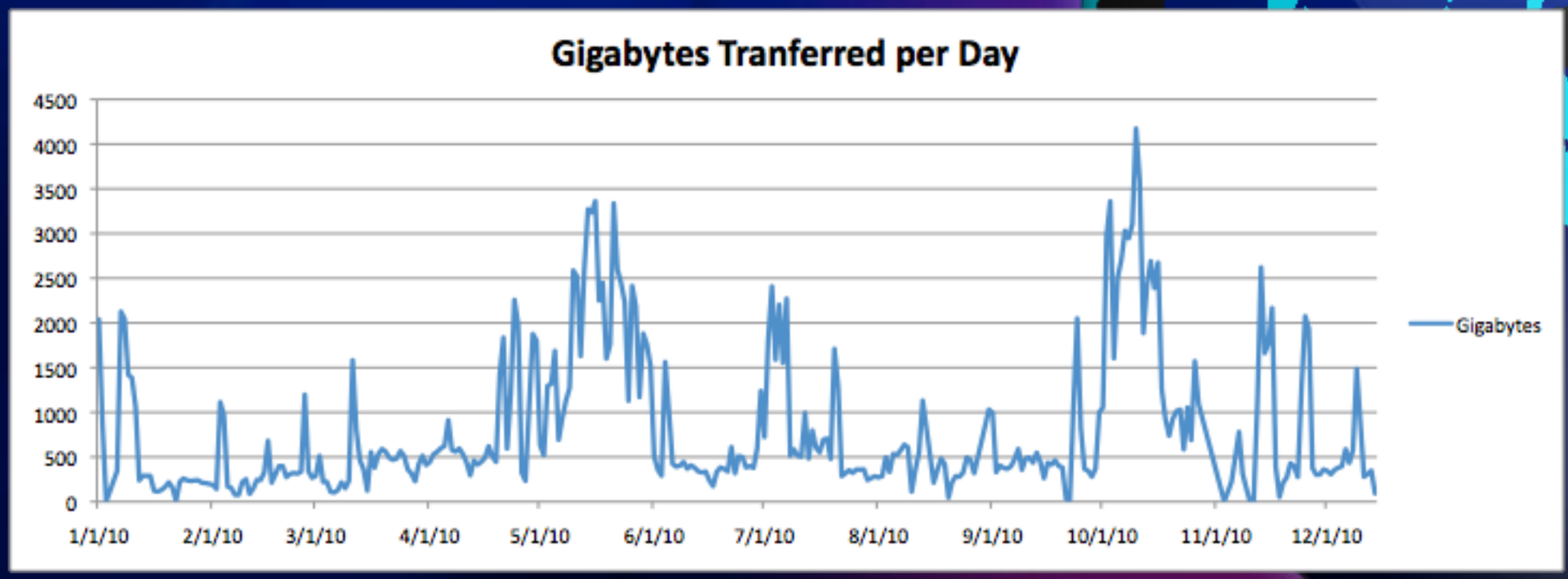
FermiLab (Chicago)

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/



MODIS Web

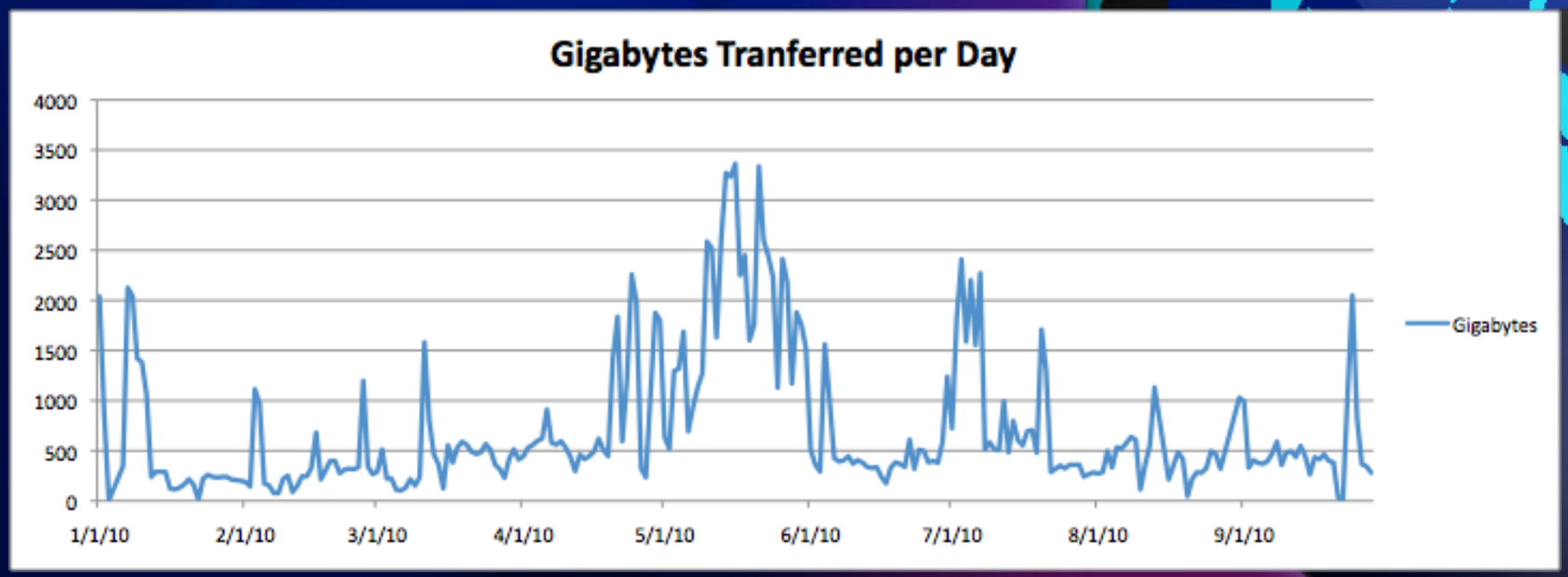
USGS MODIS Repository of Earth Satellite Imagery

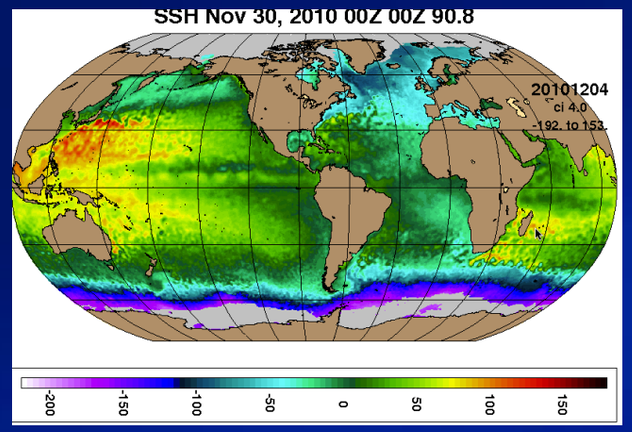
MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the 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/





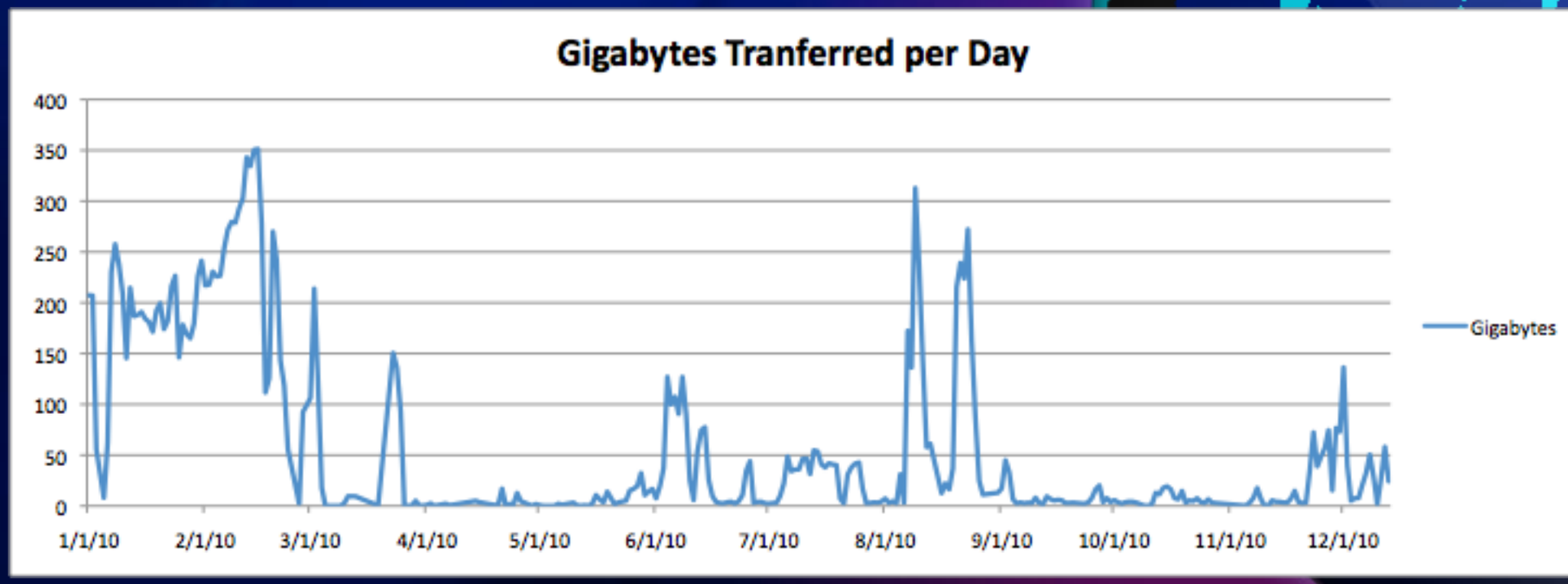
Hycom National Ocean Partnership Program

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).

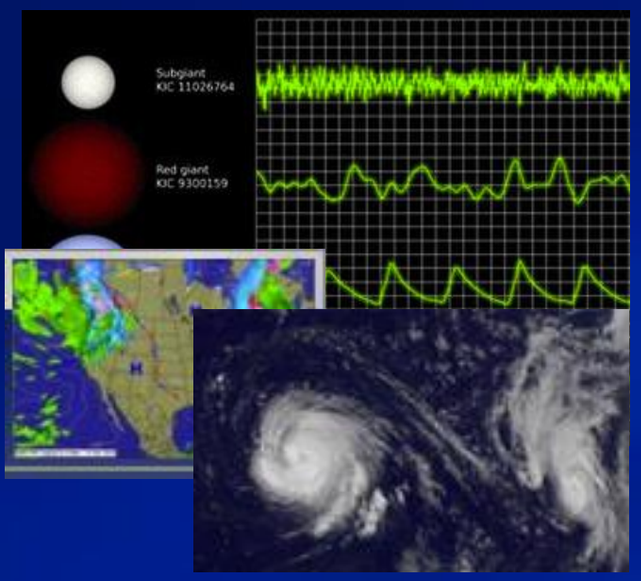
Host name
tds.hycom.org
Country
United States
Country Code
US
Region
Florida
City
Tallahassee

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

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



National Center for Atmospheric Research

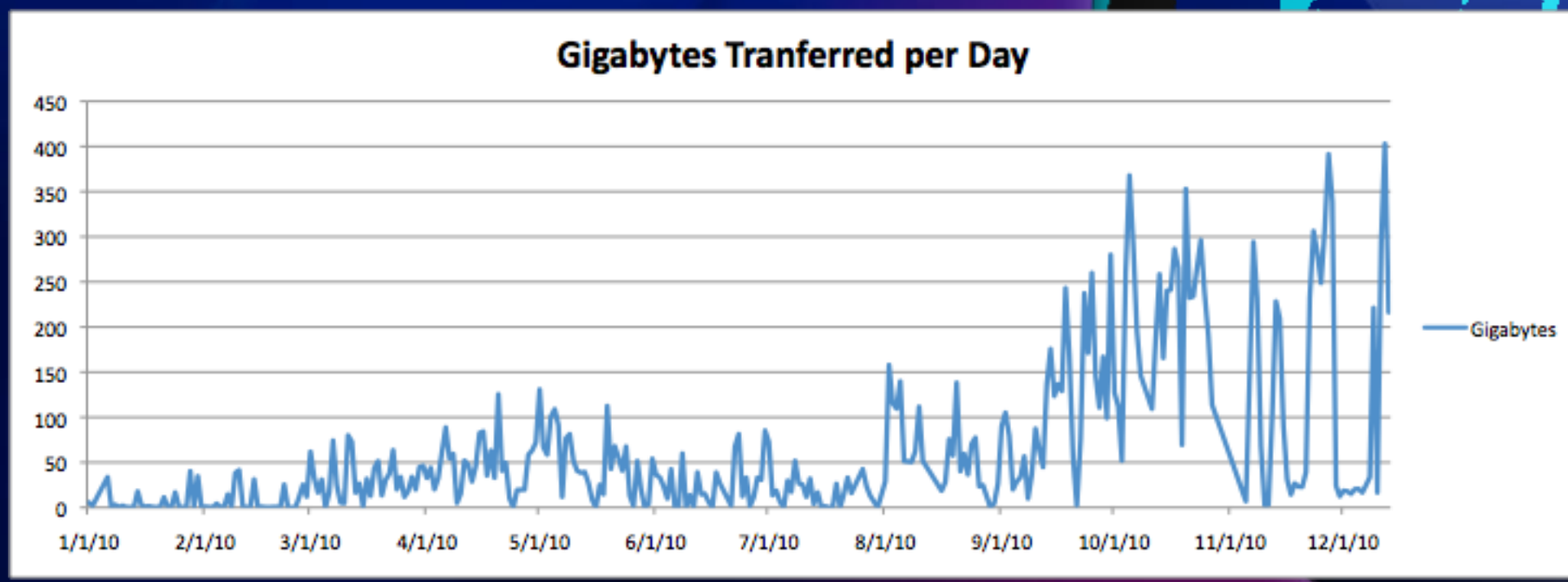


The National Center for Atmospheric Research (NCAR) is a federally funded research and development center devoted to service, research and education in the atmospheric and related sciences. NCAR's mission is to understand the behavior of the atmosphere and related physical, biological and social systems; 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)



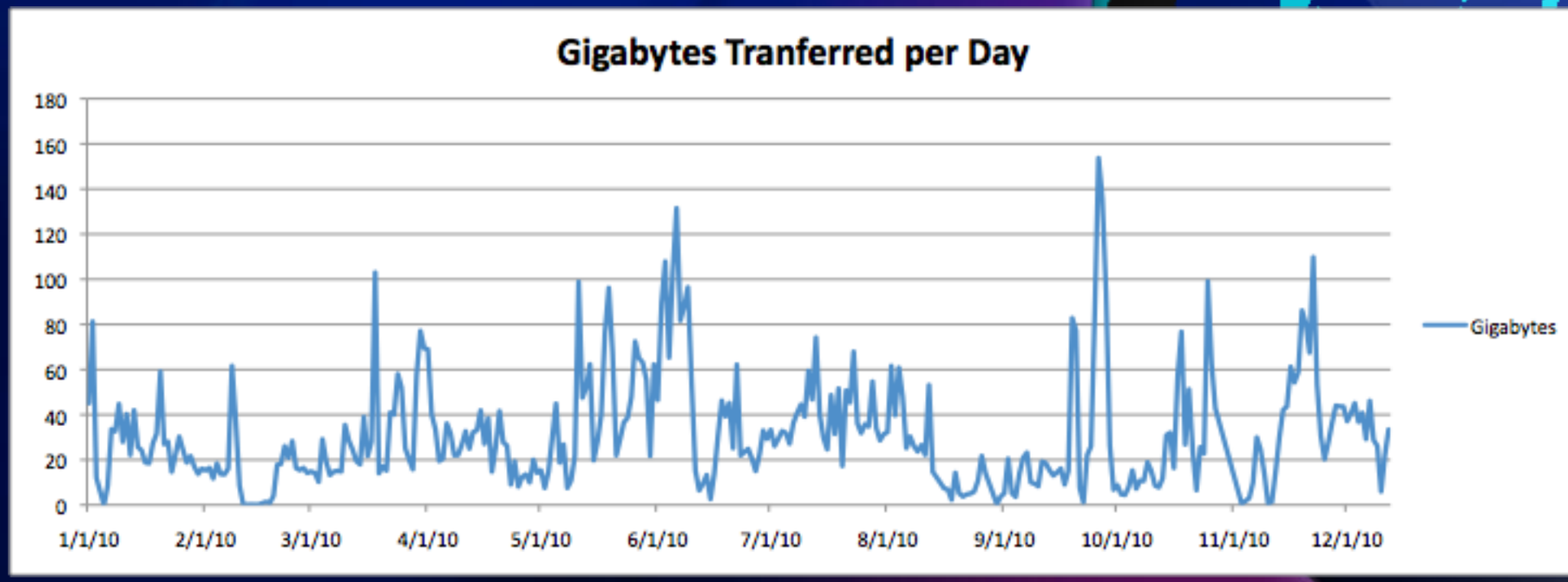
Climate Diagnostics Center (NOAA)

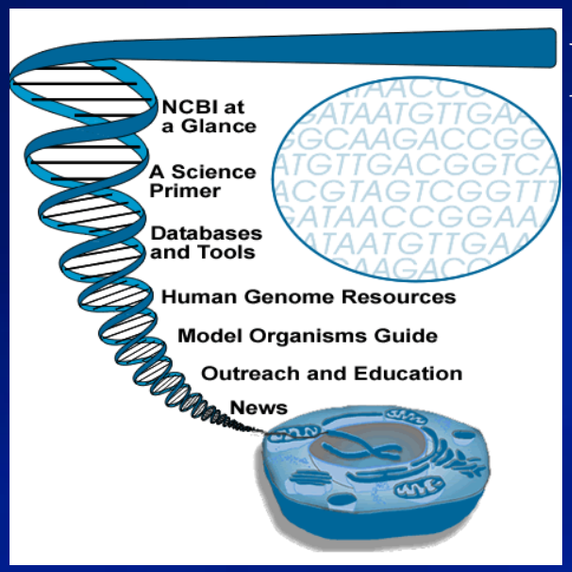
The Climate Diagnostics Center (CDC) in Boulder, Colorado advances understanding and predictions of climate variability through a vigorous research program, emphasizing state-of-the-art diagnostic techniques, directed at identifying the causes and potential predictability of important climate phenomena. 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.

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

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)





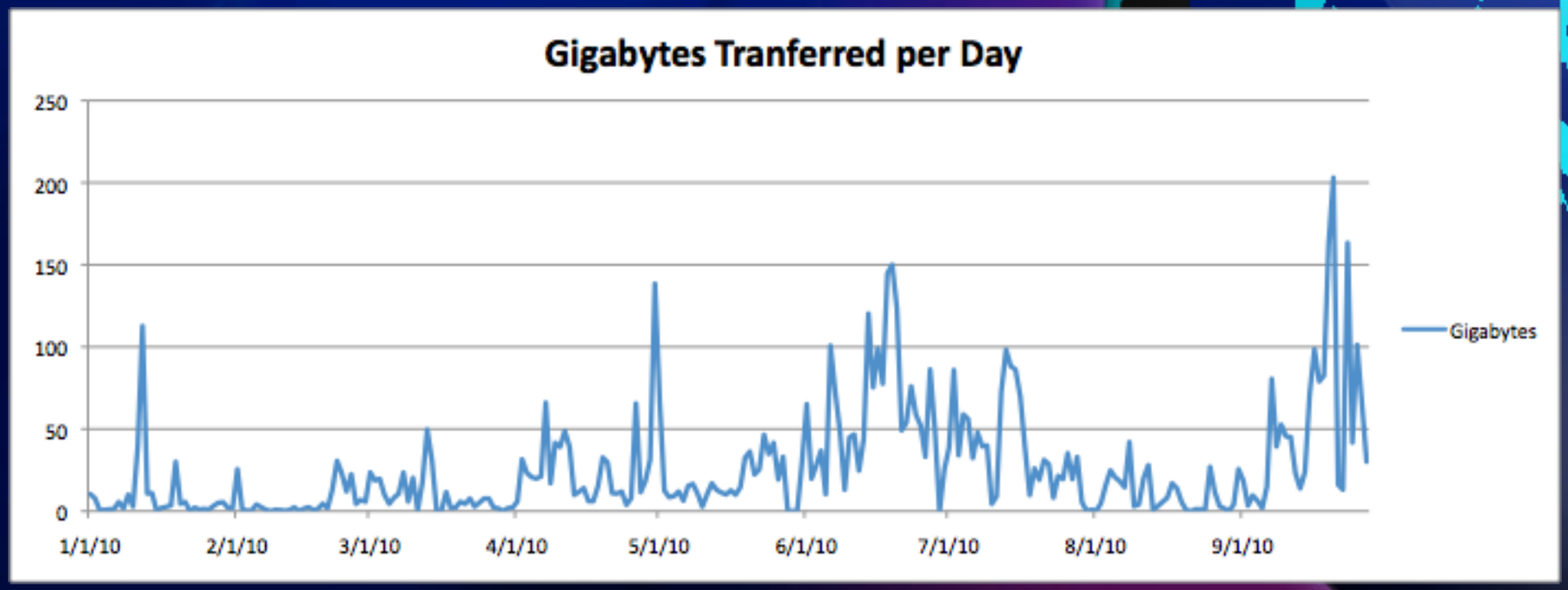
National Center for Biotechnology Information (NCBI)

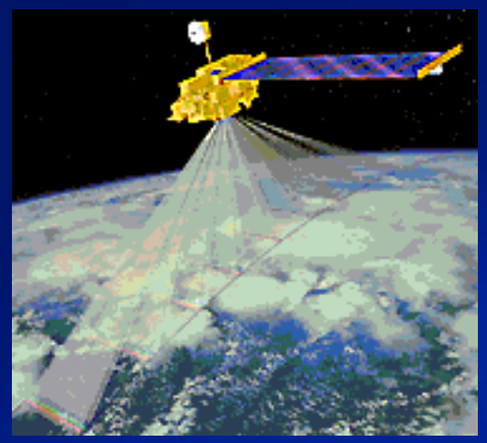
The National Center for Biotechnology Information advances science and health by providing access to biomedical and genomic information. Popular database resources include: BLAST, Bookshelf, Gene, Genome, Nucleotide, OMIM, Protein, PubChem, PubMed, PubMed Central, SNP

Host name
ftp.wip.ncbi.nim.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/





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

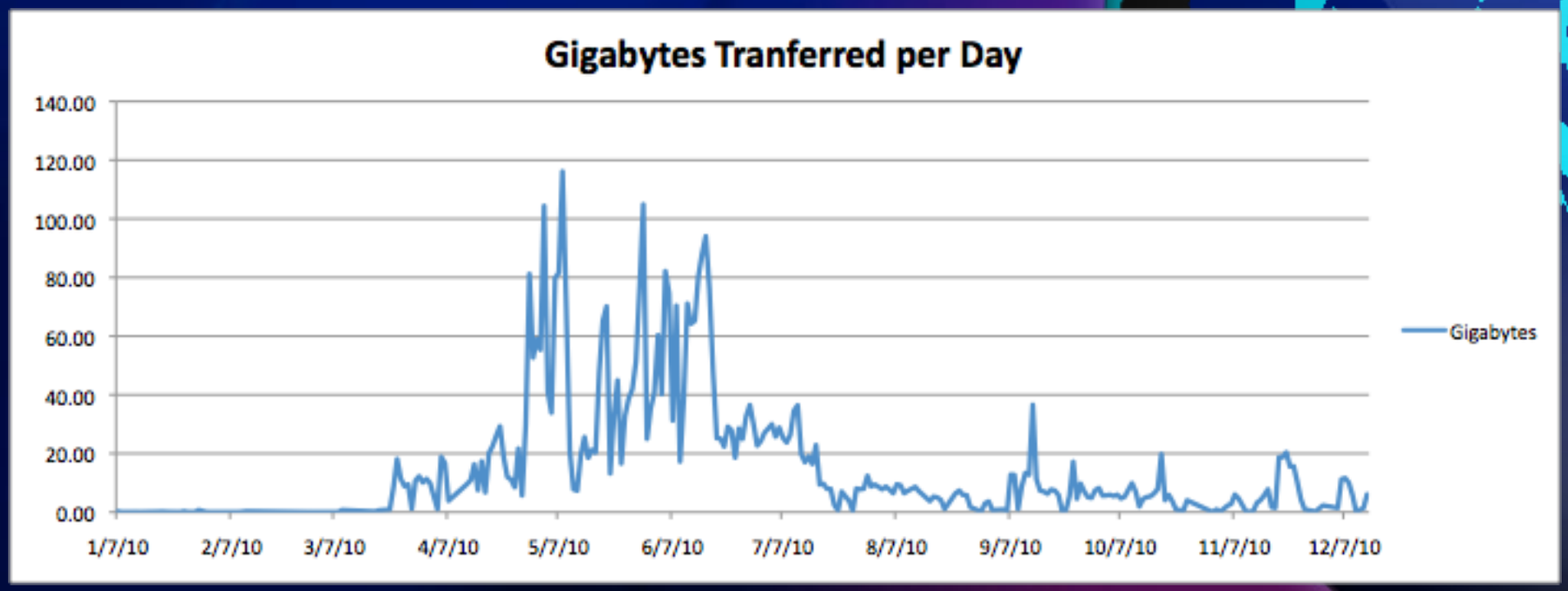
Atmospheric Science Data Center, NASA

Multi-angle Imaging SpectroRadiometer (MISR)

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



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New Kind of Neutrino Transformation Discovered

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Daya Bay Neutrino Facility in China. *Courtesy of Roy Kaltschmidt, Lawrence Berkeley National Laboratory*

Neutrinos, the wispy particles that flooded the universe in the earliest moments after the Big Bang, are continually produced in the hearts of stars and other nuclear reactions. Untouched by electromagnetism, they respond only to the weak nuclear force and even weaker gravity, passing mostly unhindered through everything from planets to people.

Years ago, scientists also discovered another hidden talent of neutrinos. Although they come in three basic "flavors" — electron, muon and tau — neutrinos and their corresponding antineutrinos can transform from one flavor to another while they are traveling close to the speed of light. How they do this has been a long-standing mystery.

But some new, and unprecedentedly precise, measurements from the multinational Daya Bay Neutrino Experiment are revealing how electron antineutrinos "oscillate" into different flavors as they travel. This new finding from Daya Bay opens a gateway to a new understanding of fundamental physics and may eventually solve the riddle of why there is far more ordinary matter than antimatter in the universe today.

The international collaboration of researchers is made possible by advanced networking and computing facilities. In the U.S., the Department of Energy's high-speed science network, ESnet, speeds data to the National Energy Research Scientific Computing Center (NERSC) where it is analyzed, stored and made available to researchers via the Web. Both facilities are located at the DOE's Lawrence Berkeley National Laboratory (Berkeley Lab).

Surprising results

Nuclear reactors of the China Guangdong Nuclear Power Group at Daya Bay and nearby Ling Ao produce millions of quadrillions of elusive electron antineutrinos every second. The six massive detectors buried in the mountains adjacent to the powerful reactors, make up the Daya Bay Experiment. Researchers in the collaboration count the number of electron antineutrinos detected in the halls nearest the Daya Bay and Ling Ao reactors and calculate how many would reach the detectors in the Far Hall if there were no oscillation. The number that apparently vanishes on the way (oscillating into other flavors, in fact) gives the value of theta one-three, written θ13.

Shortly after experimental [illegible]a is collected, it travels across the Pacific Ocean via the National Science Foundation's GLORIAD network, which c[illegible]nects to ESnet backbone in Seattle, WA. From Seattle, ESnet carries the data to the [illegible]ERSC in Oakland, C[illegible]. At NERSC the data is processed in real-time on the PDSF cluster, archived in the High

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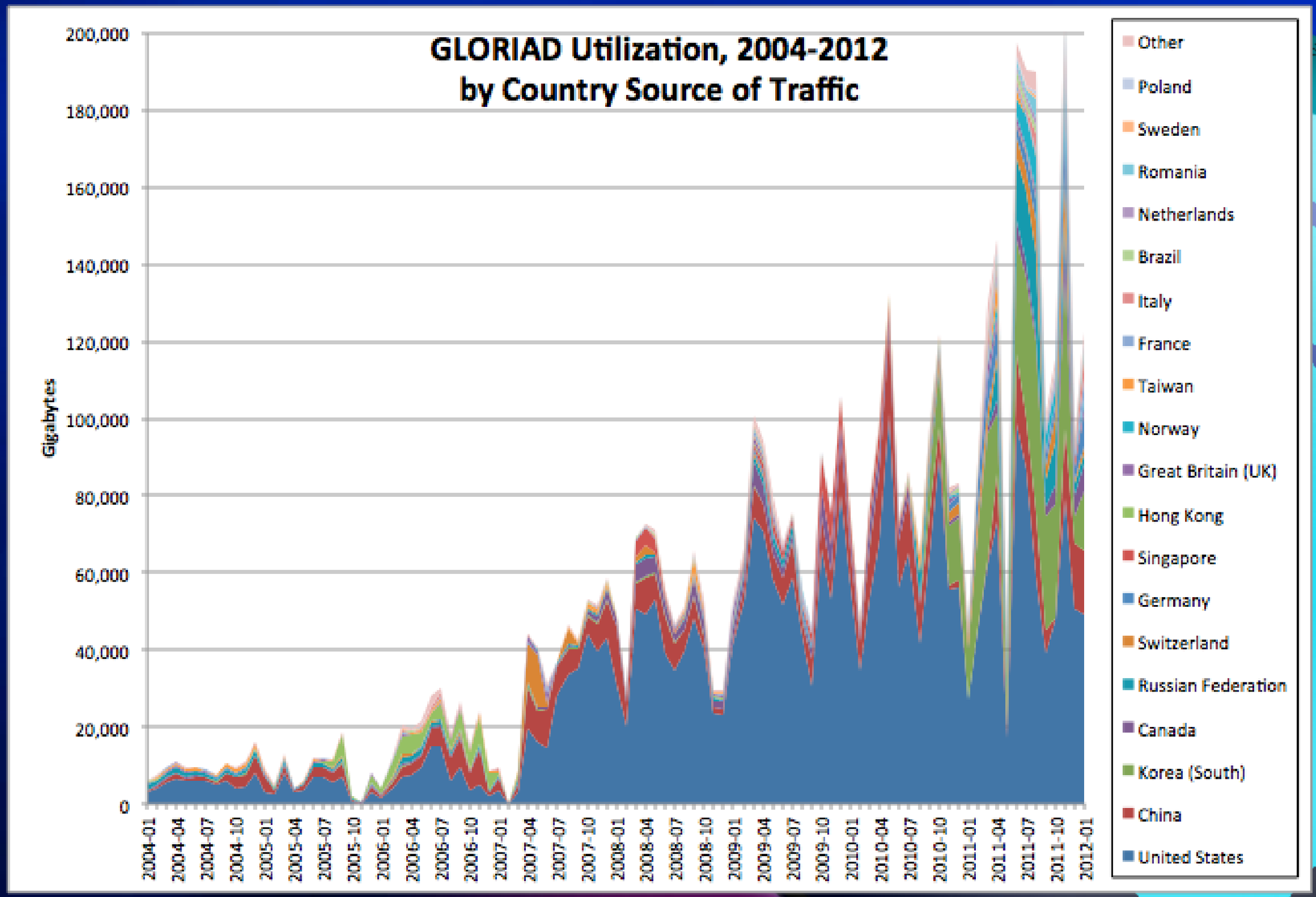
- Smithsonian Showcases Titanoboa Monster Snake
- New Layer of Genetic Coding Found
- Supersonic Snowball in Hell: Comet flight through Sun's atmosphere
- New Institute to Help Scientists Improve Massive Data Set Research
- Amazon CEO to Raise Sunken Apollo 11 Engines
- Spectacular Meteor Displays: Jupiter Assists Halley's Comet
- Ancient Flying Reptile Found
- Cool Clouds of Carina

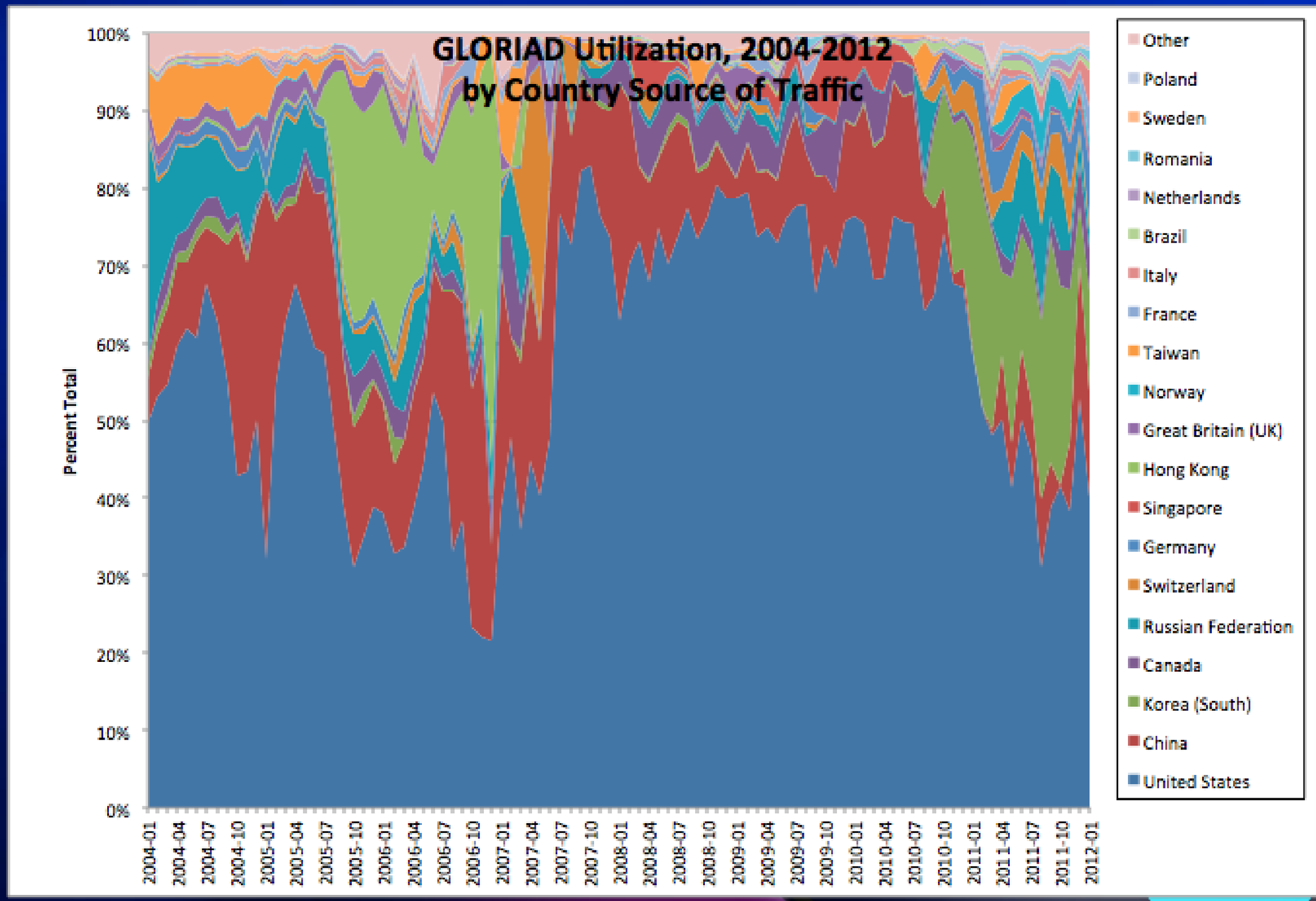
Some Numbers ...

- 18 million IP addresses routed across GLORIAD infrastructure since begin
- 600 million flow records (large flows) since begin
- 6 Terabyes - 12 Terabytes per day

Utilization



Utilization



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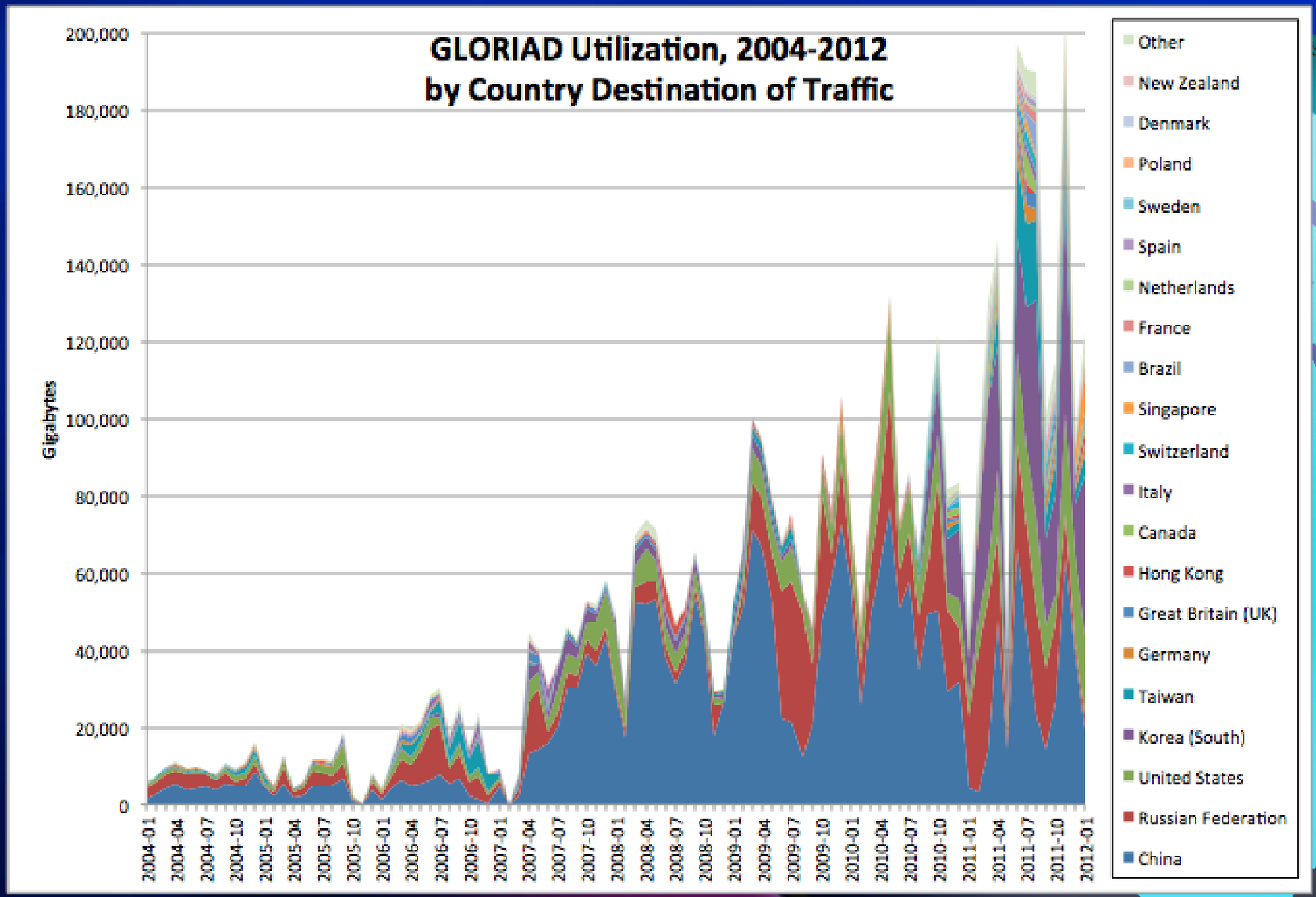
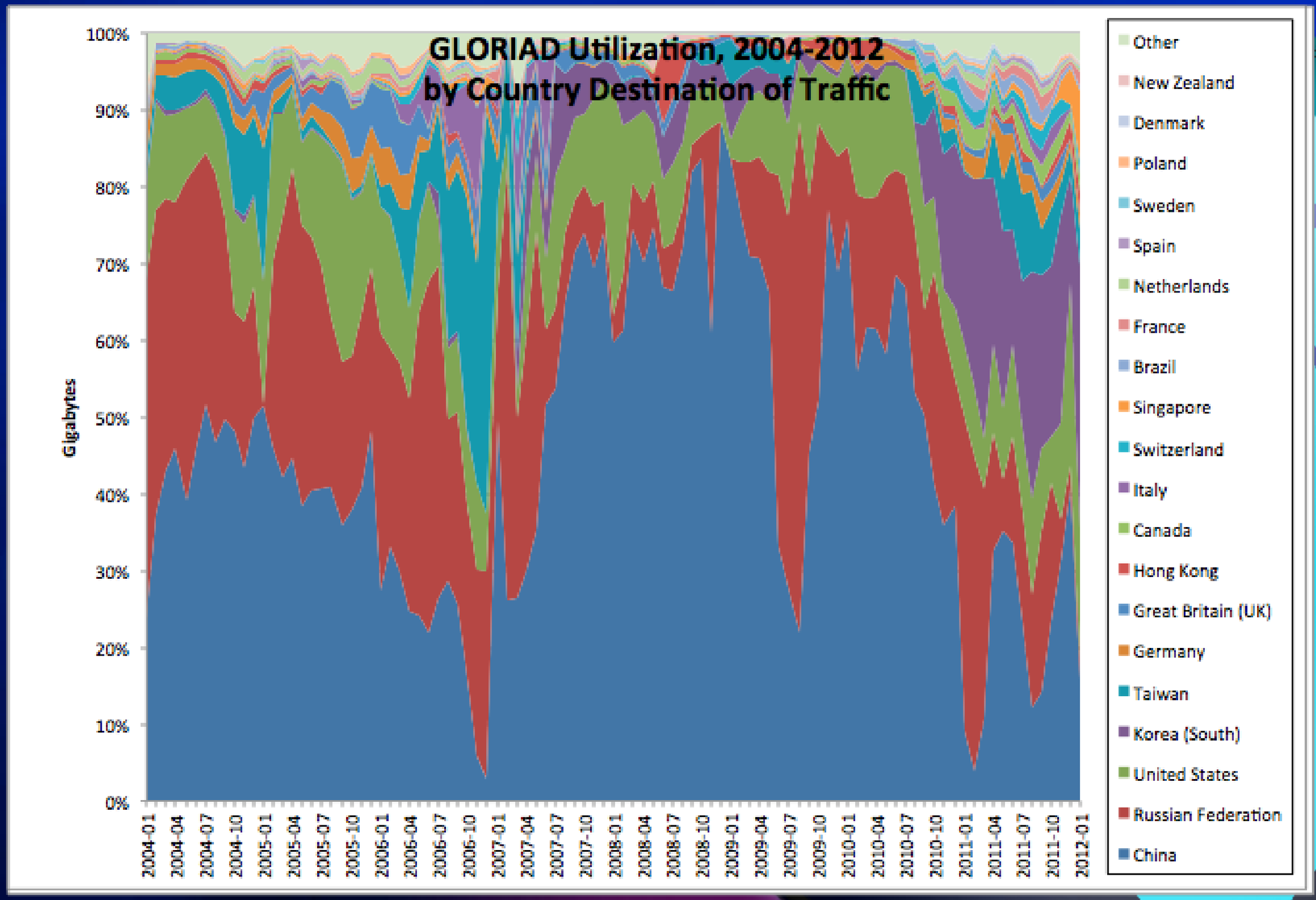


Utilization



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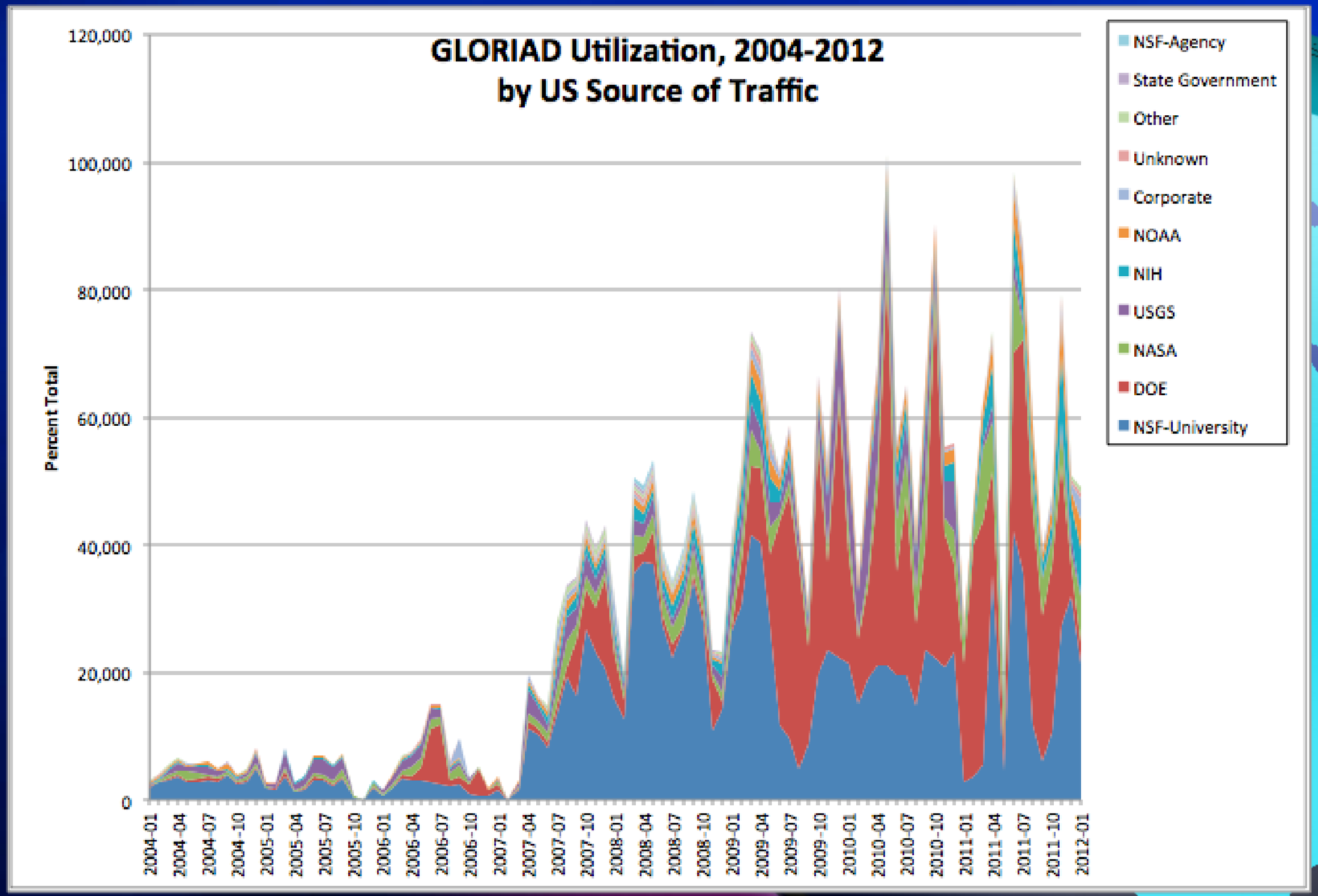

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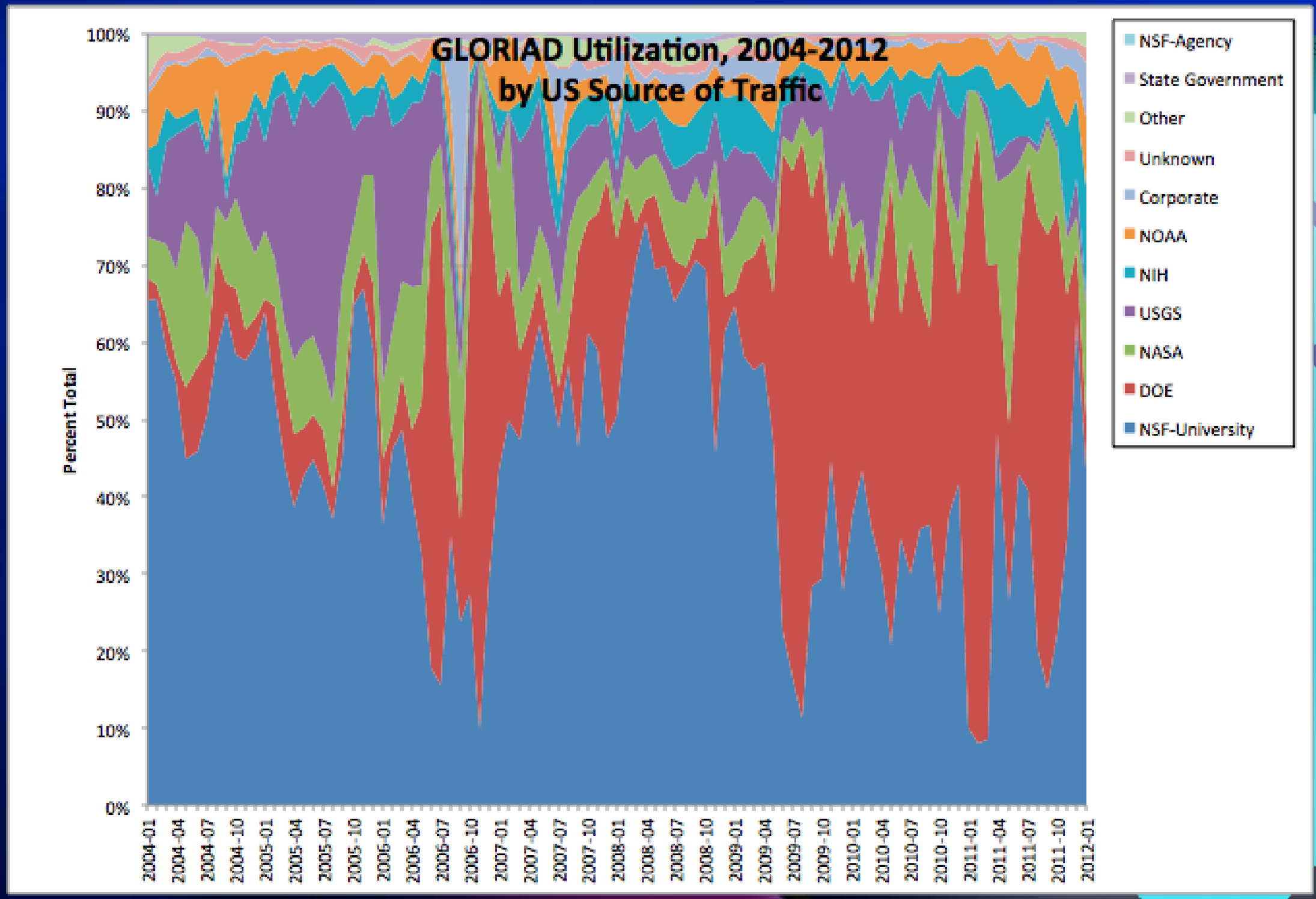

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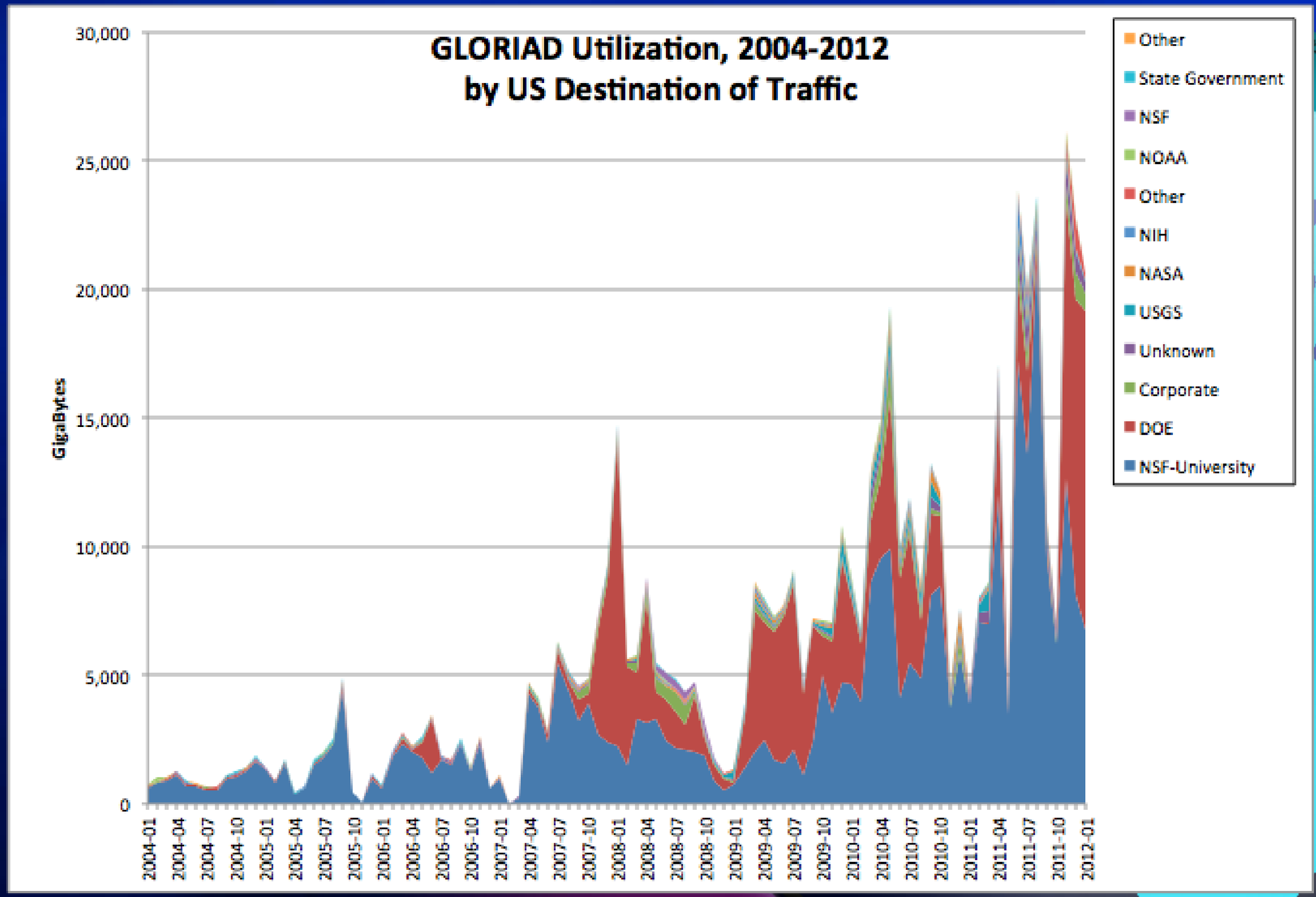
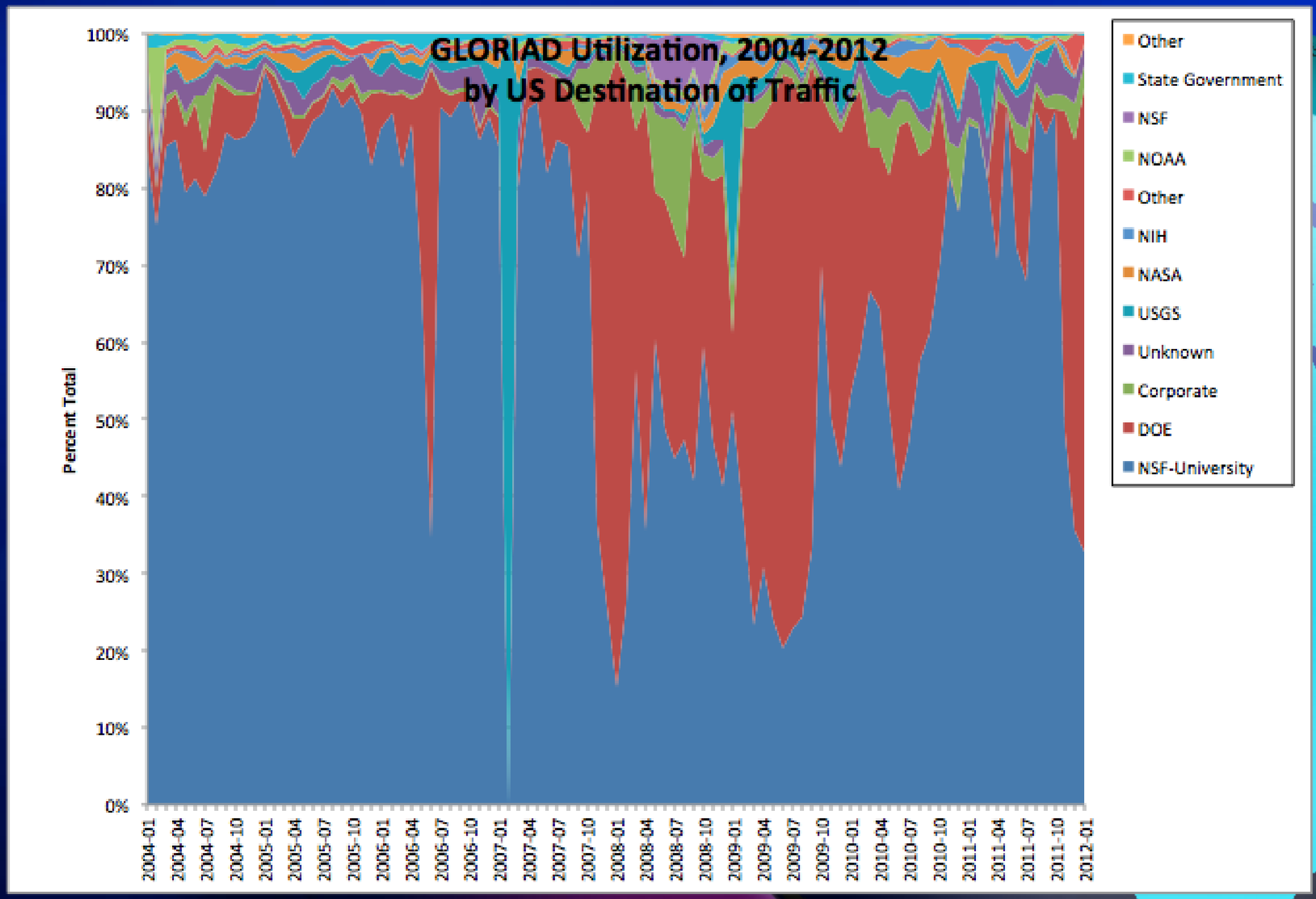


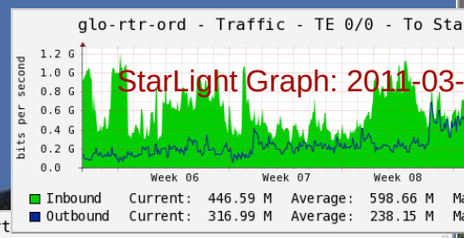
Utilization

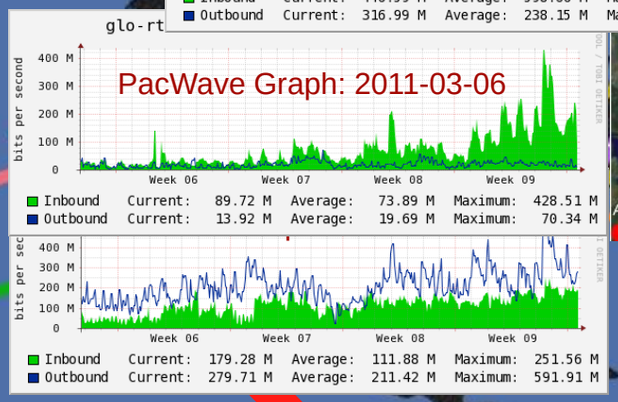


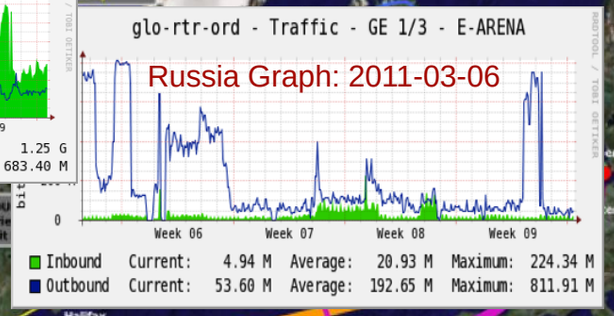
GLORIAD Goals (2010-15)

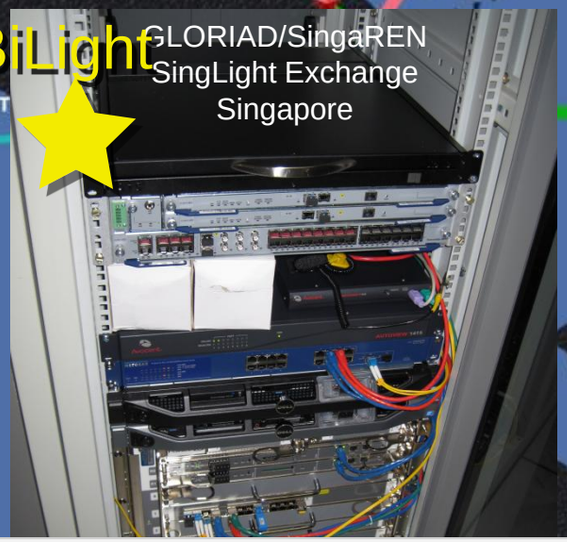
- Strengthen existing partnerships & infrastructure, and implement latest innovations in technology and governance for communities that GLORIAD has served for many years;
- Build on new Taj foundation to increase capacity and expand services across the new infrastructure; and
- Involve all GLORIAD (and GLIF and IRNC) partners and infrastructure to extend access to inadequately connected communities and underserved regions - through an increased number of “StarLight/NetherLight” type exchanges and new high capacity links

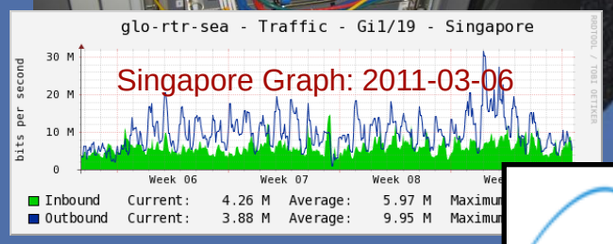
Infrastructure Improvements











Egypt

BiLight

MoscowLight

BeijingLight

KISTI

10G/glo-ru

12.5G/glo-kr

1G/glo-taj

10G/glo-cn

GLORIAD

PROJECTED

NSF

TATA

Leadership with trust

Global Netwave

INTERNATIONAL CENTRE for THEORETICAL SCIENCES

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

tifr

Bangalore India Open Exchange Facility for Global Scientific Cooperation - BIxLight

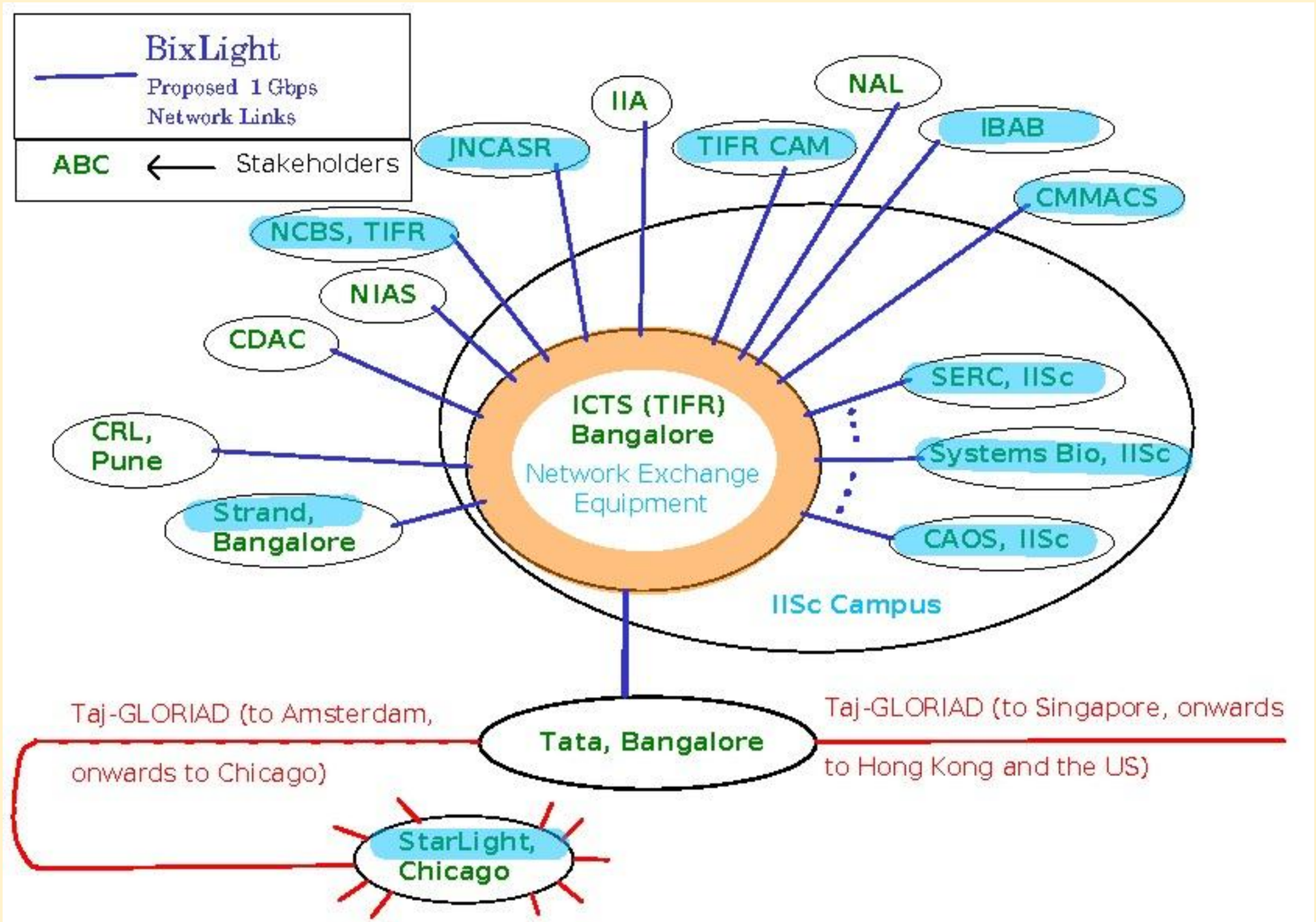
Project Initiated by some of India's leading Researchers and Institutions to support the Data Intensive Sciences

Principal Investigator – Prof. Spenta Wadia

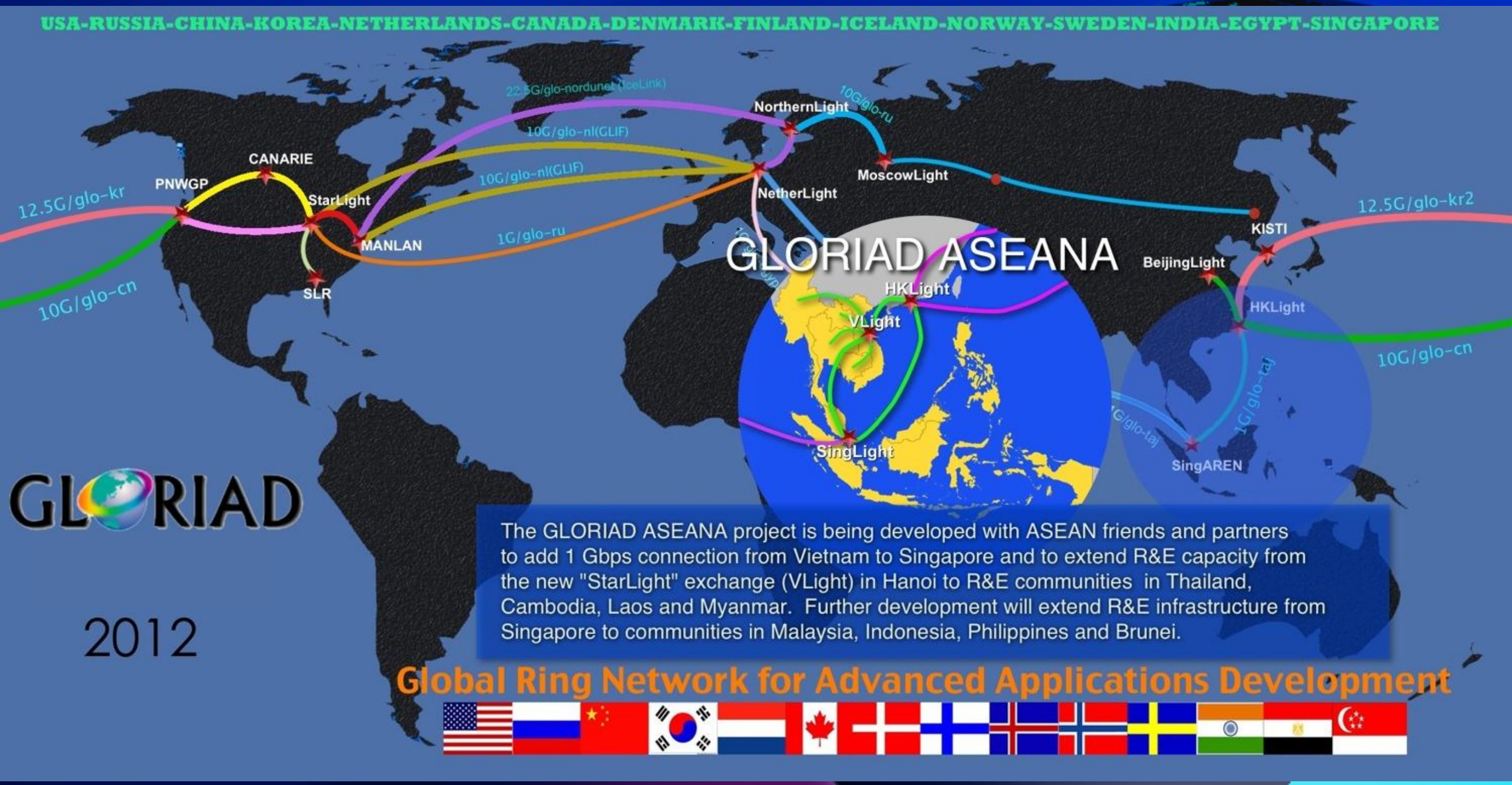
Director, International Centre of Theoretical Sciences (ICTS) of the Tata Institute of Fundamental Research (TIFR)

Chief Mentor– Prof. Roddam Narasimha

Broad areas of research covered so far include Atmospheric and Oceanic Sciences, Biological Sciences, Physics, including High Energy Physics and Astrophysics and Material Science



Vietnam/ASEAN Cooperation



GLORIAD

2012

The GLORIAD ASEANA project is being developed with ASEAN friends and partners to add 1 Gbps connection from Vietnam to Singapore and to extend R&E capacity from the new "StarLight" exchange (VLight) in Hanoi to R&E communities in Thailand, Cambodia, Laos and Myanmar. Further development will extend R&E infrastructure from Singapore to communities in Malaysia, Indonesia, Philippines and Brunei.

Global Ring Network for Advanced Applications Development

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

NSF

USAID
FROM THE AMERICAN PEOPLE

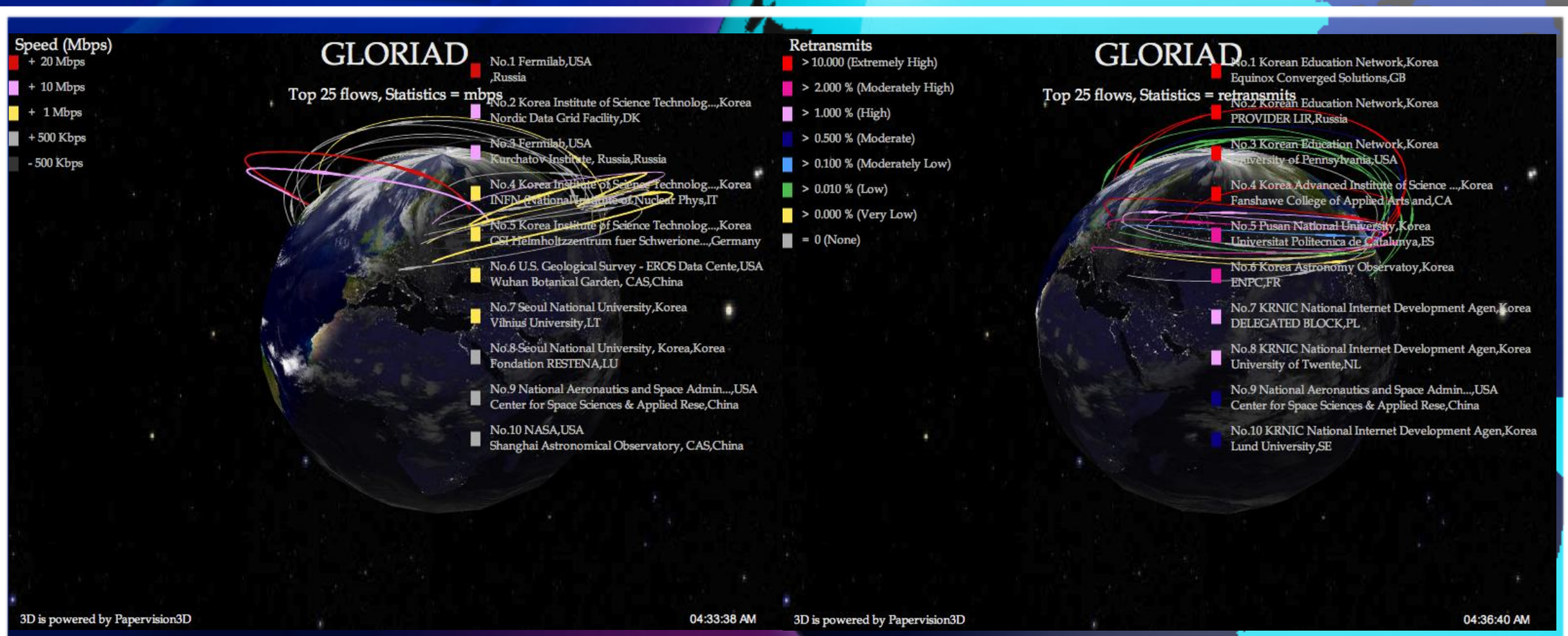
Egyptian Advanced Science and Technology Exchange ("EASTLight") "StarLight in Cairo"

- Managed by ENSTInet and TE
- Serve as interconnect for Egyptian Networks, Institutions
- Serve as regional hub for connectivity with R&E communities – ex: Kenya, Ethiopia, North/South Sudan
- Serve as exchange for high capacity circuits to Asia (India, Singapore) and Europe (Amsterdam, Marseille, etc.)
- Serve as eastern connect for North African Ring
- Serve as regional development/support center for advanced infrastructure and applications development (HPDMnet, LHCone, OpenFlow, iGENI, etc.)
- Serve as host for data storage/database hosting/mirroring, grid clusters, testbed infrastructure

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. Software base: Luca Deri’s nprobe.

Thank you China/CSTnet partners (especially Hui Li and Zhang Lei during their 2 month stay in Knoxville)



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 (limited to 1 Gbps circuit capacity).

GLORIAD Next Steps

- Work with Egyptian partners on new link and Starlight" facility (and partnership on new USAID-funded GLORIAD in Africa project)
- Hong Kong Workshop on GLORIAD in Asia (Singapore, China, India, Vietnam, Korea, Egypt, US)
- 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" (10G upgrade)
- Improve North American services/capacity for GLORIAD/GLIF partners (especially Seattle-Chicago)
- NSI deployment
- ***LHCONE deployment/support***
- Continued development of new dvNOC and Zeeba programs
- Upgrade of PacWave connection to 10 Gbps (from 1Gbps)
- IPv6 services (recent acquisition of IPv6 address space)

GLORIAD Next Steps

- GLORIAD Performance Data feed to PerfSonar
- Two REU students
- Improvements to measurement/monitoring infrastructures (including new work on security (Bro at 10Gbps))
- Improve planning and integration with GLIF community
- Discuss/Develop possibilities for North Africa Ring
- Develop/Support efforts for “GLORIAD in Africa” program - with AMCOST, ENSTInet and GLORIAD/GLIF partners
- Green GLORIAD

Thank you