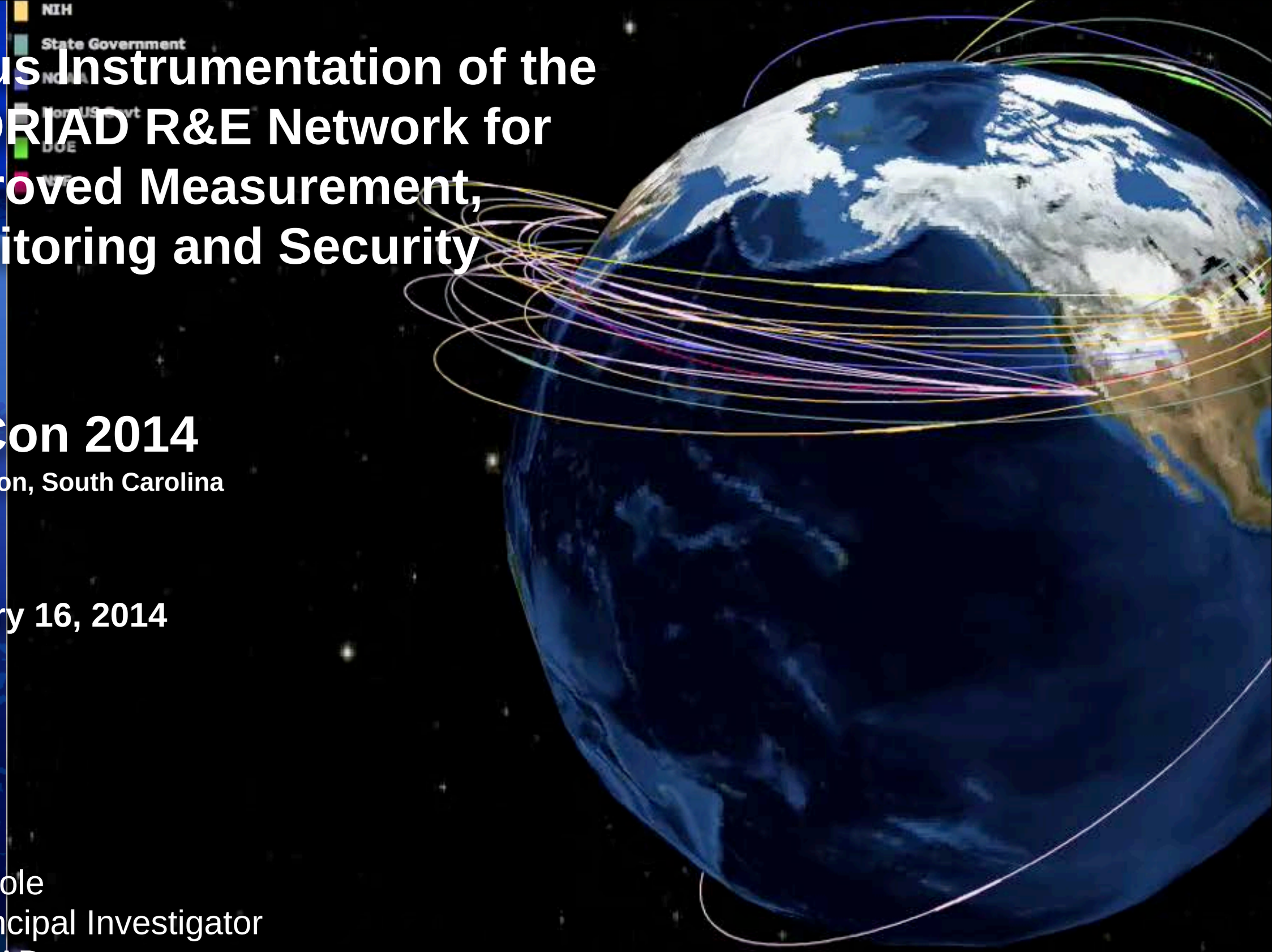
Argus Instrumentation of the GLORIAD R&E Network for Improved Measurement, Monitoring and Security



FloCon 2014

Charleston, South Carolina

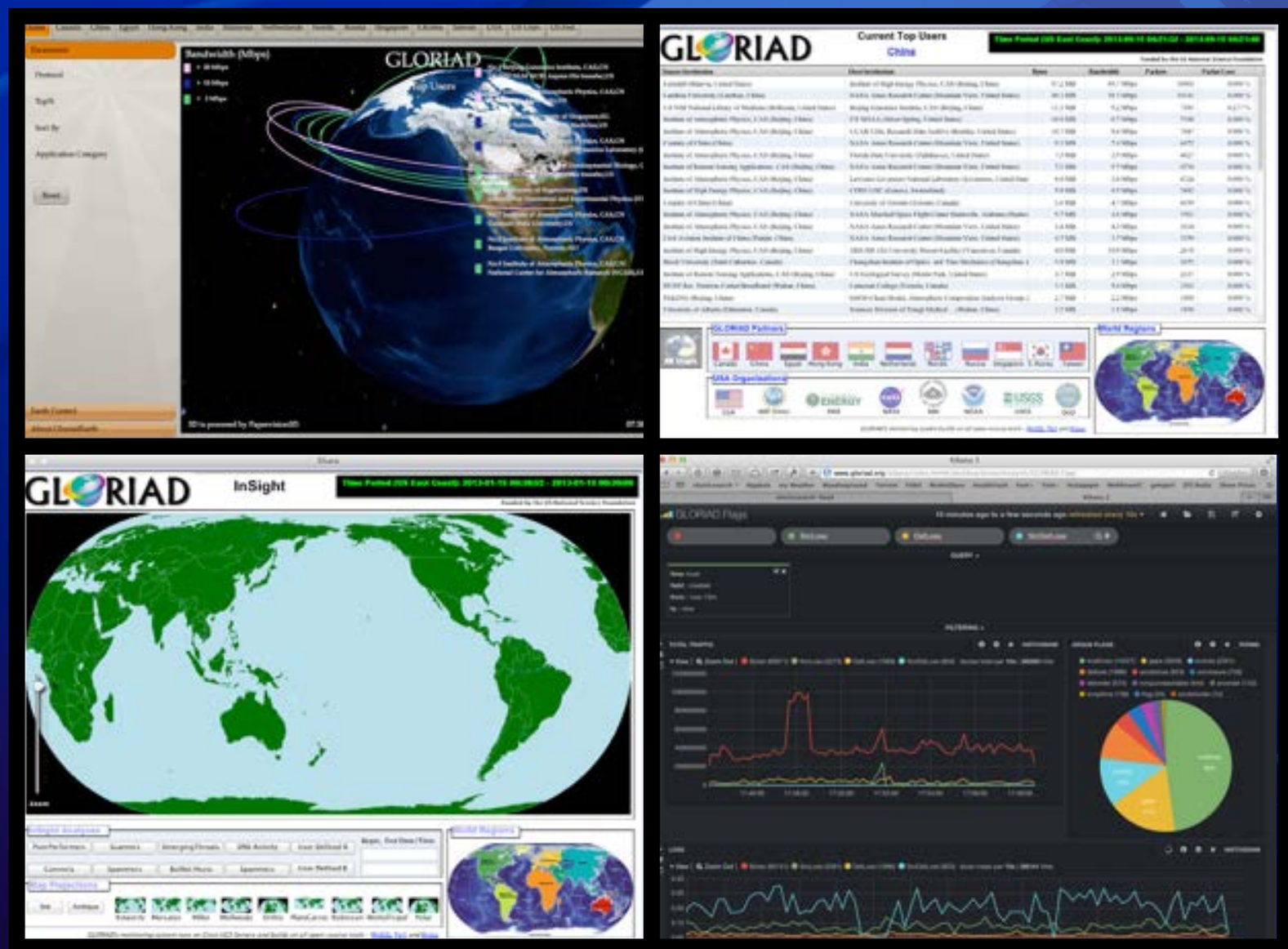
January 16, 2014

Greg Cole
US Principal Investigator
GLORIAD
gcole@gloriad.org

GLORIAD

Measurement and Monitoring System

or how do we get (meaningful/useful/actionable information) from ...



for sustaining and operating a global high-speed research & education network

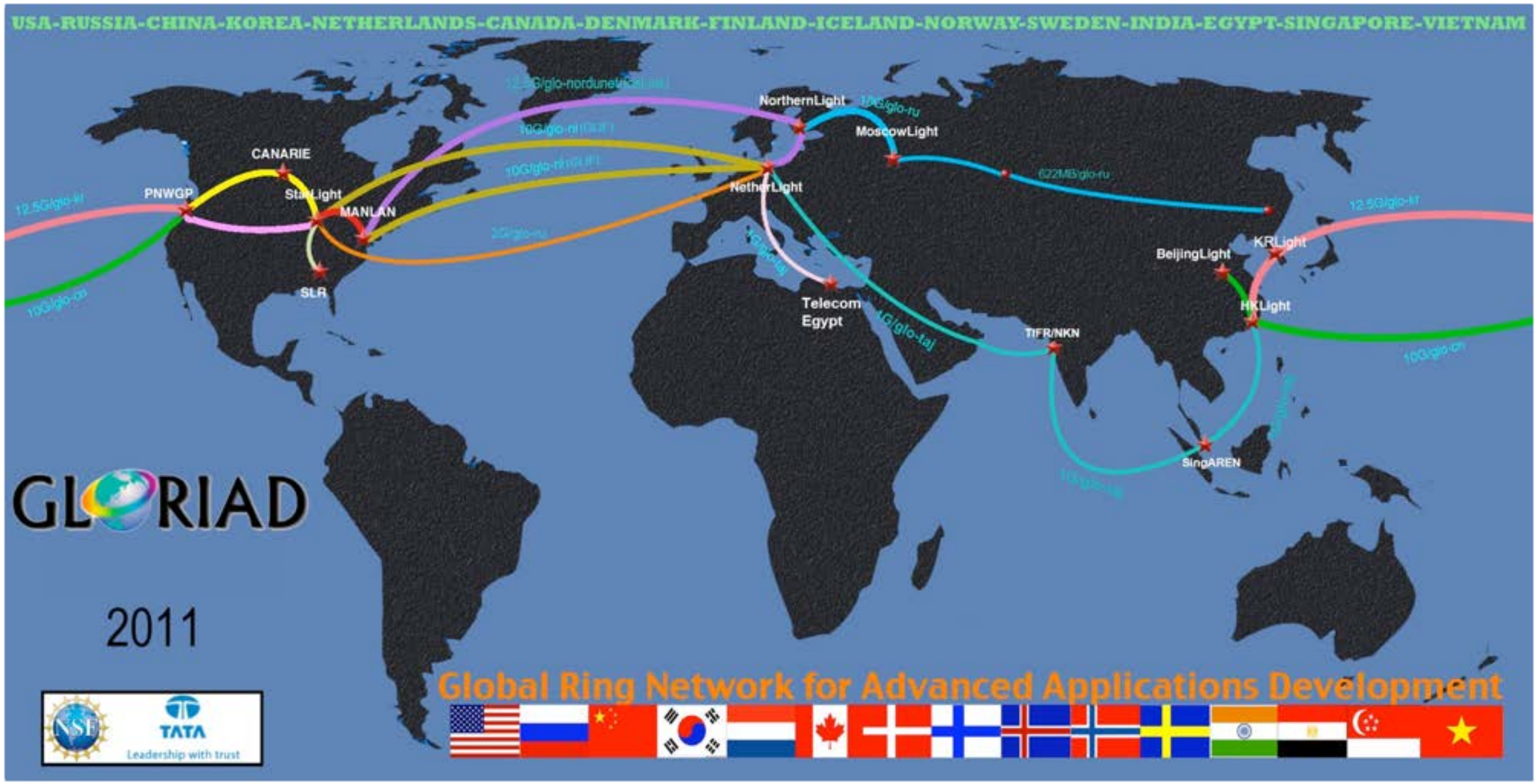
Presentation Objectives

- Not selling anything ..
- Not looking for money ..
- Looking to share and explore ideas ..
- Looking for partners to build and promote open networks for global science, education and medical collaboration ..
- Looking for best ideas for analyzing and visualizing tons of argus data

Schedule ..

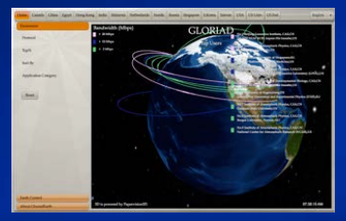
- 5m: introduction and demonstrations
- 5m: GLORIAD
- 20m: Technical map

The GLORIAD Science & Education Network



- Partners: SURFnet, NORDUnet, CSTnet (China), e-ARENA (Russia), KISTI (Korea), CANARIE (Canada), SingaREN, ENSTInet (Egypt), Tata Inst / Fund Rsrch/Bangalore Science Community, NAv6 (Malaysia), NLR/Internet2/NLR/NASA/ FedNets, CERN/LHC
- Sponsors: US NSF ($18.5M 1998-2015), Tata ($6M), USAID ($3.5M 2011-2013) 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; 2013 GLORIAD/Malaysia

Demo



User Tools for Analysis, Operational Support and Visualization

dvNOC | GloTOP | GLOEarth | Ticketing System | ... | NOC Access

"Farm" of Perl/POE/IKC Daemons Near-Realtime Analytics and Local Storage of Data

"Top Users" | DNS Analysis | Bad Performers | Link Analytics | BGP Analysis | ... | ICMP Analysis | Scan Analysis

32 core Cisco Blade Server (freeBSD) with 128G RAM, 5T RAID storage

Argus Data (from Argus Nodes to a Core Radium Collector)

Argus Nodes (for GLORIAD currently, Chicago and Seattle)

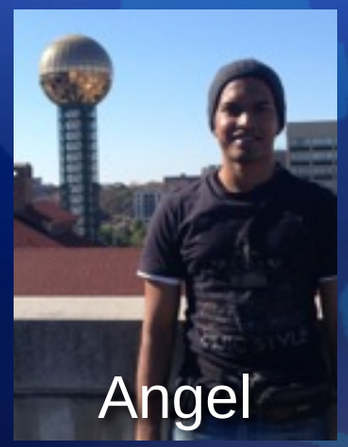
But First ..

Thank you

QoSient, LLC


Harika


Casey


Angel

FloCon2014

January 13-16, 2014 | Charleston, South Carolina

Global Ring Network for Advanced Applications Development (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, 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: ~$240M). Part of broader NSF Program called International Research Network Connections.

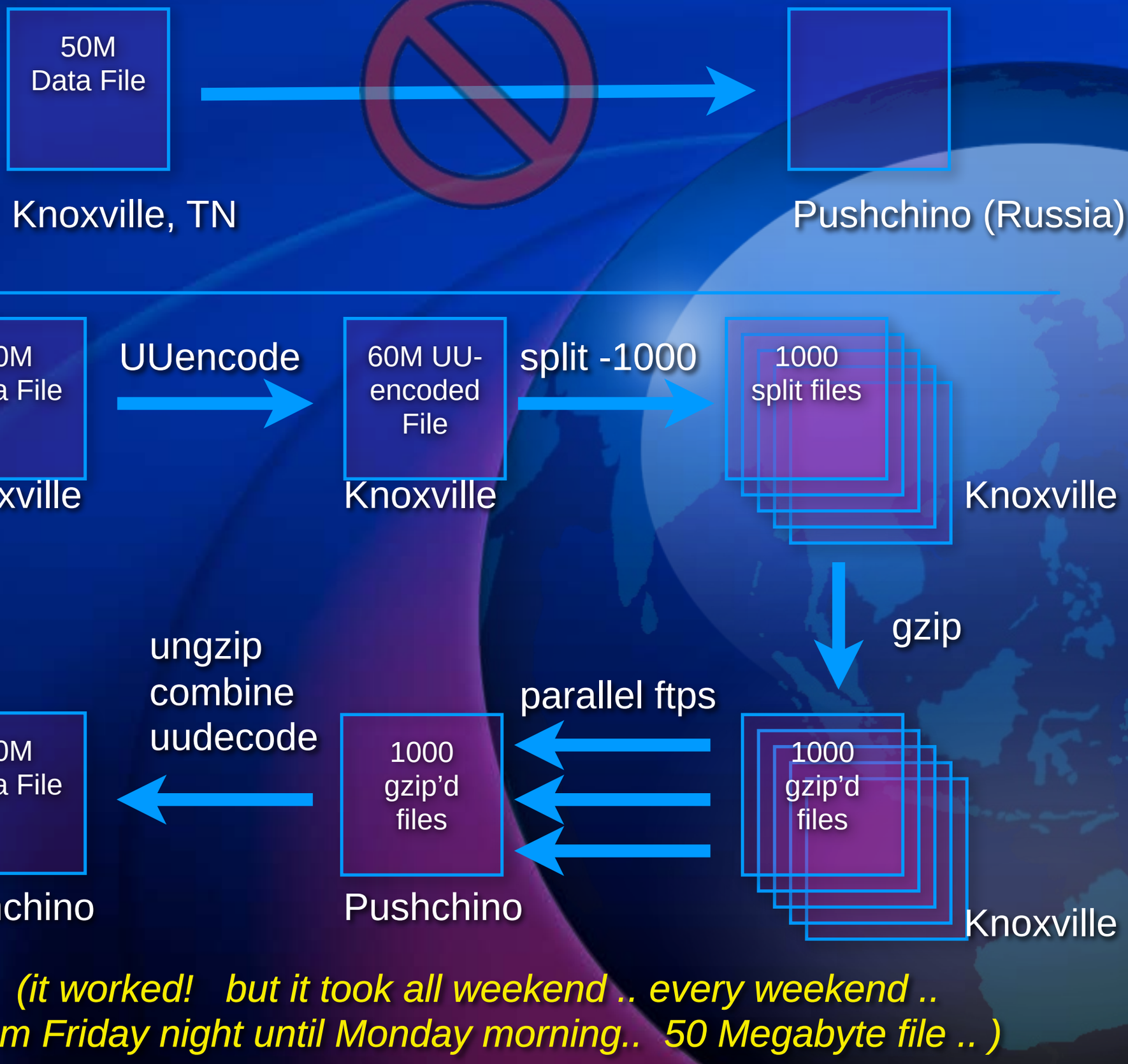
- Started from a single email ..

GLORIAD: The Movie

Produced by Korean partners at KISTI

Since production of this movie, GLORIAD has welcomed new partners in NORDUnet (Norway, Denmark, Finland, Iceland, Sweden), Egypt, Singapore and India

Why High Speed Networking? (from 1996)



(it worked! but it took all weekend .. every weekend ..
from Friday night until Monday morning.. 50 Megabyte file ..)

Why High Speed Networking?

Share

GLORIAD

Current Top Users

Russian Federation

Time Period (US East Coast): 2014-01-08 15:57:41 - 2014-01-08 15:57:50

Funded by the US National Science Foundation

Source Institution	Dest Institution	Bytes	Bandwidth	Packets	Packet Loss
TRIUMF (Tri University Meson Facility) (Vancouver, Canada)	Institute of High Energy Physics RAS (Protvino, Russian Federati	428.1 MB	342.5 Mbps	288474	0.000 %
Institute of High Energy Physics RAS (Protvino, Russian Federatio	CERN LHC (Geneva, Switzerland)	68.5 MB	54.8 Mbps	46190	0.000 %
INFN (National Institute of Nuclear Physics) (Bologna, Italy)	Institute for Theoretical and Experimental Physics (ITEP) (Moscov	51.9 MB	41.5 Mbps	34201	0.000 %
Kurchatov Institute (Moscow, Russian Federation)	ESnet (Berkeley, United States)	34.0 MB	27.2 Mbps	22371	1.274 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	Karlsruhe Institute of Technology (KIT) (Leopoldshafen, Germany	27.4 MB	21.9 Mbps	18098	0.000 %
National Laboratory for High Energy Physics (KEK) (Ibaraki, Japa	Kurchatov Institute (Moscow, Russian Federation)	23.5 MB	18.8 Mbps	15467	0.000 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	CERN LHC (Geneva, Switzerland)	16.5 MB	13.2 Mbps	10896	0.000 %
NASA Ames Research Center (Mountain View, United States)	Institute of Atmospheric Physics RAS (Moscow, Russian Federati	8.1 MB	6.5 Mbps	5347	0.243 %
Kurchatov Institute (Moscow, Russian Federation)	Lawrence Livermore National Laboratory (Livermore, United State	6.8 MB	5.4 Mbps	4458	1.077 %
Kurchatov Institute (Moscow, Russian Federation)	National Laboratory for High Energy Physics (KEK) (Ibaraki, Jap	5.4 MB	4.3 Mbps	3526	0.000 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	Academia Sinica Grid Computing (Taipei, Taiwan)	5.0 MB	4.0 Mbps	3295	0.000 %
Kurchatov Institute (Moscow, Russian Federation)	KISTI (Korea (South))	3.4 MB	2.7 Mbps	2256	0.709 %
Kurchatov Institute (Moscow, Russian Federation)	Korea Institute of Science and Technology Information (KISTI) (D	3.1 MB	2.5 Mbps	2048	43.555 %
Space Research Institute (CPI company LAN) (Moscow, Russian F	Country of Japan (Japan)	2.6 MB	2.1 Mbps	1791	0.000 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	Lawrence Livermore National Laboratory (Livermore, United State	2.1 MB	1.7 Mbps	1363	2.788 %
Helmholtz Centre for Heavy Ion Research (GSI) (Darmstadt, Germa	Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mo	2.0 MB	1.6 Mbps	1394	0.000 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	TUBITAK - Scientific and Technological Research Council of Tur	1.9 MB	1.5 Mbps	1269	0.000 %
Karlsruhe Institute of Technology (KIT) (Leopoldshafen, Germany)	Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mo	1.6 MB	1.3 Mbps	1128	0.000 %
National Laboratory for High Energy Physics (KEK) (Ibaraki, Japa	Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mo	1.6 MB	1.3 Mbps	1050	0.000 %
Institute for Nuclear Research, Scientific Center Troitsk, RAS (Mos	Korea Institute of Science and Technology Information (KISTI) (D	1.6 MB	1.3 Mbps	1036	3.764 %

All Users

GLORIAD Partners

Canada China Egypt Hong Kong India Netherlands Nordic Russia Singapore S. Korea Taiwan

USA Organizations

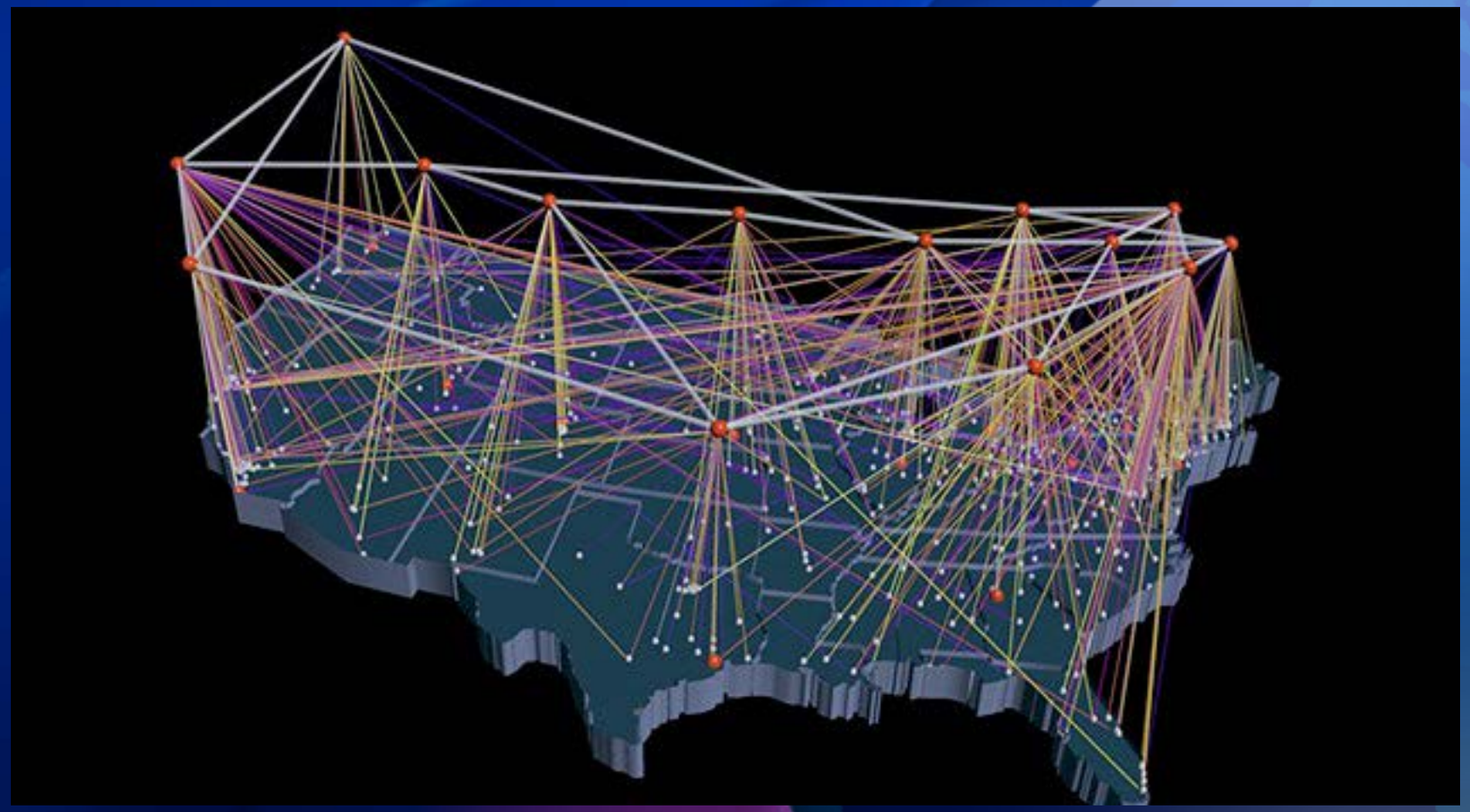
USA NSF (Univ) DOE NASA NIH NOAA USGS DoD

World Regions

GLORIAD's monitoring system builds on all open-source tools - MySQL, Perl and Argus

Research and Education Networking?

Early* NSF vision of R&E networking



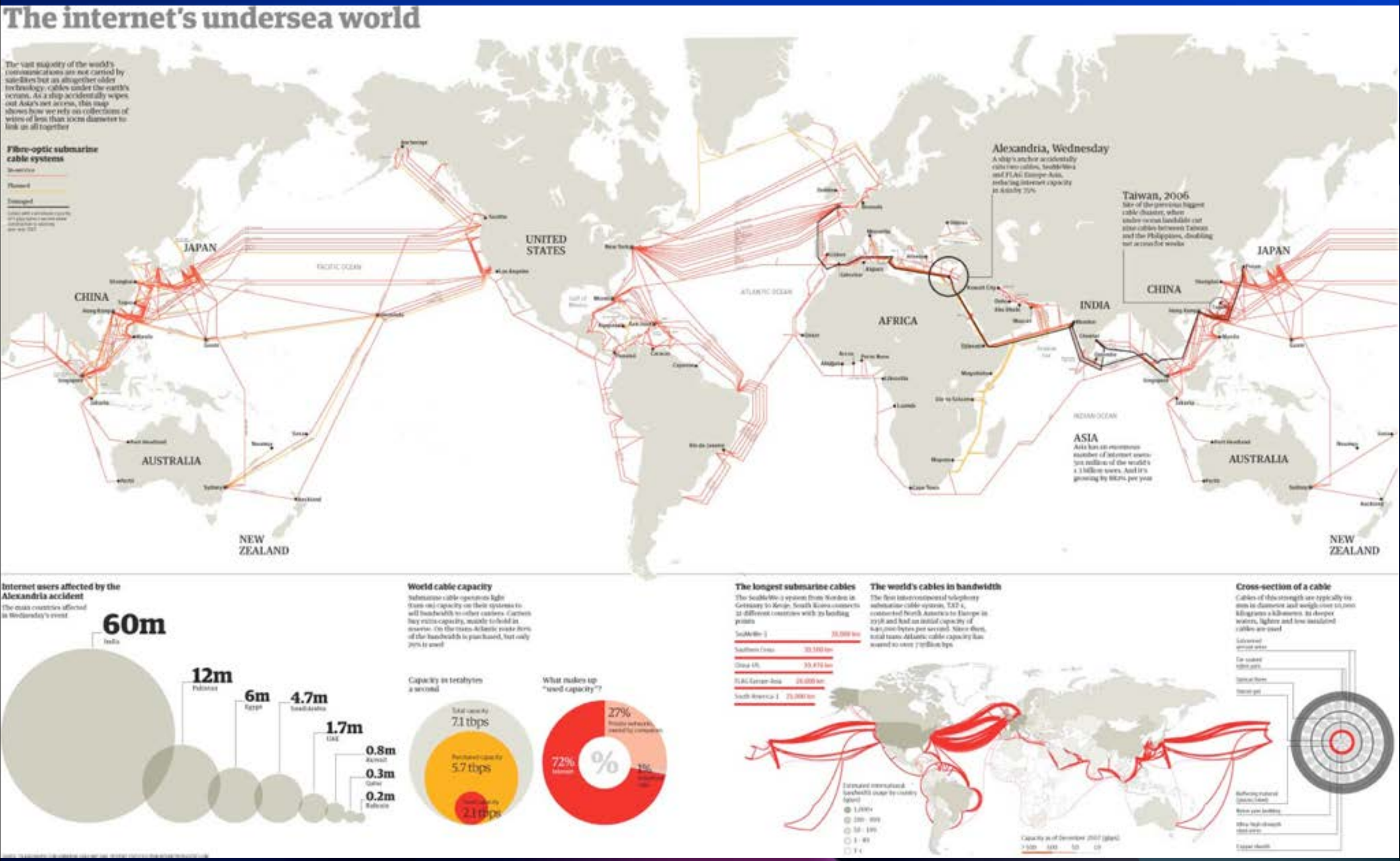
*1992, by Donna Cox and Bob Patterson of NCSA

Advanced R&E networking today

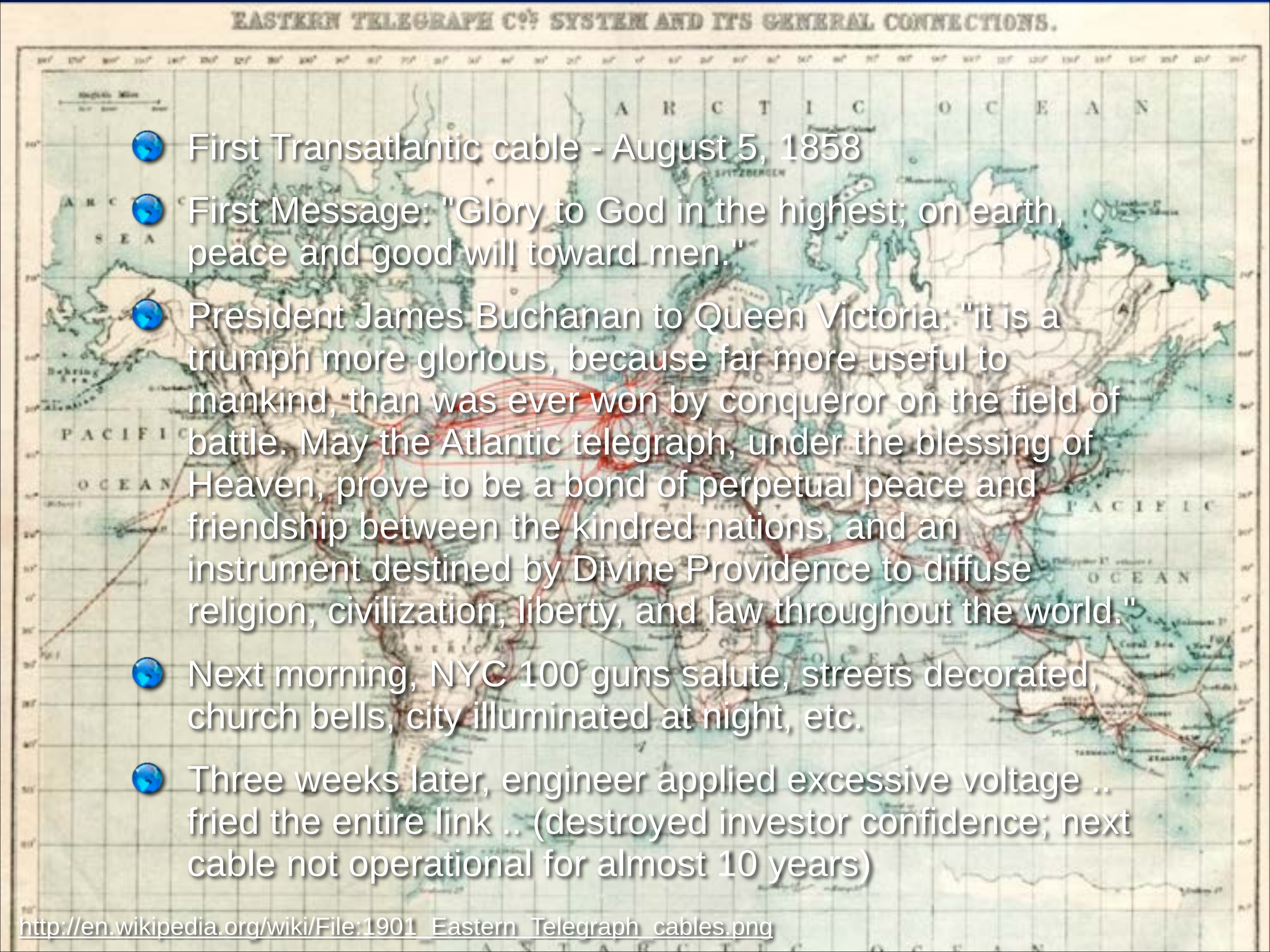
*2008, by Maxine Brown, Bob Patterson, TransLight/StarLight, NCSA, GLIF

FROM: HTTP://WWW.GLIF.IS/PUBLICATIONS/MAPS/GLIF_8-08_640X368.MOV

The Internet's Undersea World



http://image.guardian.co.uk/sys-images/Technology/Pix/pictures/2008/02/01/SeaCableHi.jpg



- First Transatlantic cable - August 5, 1858
- First Message: "Glory to God in the highest; on earth, peace and good will toward men."
- President James Buchanan to Queen Victoria: "it is a triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle. May the Atlantic telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty, and law throughout the world."
- Next morning, NYC 100 guns salute, streets decorated, church bells, city illuminated at night, etc.
- Three weeks later, engineer applied excessive voltage .. fried the entire link .. (destroyed investor confidence; next cable not operational for almost 10 years)

http://en.wikipedia.org/wiki/File:1901_Eastern_Telegraph_cables.png

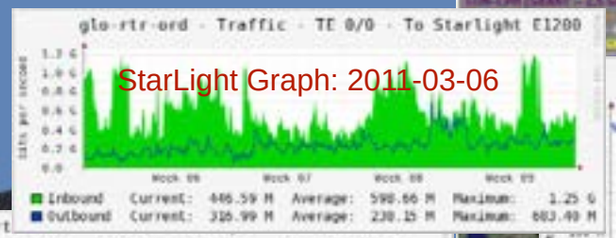
GLORIAD History

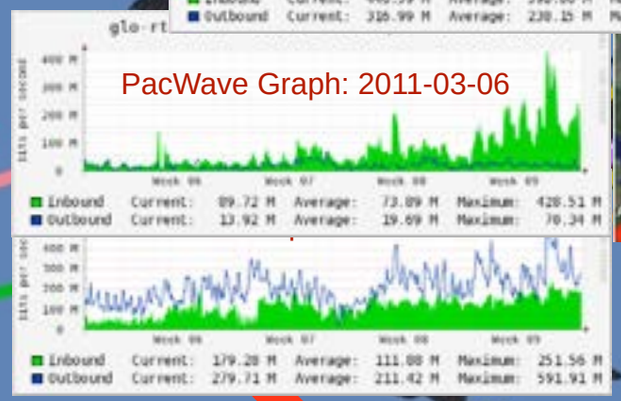
- 1994 - Started “Friends & Partners” on-line community network
- 1995 - Started KORRnet and Russian Civic Networking Projects
- 1997 - Started MIRnet US-Russia high speed science network
- 2001 - Moved to NCSA, University of Illinois
- 2002 - Upgraded MIRnet to 45 Mbps
- 2003 - Upgraded MIRnet to 155 Mbps
- 2004 - Added China/CSTnet! Launched “Little-GLORIAD” as first R&E network ring around the world (US-Russia-China - 155 Mbps)
- 2004 - Moved project back to ORNL/UT (JICS) with new 5-year NSF Funding
- 2005 - Added Korea (10G!), Netherlands (Europe exchange), Canada (transit NA)
- 2006 - Added Nordic countries (re-established direct US-Nordic ties)
- 2009 - Started Taj project (Stimulus funds)
- 2010 - New 5 year NSF Funding
- 2011 - GLORIAD-Singapore Launched; New USAID Funding for GLORIAD in Africa
- 2011 - December - GLORIAD Egypt Launches
- 2012 - January - Hong Kong Workshop; June - GLORIAD India Launched
- 2012 - August - APAN - GLORIAD Agreement
- 2013 - October - Visits to Qatar and Malaysia

“Little GLORIAD” January 12, 2004 Beijing

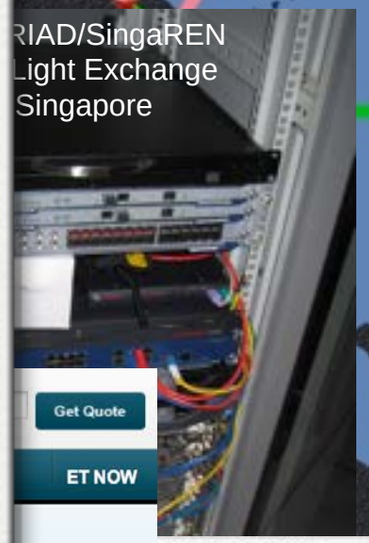
Infrastructure Improvements: 2009 to 2012

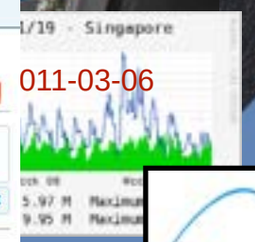
Taj Project ($2.2M US Stimulus Funds + $11M intl match)





so that .. young person in Kansas can communicate instantly with a young person in Cairo .. “
June 4, 2009, Cairo, Egypt





GLORIAD PROJECTED

NSF TATA Leadership with trust

Global Netwave

Single flows > 2 Terabytes so far

Key word in

GLORIAD:

Applications

The Driver: Science, Education and Medical Applications (Sample: US-Malaysia/Indonesia)

Building a molecular foundation for tropical mycorrhizal biology: Sporocarp surveys of ectomycorrhizal fungal diversity of Southeast Asian dipterocarp forests

Peay, Kabir CA
Stanford University
kpeay@stanford.edu
Systematics & Biodiversity Sci

The Dipterocarpaceae is the most diverse and abundant tree family in the lowland tropical rain forests of Southeast Asia. There are more than 500 species and all depend on root-associated fungi called ectomycorrhizal (ECM) fungi to obtain soil nutrients. Ectomycorrhizal fungi have evolved intimate associations with particular groups of trees in forest communities across the world, but they are rare in most lowland tropical regions. However, the extent of ECM fungal diversity is unknown, thereby making tests of important evolutionary and ecological hypotheses difficult. While soil fungi predominantly exist in microscopic form, many fungi make macroscopic fruiting bodies during the sexual stage of their life cycle, enabling taxonomic identifications that can be coupled with molecular data. This project will make use of an existing collection of identified and curated fungi in Malaysia to begin building and DNA database for fungal diversity in dipterocarp forest. This effort will allow environmental samples of soils and roots to be linked to specific species of fungi. Also, fungal fruiting bodies from the dipterocarp forest will continue to be collected, identified, and sequenced at a greater intensity with efforts to identify host tree species of specific fungi. Broader impacts for this project include the teaching and training of local Malaysian assistants and students. We will also provide an intensive training workshop for foreign and Malaysian researchers in the collection and identification of fungal sporocarps in the field. Digital images of sporocarps will be publicly available online. Since dipterocarps are also highly prized for timber and have experienced some the highest deforestation rates in the world, this research will be useful for implementing strategies for forest conservation and regeneration.

Video-Conferencing

Bio/medical Apps

Korea-Nordic Live Surgical Procedure, 1 Gbps Video


8K Video Streaming (70 Gbps)

www.ubuntunet.net/sites/ubuntunet.net/files/smithb.pdf

Each antenna must transmit data from two polarisations, so the total data rate for each antenna is 200 Gb/s. Given that the entire structure will have 3000 antennas by the time Phase 2 is complete, suggests a total capacity requirement of 600 Tb/s.

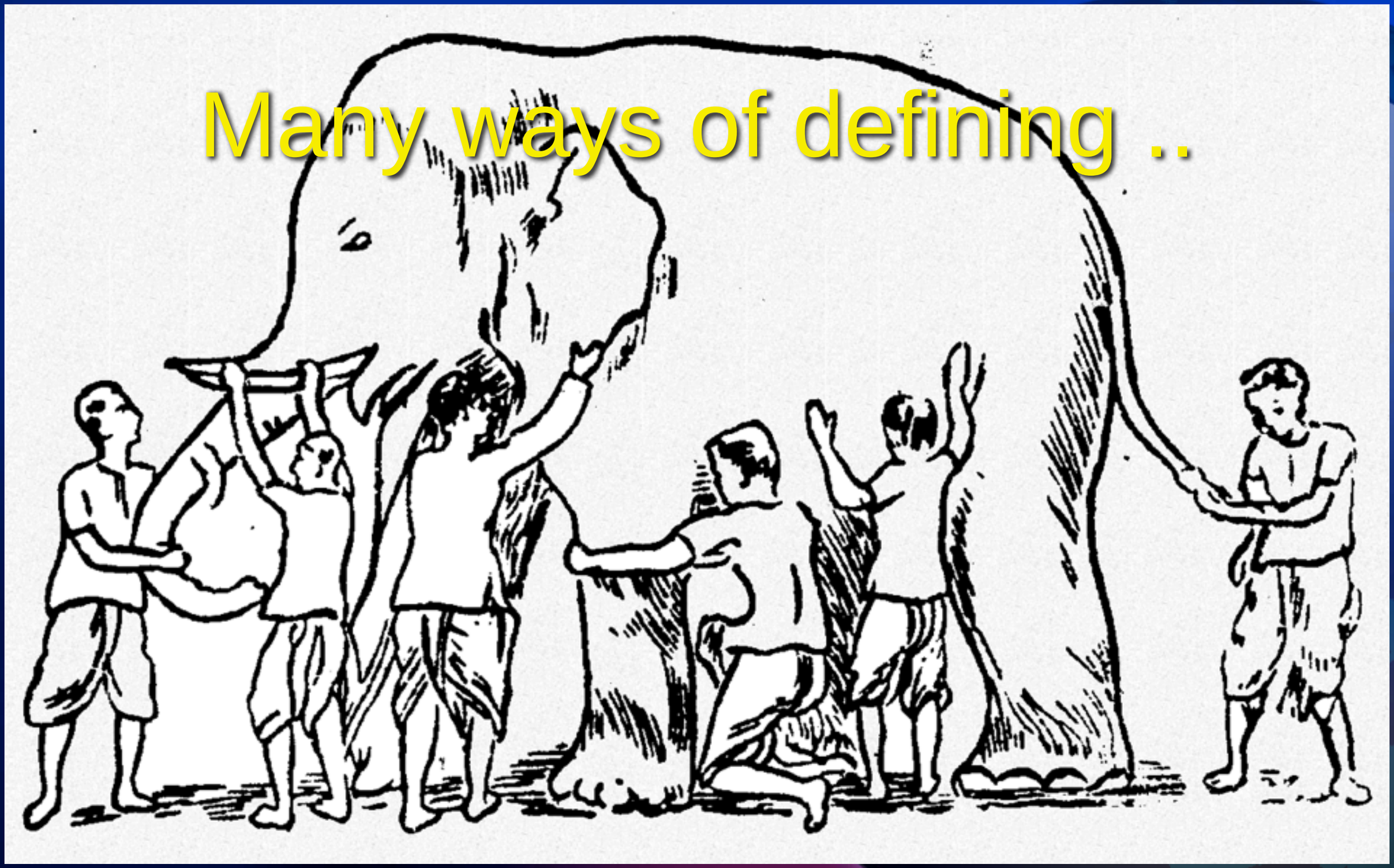
Using recent forecast data, global internet traffic is predicted to reach 100 exabytes (1018) per month by 2016. Assuming a CAGR (Compound Annual Growth Rate) of 25%, it is estimated that global internet traffic will be 750 Tb/s by 2020.

The implication is that, by the time Phase 2 of the Square Kilometre Array is completed and operational, it will be carrying the equivalent of 80% of the global internet traffic over the South African based antenna array alone.

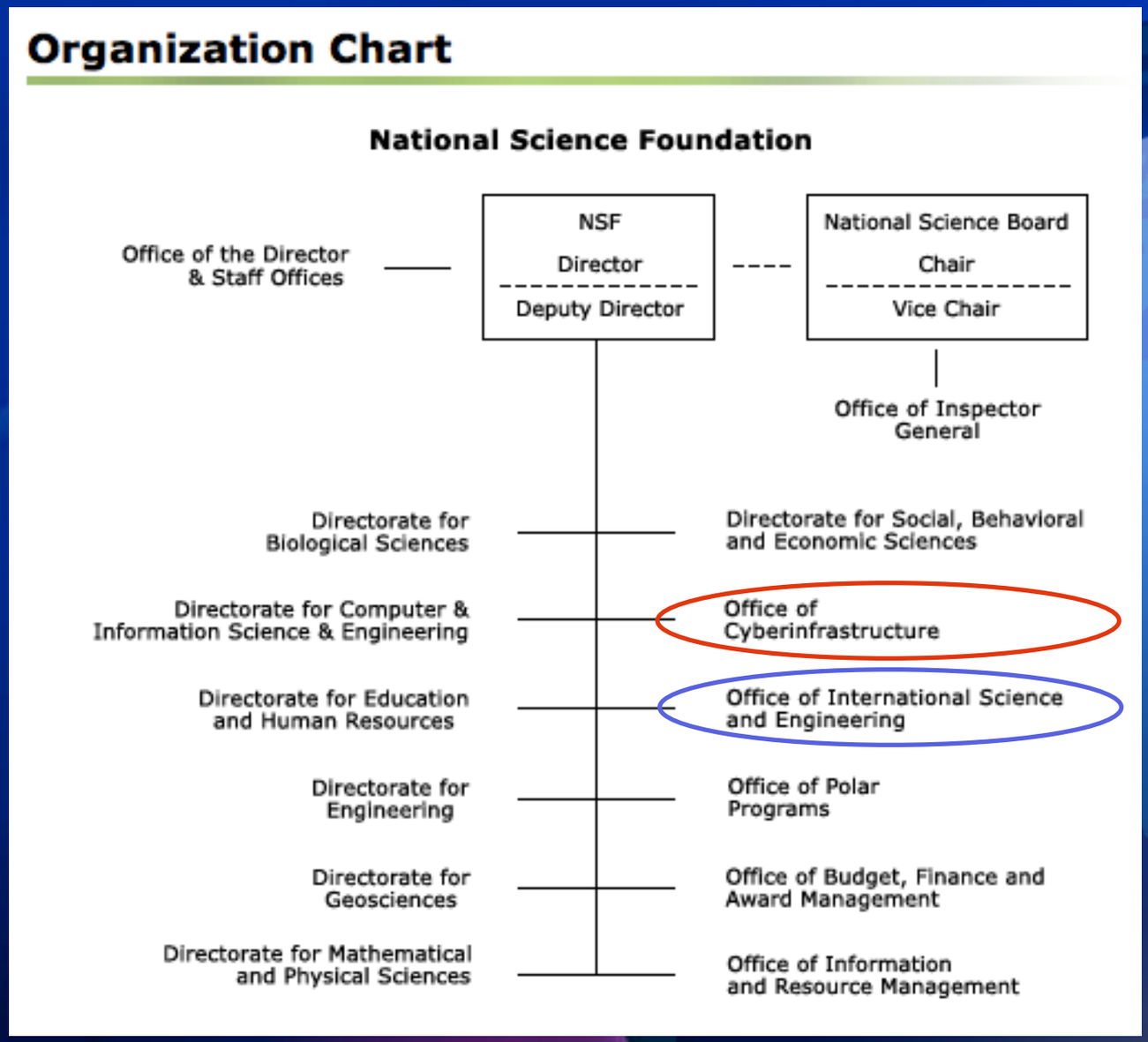
Benefits to Global Partners

- Scientists, educators and students are able to:
  - participate in thousands of simultaneous video-conferences; engage in distance learning, remote seminars, etc.
  - exchange enormous (terabyte-size) data sets
  - share advanced cyberinfrastructure (supercomputers, etc.) in other parts of the world
  - utilize advanced visualization and immersive technologies (such as 3d caves, etc.)
  - utilize remote scientific instrumentation - telescopes, microscopes, seismic instruments, etc.
  - engage more easily and more regularly with peers throughout the world
  - build ever more capable internal cyberinfrastructure

GLORIAD?



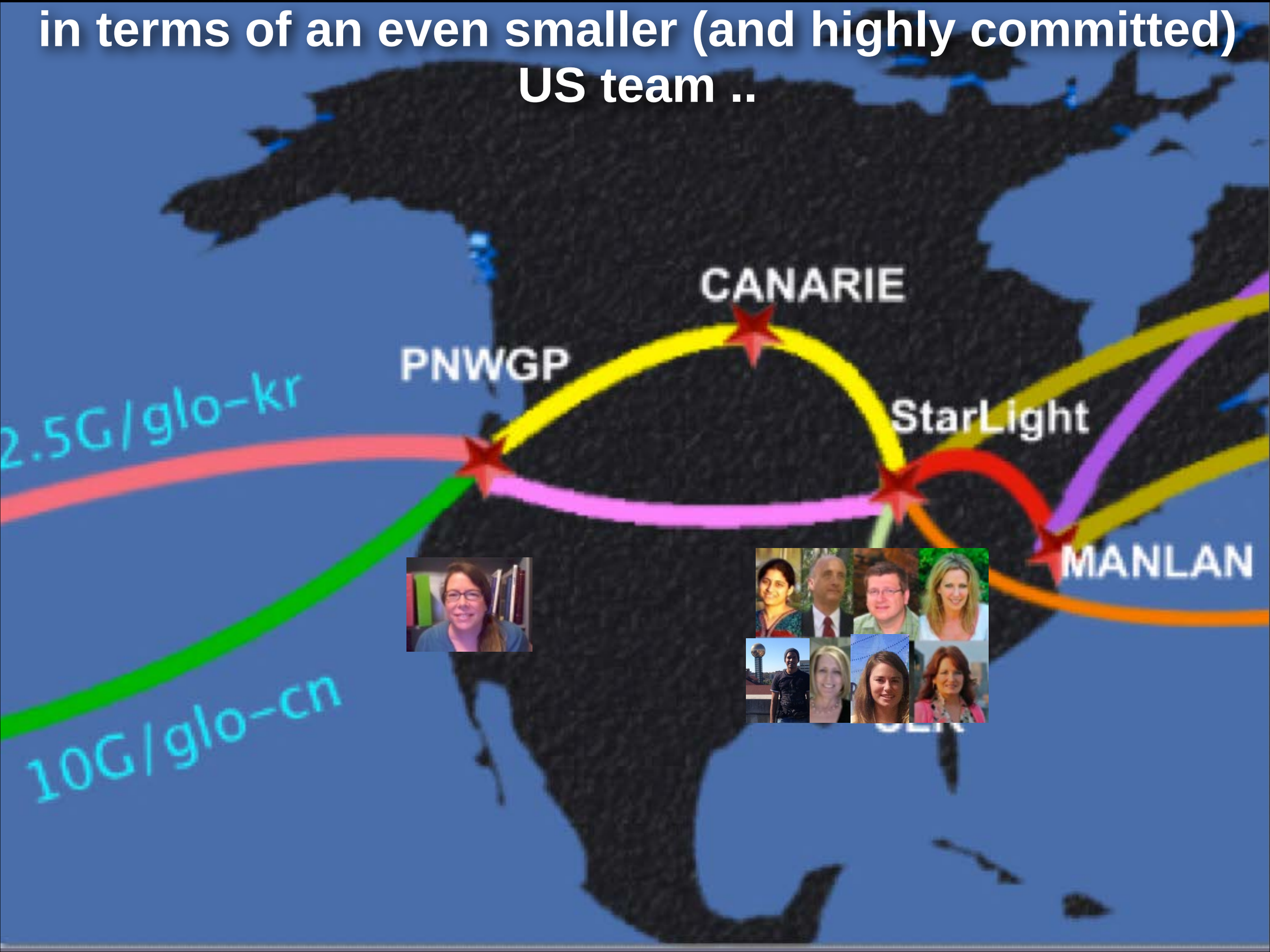
in terms of Sponsorship ..



One of the NSF IRNC Projects (2010-2015)
Follow-on to NSF-/Russian MinSci-Funded MIRnet and NaukaNet programs
(Total NSF $18.5M, 1998-2015; International: ~$240M)

in terms of a very small but committed community ..

in terms of an even smaller (and highly committed) US team ..



in terms of Technical Operations

National LambdaRail (NLR)

Internet2

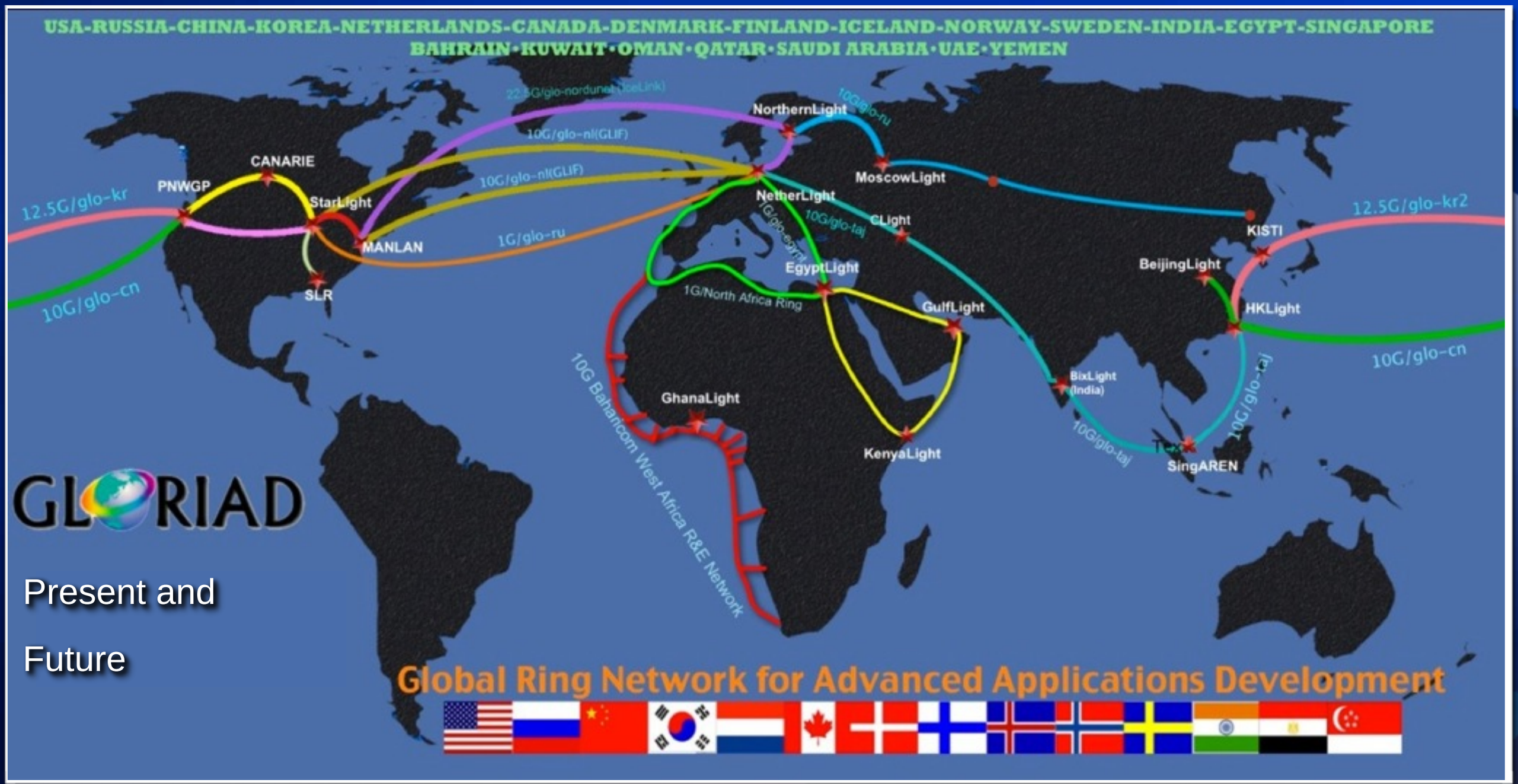
NASA Networks

Federal Research Networks (NIH, USGS, NOAA, etc.)

DOE ESnet

Southern Light RAil

in terms of the International Infrastructure (circuits) ..



- 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
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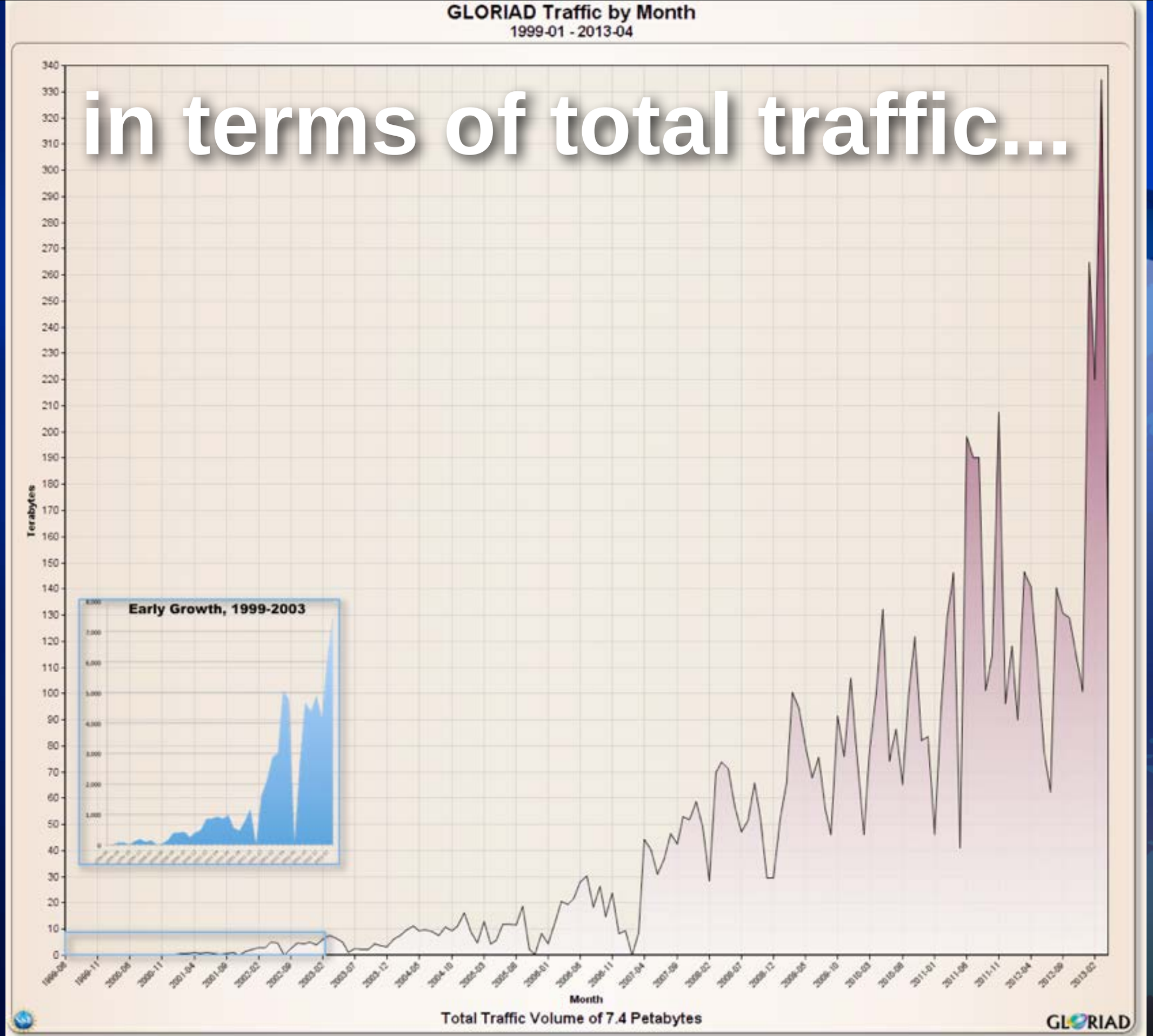

GLORIAD Traffic by Month
1999-01 - 2013-04
in terms of total traffic...
Terabytes
Early Growth, 1999-2003
Month
Total Traffic Volume of 7.4 Petabytes
GLORIAD

in terms of the customers ...

Share

GLORIAD

Current Top Users

United States

Time Period (US East Coast): 2013-10-29 21:06:24 - 2013-10-29 21:06:30

Funded by the US National Science Foundation

Source Institution	Dest Institution	Bytes	Bandwidth	Packets	Packet Loss
Joint Institute for Nuclear Research (Dubna, Russian Federation)	Vanderbilt University (Nashville, United States)	263.7 MB	210.9 Mbps	173702	1.488 %
University of Nebraska Lincoln (Lincoln, United States)	Joint Institute for Nuclear Research (Dubna, Russian Federation)	160.7 MB	128.6 Mbps	105870	0.000 %
US Geological Survey (Menlo Park, United States)	Russian Space Science Internet (Moscow, Russian Federation)	146.0 MB	116.8 Mbps	96246	0.016 %
Purdue University (West Lafayette, United States)	Institute of High Energy Physics, CAS (Beijing, China)	130.9 MB	104.7 Mbps	91033	0.000 %
Joint Institute for Nuclear Research (Dubna, Russian Federation)	UC San Diego (La Jolla, United States)	94.4 MB	75.5 Mbps	62201	0.730 %
Joint Institute for Nuclear Research (Dubna, Russian Federation)	Purdue University (West Lafayette, United States)	88.3 MB	70.7 Mbps	58305	1.019 %
Fermilab (Batavia, United States)	Institute of High Energy Physics, CAS (Beijing, China)	83.1 MB	66.5 Mbps	55184	0.000 %
Vanderbilt University (Nashville, United States)	Kyungpook National University (Taegu, Korea (South))	79.8 MB	63.8 Mbps	52560	0.000 %
National University of Singapore (Singapore, Singapore)	US NIH National Library of Medicine (Bethesda, United States)	60.8 MB	48.6 Mbps	42273	0.000 %
Joint Institute for Nuclear Research (Dubna, Russian Federation)	EP.NET LLC (Marina Del Rey, United States)	47.1 MB	37.7 Mbps	31042	0.870 %
Ministry of Education Computer Center Taiwan (MOEC) (Taiwan)	University of Virginia Charlottesville (Charlottesville, United State	42.4 MB	33.9 Mbps	27912	0.000 %
CITY University of Hong Kong (Central District, Hong Kong)	UCAR CISL Research Data Archive (Boulder, United States)	34.3 MB	27.5 Mbps	22622	0.000 %
Joint Institute for Nuclear Research (Dubna, Russian Federation)	California Institute of Technology (Pasadena, United States)	33.0 MB	26.4 Mbps	21724	0.980 %
Ministry of Education Computer Center Taiwan (MOEC) (Taiwan)	National Center for Atmospheric Research (NCAR) (Boulder, Uni	28.0 MB	22.4 Mbps	18672	0.000 %
Joint Institute for Nuclear Research (Dubna, Russian Federation)	Massachusetts Institute of Technology (Cambridge, United States)	24.2 MB	19.4 Mbps	16023	0.000 %
Korea Ocean Research and Development Institute (Seoul, Korea (S	NASA Ocean Color Biology Processing Group (Greenbelt, Unitec	22.2 MB	17.8 Mbps	14655	0.000 %
US NIH National Library of Medicine (Bethesda, United States)	Shanghai Institutes for Biological Sciences, CAS (Shanghai, China	18.3 MB	14.6 Mbps	12151	4.461 %
Kurchatov Institute (Moscow, Russian Federation)	University of Nebraska Lincoln (Lincoln, United States)	14.5 MB	13.1 Mbps	9553	0.000 %
Institute of High Energy Physics RAS (Protvino, Russian Federatio	California Institute of Technology (Pasadena, United States)	11.0 MB	8.8 Mbps	7224	0.554 %
Kurchatov Institute (Moscow, Russian Federation)	Indiana University (Bloomington, United States)	8.4 MB	8.2 Mbps	5550	0.000 %

All Users

GLORIAD Partners

Canada China Egypt Hong Kong India Malaysia Netherlands Nordic Russia Singapore S. Korea Taiwan

USA Organizations

USA NSF (Univ) DOE NASA NIH NOAA USGS DoD

World Regions

GLORIAD's monitoring system builds on all open-source tools - MySQL, Perl and Argus

in terms of the numbers ...

- 14.8 million IP addresses routed across GLORIAD infrastructure since beginning
- 1.7 billion flow records (large flows) since beginning
- 300 million flow update records (argus) daily
- 6 Terabyes - 18 Terabytes per day

in terms of the science applications

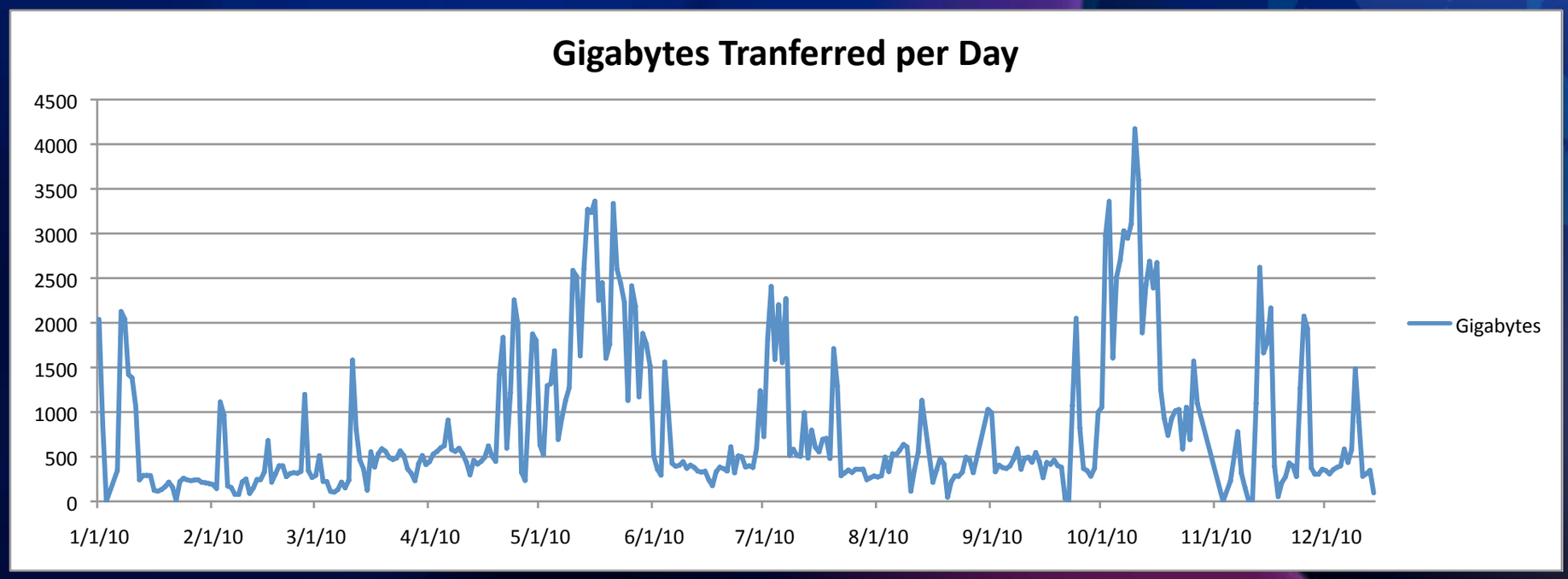
FermiLab (Chicago)

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/



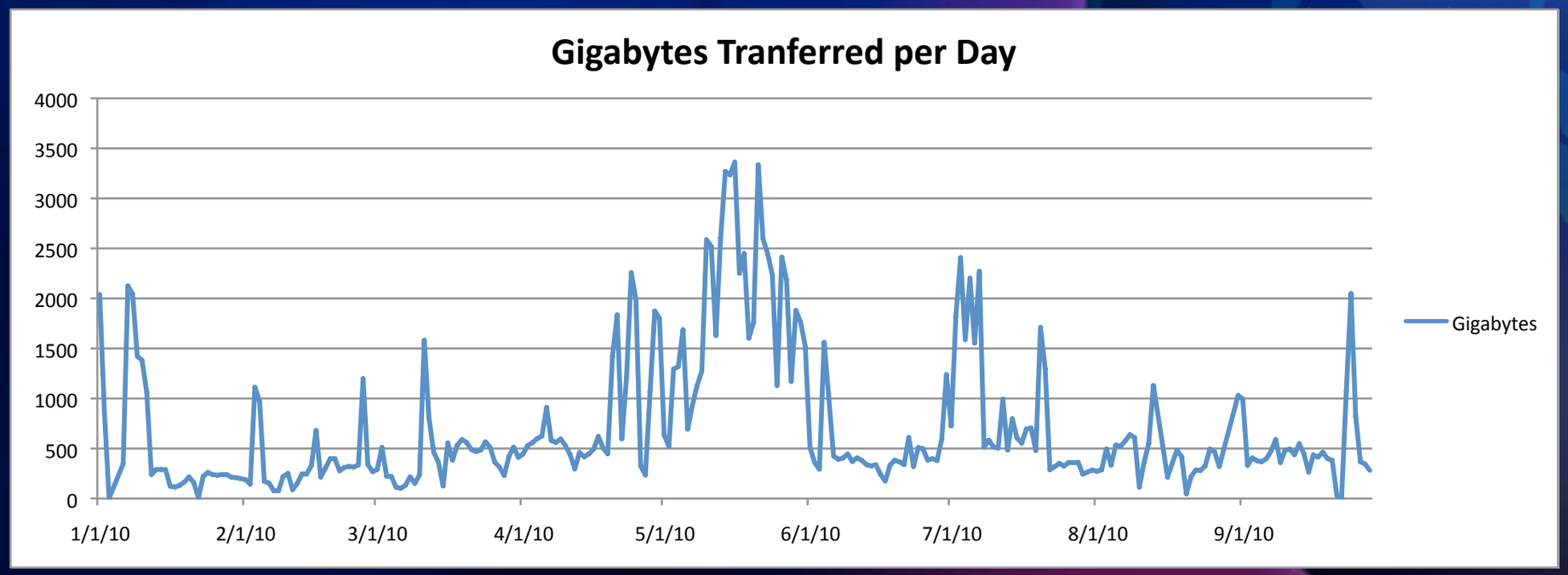
MODIS Web

USGS MODIS Repository of Earth Satellite Imagery

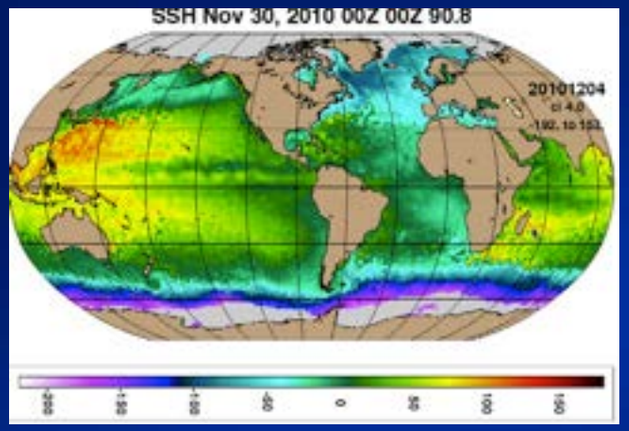
MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the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

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

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



Host name
e4ftl01.cr.usgs.gov
Country
United States
Country Code
US
Region
South Dakota
City
Sioux Falls



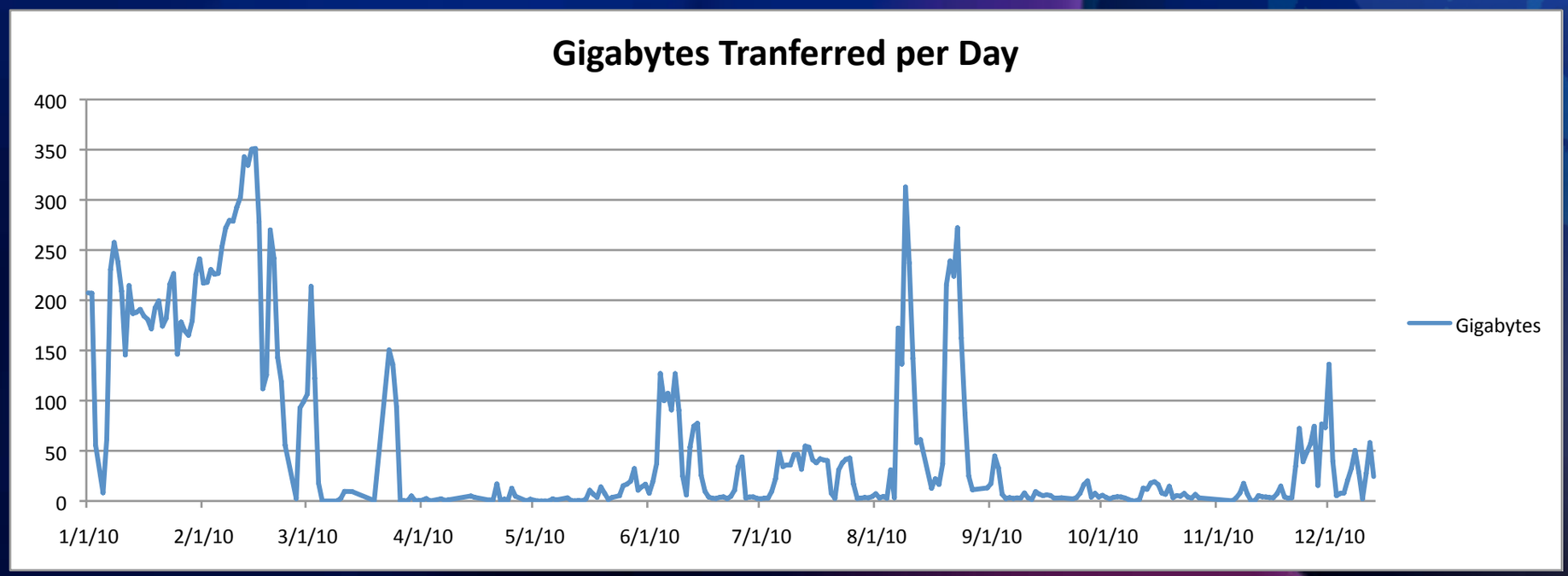
Hycom National Ocean Partnership Program

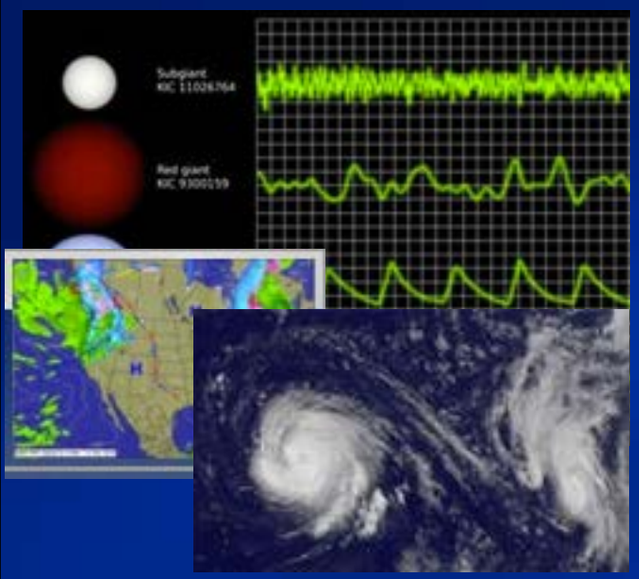
The HYCOM consortium is a multi-institutional effort sponsored by the National Ocean Partnership Program (NOPP), as part of the U. S. Global Ocean Data Assimilation Experiment (GODAE), to develop and evaluate a data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called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





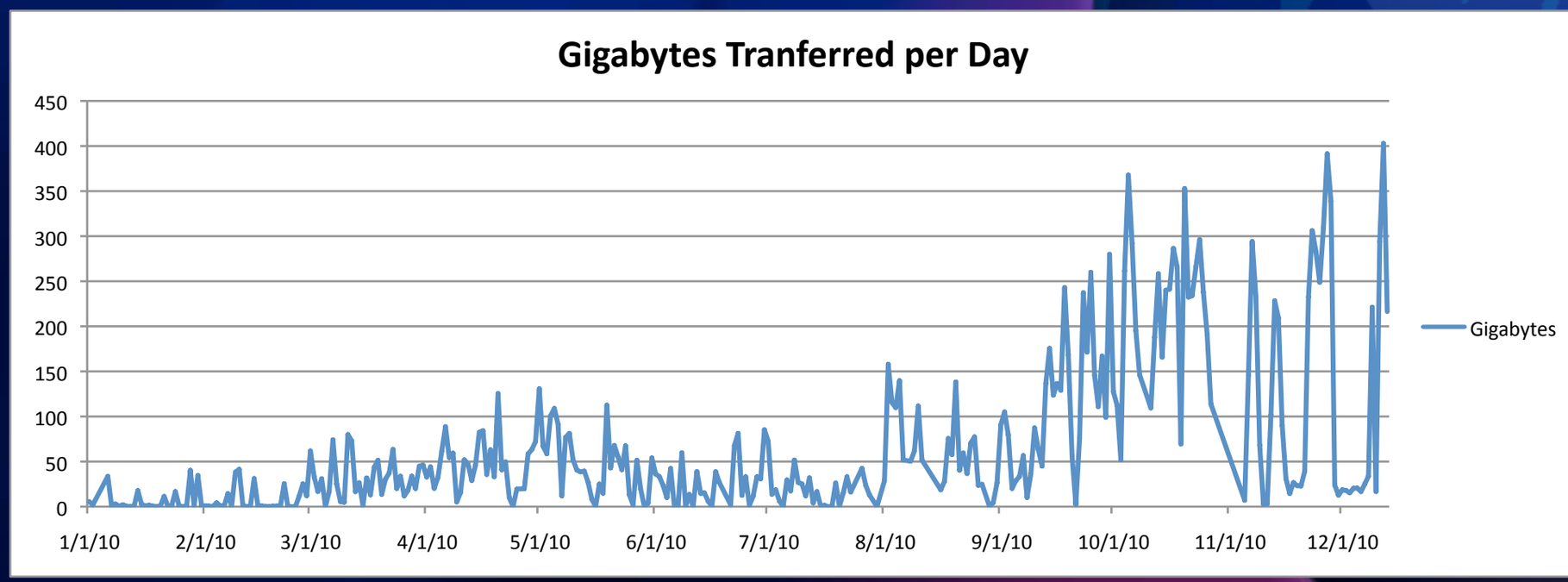
National Center for Atmospheric Research

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)



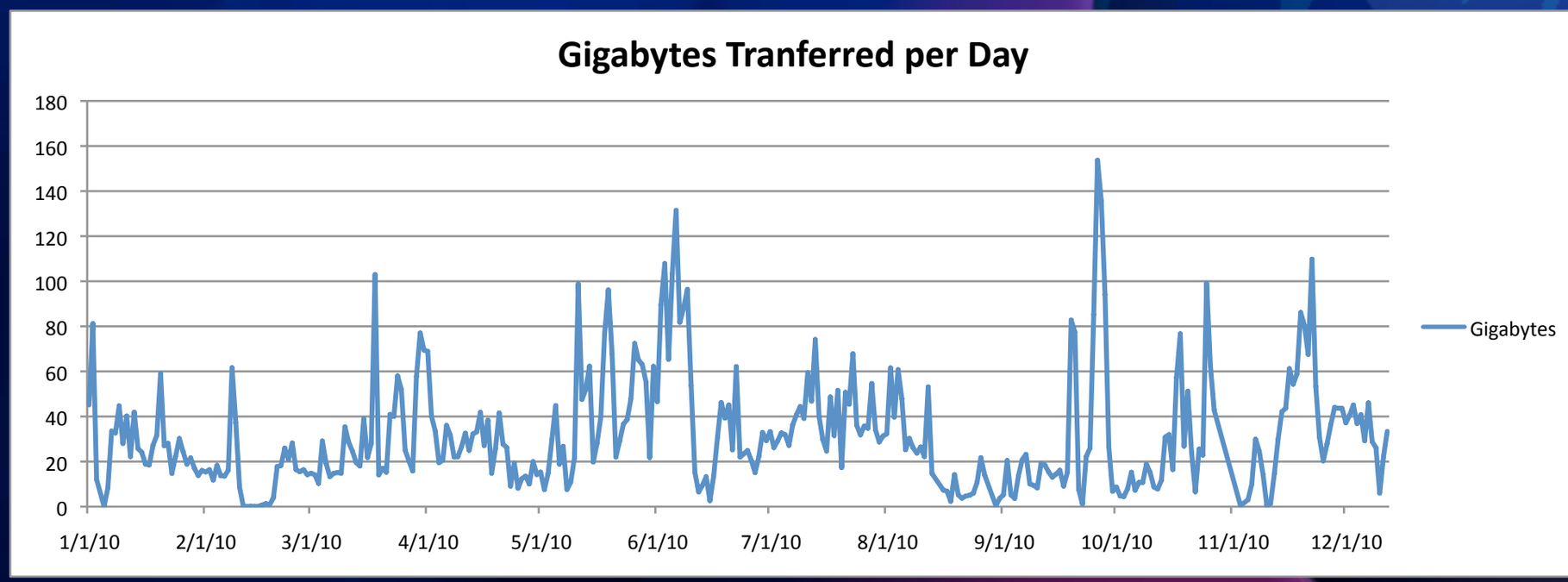
Climate Diagnostics Center (NOAA)

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)



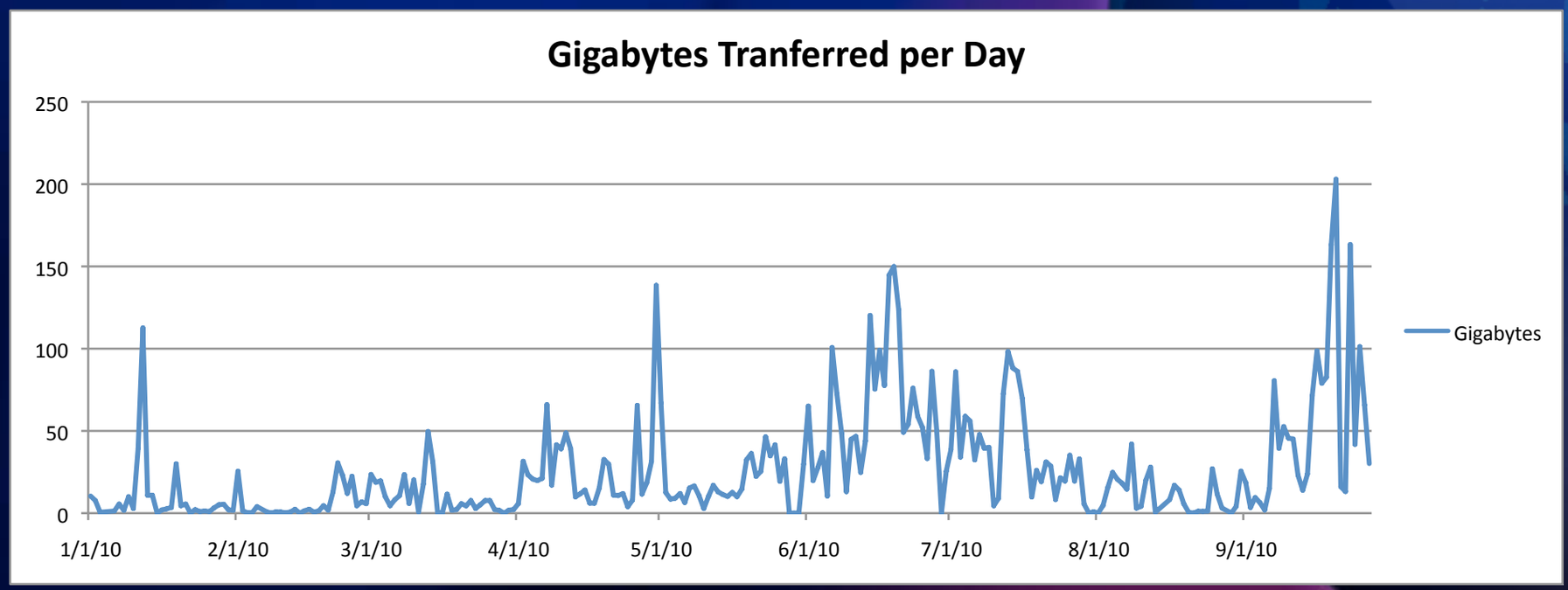
National Center for Biotechnology Information (NCBI)

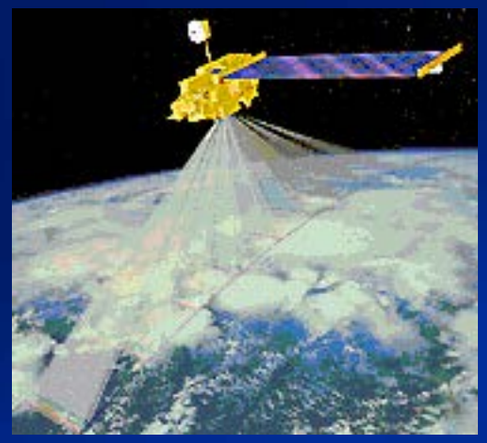
The National Center for Biotechnology Information advances science and health by providing access to biomedical and genomic information. Popular database resources include: BLAST, Bookshelf, Gene, Genome, Nucleotide, OMIM, Protein, PubChem, PubMed, PubMed Central, SNP

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)

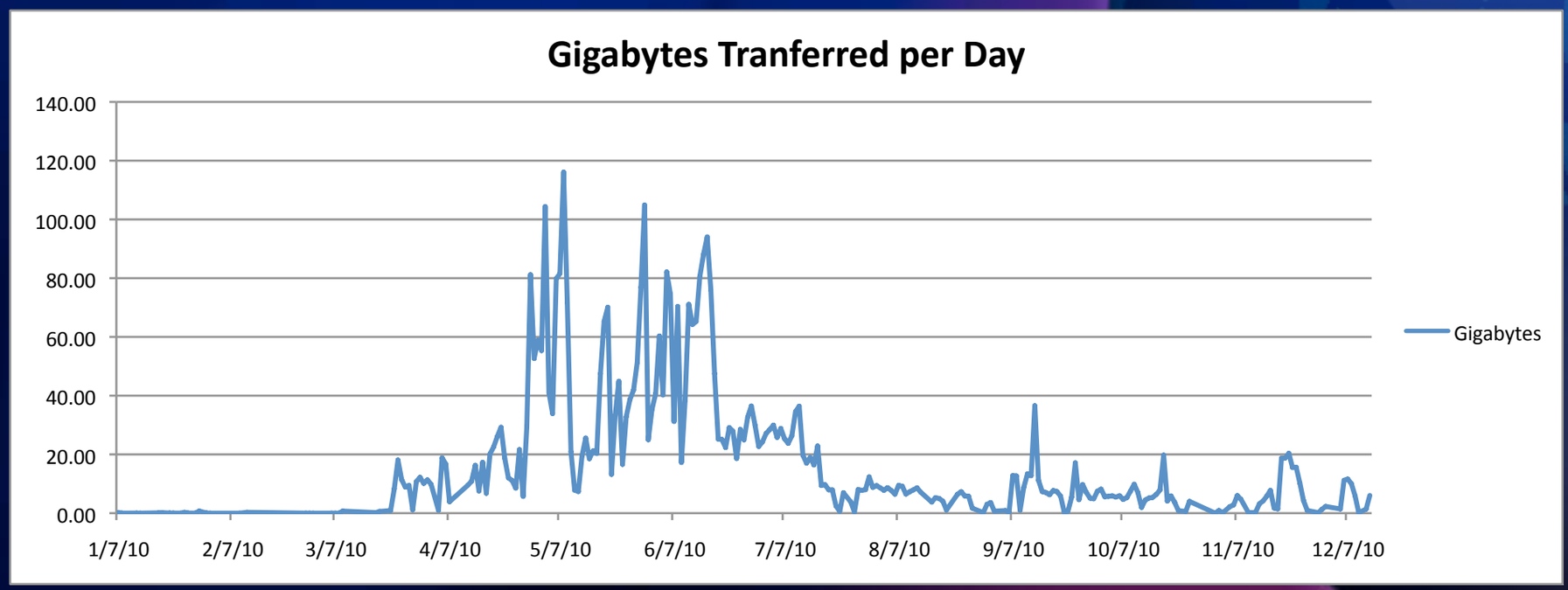
Atmospheric Science Data Center, NASA

Multi-angle Imaging SpectroRadiometer (MISR)

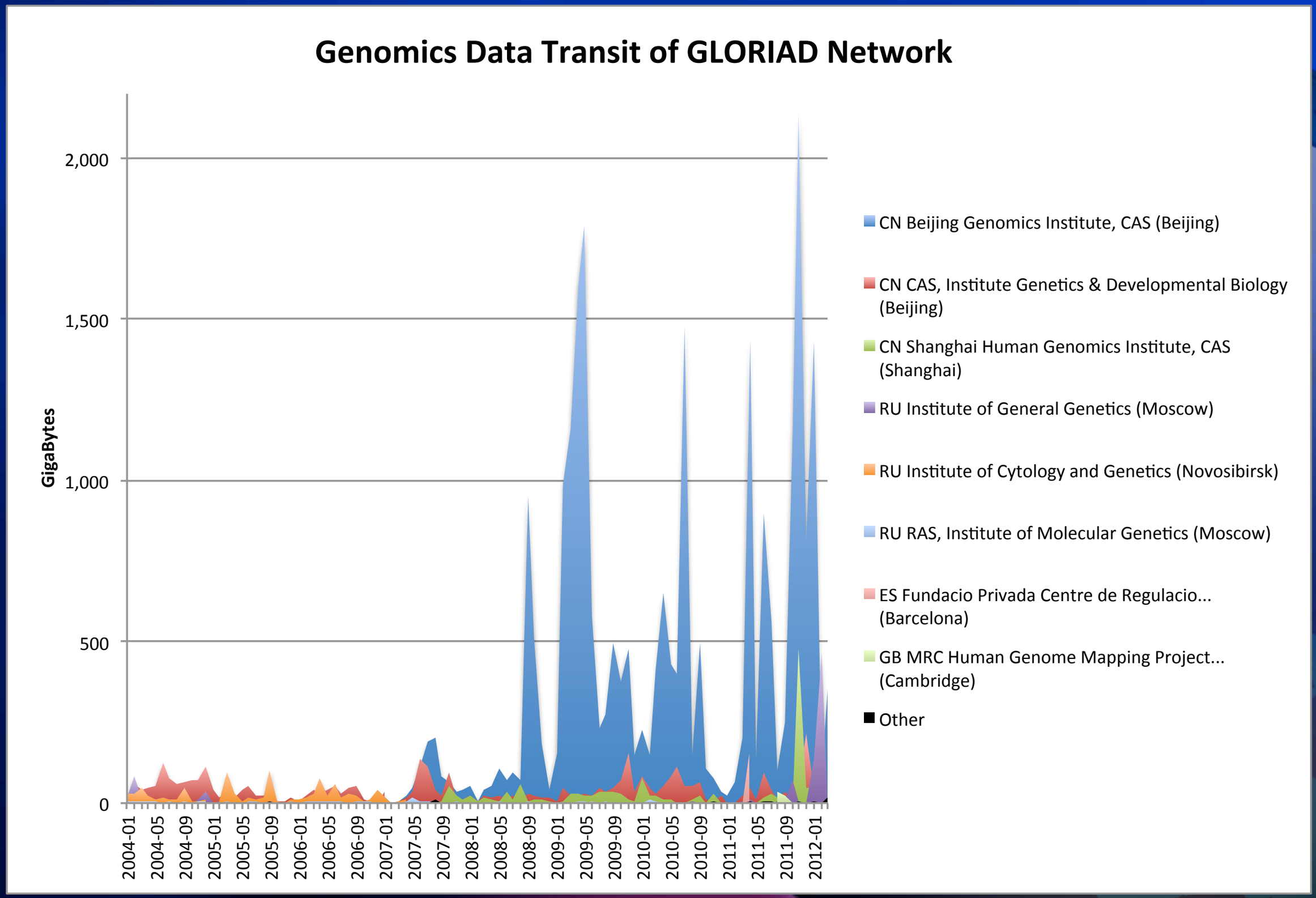
MISR provides new types of information for scientists studying Earth's climate, such as the regional and global distribution of different types of atmospheric particles and clouds on climate. The change in reflection at different view angles combined with stereoscopic techniques enables construction 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

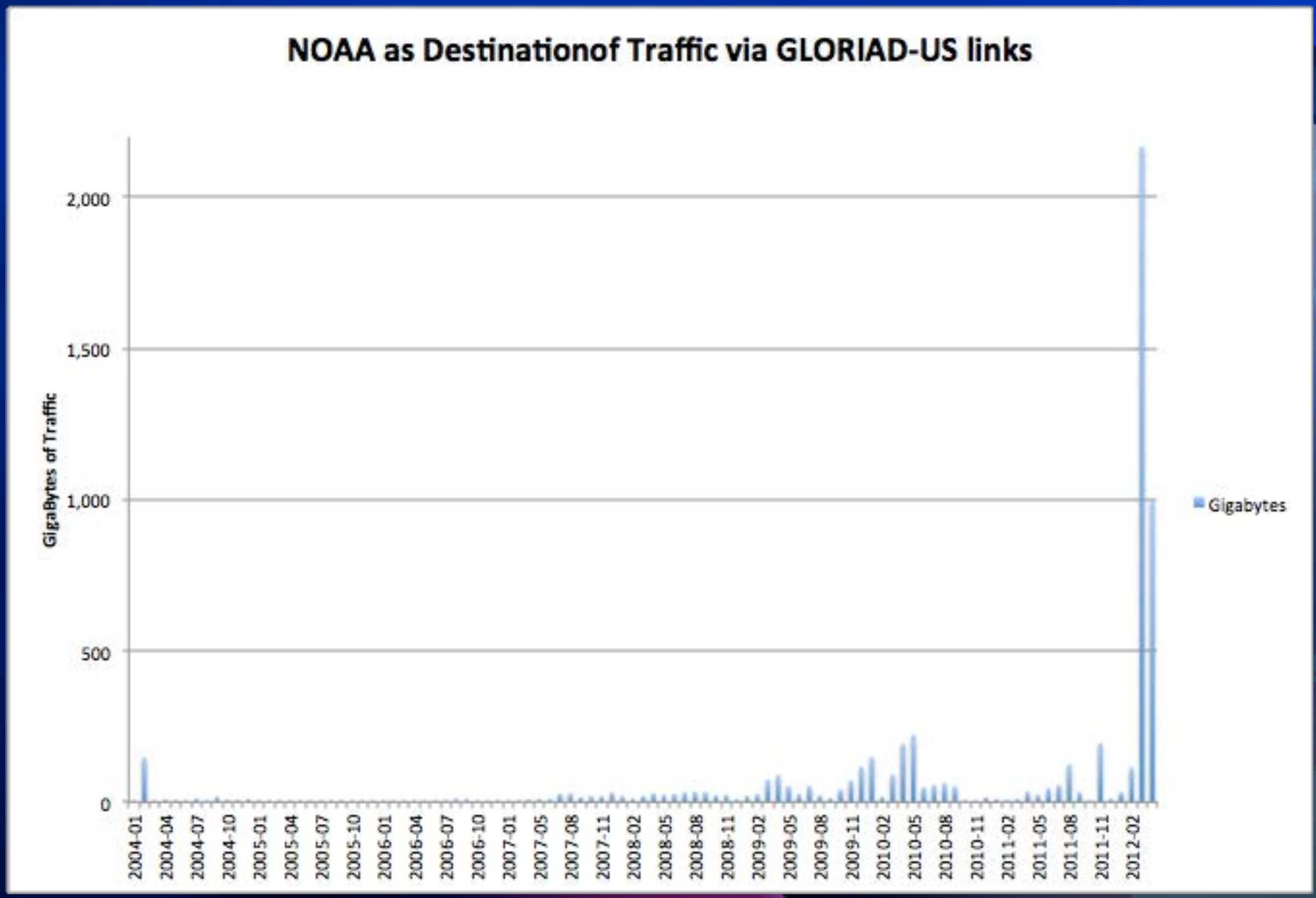
Host name
l4ftl01.larc.nasa.gov
Country
United States
Country Code
US
Region
Virginia
City
Hampton



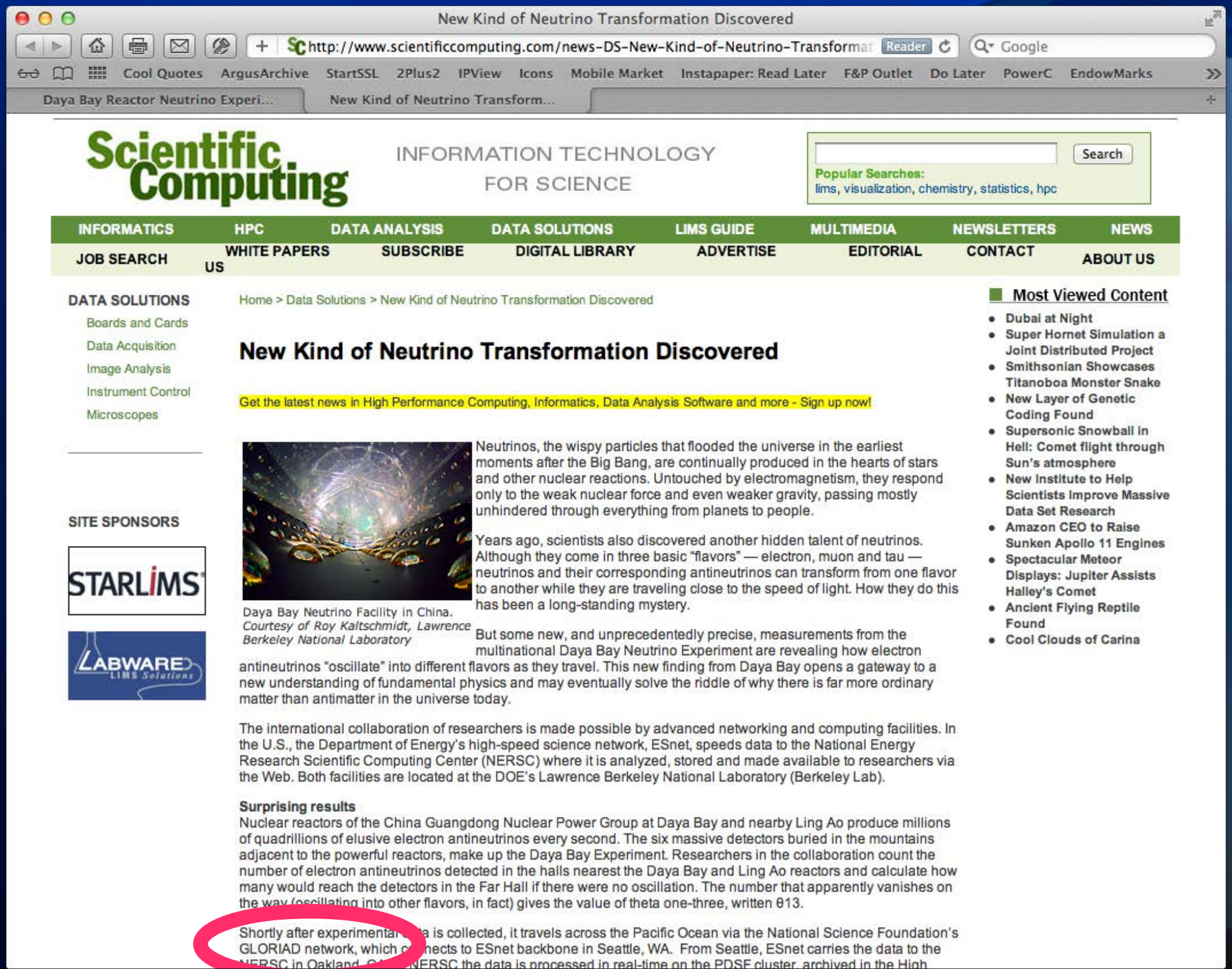
Genomics Data Transit: GLORIAD



NOAA Use of GLORIAD



in terms of the science "success stories"



Note: it's not all about "big science"

- We expect to see more and more "big discoveries" come from "little science" players (i.e., "citizen science" (ex: open source drug discovery program in India), student collaborations, etc.) connected with solid infrastructure
- Young-people-led initiatives (with good access to infrastructure) have been quite transformative (www, mosaic, google, facebook, etc.)

("aim at connecting the students; the scientists will be connected too")

GLORIAD

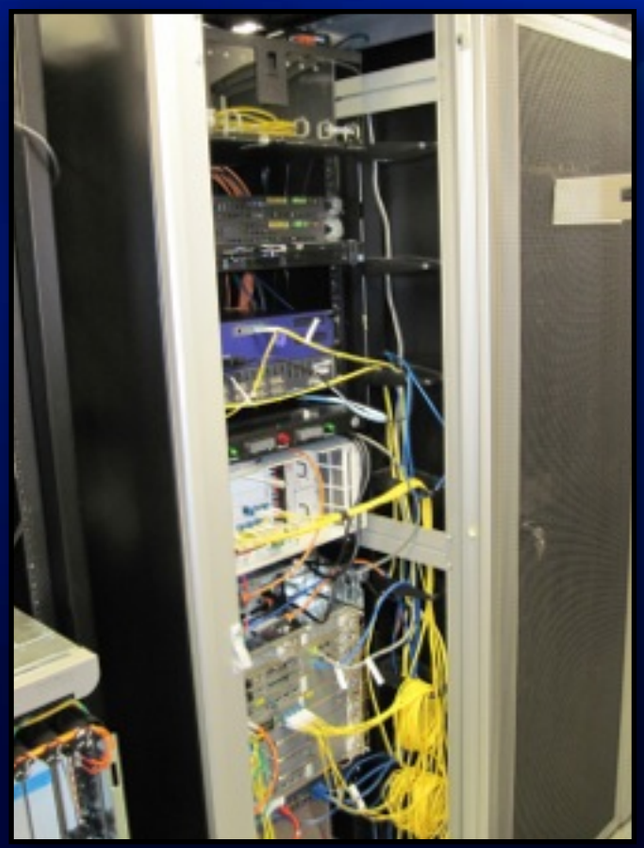
GLORIAD is a loose-knit trust community of individuals sharing core values about the value of open networking and committed to building and cooperatively managing leading-edge information and communications infrastructure connecting scientists, educators and students in a ground-level, bottom-up approach - to facilitate shared work on challenges common to all cultures in virtually all domains of science, education, health care and infrastructure. It is community-born, community-driven and community-led – always changing, ever evolving, chaotic, synergistic, center-less, tolerant, informal, but intensely purposeful – standing on the shoulders of and building on the good work of those who gave the world a common Internet infrastructure.

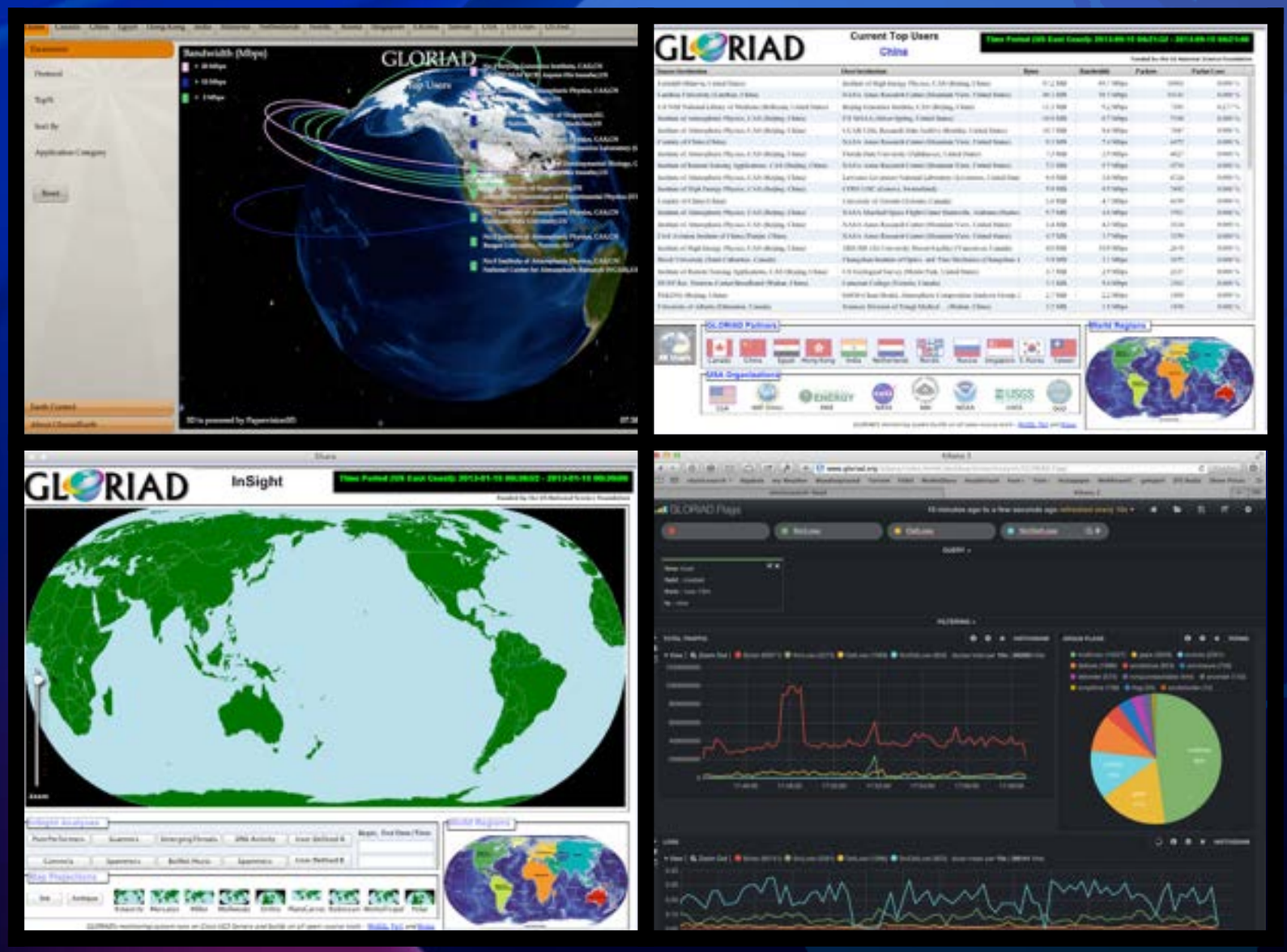
Think "ecosystem" instead of organization.

GLORIAD

Measurement and Monitoring System

or how do we get (meaningful information) from ...





for a global high-speed research & education network

Remainder of Presentation

During the past year, GLORIAD has been working on a new system for measuring and monitoring global network infrastructure focused less on "links" and more on addressing needs of individual users. To accomplish its goal of actively improving global infrastructure for individual customers, the new system is designed to:

(1) understand the network needs and requirements of a global customer base by actively studying utilization; (2) identify poor performance of individual applications by constantly (and in near-real-time) analyzing information on such per-flow metrics as load, packet loss, jitter and routing asymmetries; (3) mitigate poor performance of applications by identifying fabric weaknesses (4) build richly visual analysis applications such as GLORIAD-Earth and the new GloTOP to help make sense of the enormous volume of data.

To realize this new model of measurement and monitoring (focused less on links and more on individual customers), GLORIAD has recently moved from its old flow-based system (used since 1998 and storing approximately 1 million records per day) to a new, much more detailed system – collecting, storing and analyzing 200-400 million network utilization records per day – based on deployment of open-source Argus software (www.qosient.com/argus). The talk will focus on the benefits and the technical challenges of this new and actively evolving work.

GLORIAD Metrics

("It's all about improving situational awareness and instrumenting towards that goal")

TECHNOLOGIES

- Argus (with netmap ring buffer)
- "Modern Perl" / POE (asynchronous non-blocking cooperative multi-tasking services; enterprise service bus) (could be C, Python, Ruby, etc.)
- Database (MySQL (MariaDB?), SQLite)
- RunRev LiveCode (Multiplatform, media-rich client development)
- ElasticSearch

TECHNOLOGIES

(CONTINUED)

- ZeroMQ (Powerful messaging library and framework)
- Serialization (JSON, MessagePack (, Protobufs?))
- Gearman (Job queue; workload distribution)
- Caching Strategies
  - MemCached (Redis?)
  - Perl CHI (works with MemCached and Redis) to give both local (in process) cache + external cacheing service

TECHNOLOGIES

(CONTINUED)

- Generic Mapping Tools for GEO/GIS
- Git (code organization, sharing, version control)
- Monit (managing, monitoring unix-system processes)

TECHNOLOGIES

(CONTINUED)

- Hardware
  - Cisco UCS Blade Servers (64 core hyper-threaded (32 real); ZFS file system (raidz, 800 MB/s throughput), Massive RAM (1.5 Terabytes), Xeon PHI CoProcessor)
  - Dell
  - Raspberry PI
  - Network Cards (Intel 10G, Myrinet 10G)

TECHNOLOGIES

(CONTINUED)

- Operating Systems
  - FreeBSD (openness, stability, security, dtrace, zfs)
  - Linux (retiring; only for Xeon PHI coprocessor)
  - MacOS Server (retiring)

COMPONENTS

1. Raw Data Collection (Argus)
2. Database Organization, Storage and Retrieval
    - 2.1. Global Science Registry
    - 2.2. MySQL Flow Tables
    - 2.3. MySQL Summary Tables
3. Visualization and Analysis “Farm”

4

ElasticSearch

1

5 minute datafiles
Document radium.conf
rastream
Document argus.conf
Radium
Argus 1 (Chicago)
ra tools
Argus 2 (Seattle)

2

MaxMind GeoIP Database
Domains
Domain Tables
Domains MetaData
Domains Traffic Summary Tables
ScienceRegistry
MySQL Database
IP Tables
IPsText
IPAssign
IP Assignment Process (mapping IPs to Domains)

3

Master MySQL Databases
Animals do 3 things:
1) feed (consume live data)
2) groom (trim/update data)
3) talk (i.e., report)
Bam
Animals (use SQlite datastores)
Clients
Farmer
Visualization and Analysis Engine (Farm)

GloMON Documentation

Update Process (every 5 minutes)

Summarize by Year + All
Daily Tables
Summarize by All
Monthly Tables
Domains (Institutions)
Countries
ASnums
MySQL Summary Tables

MySQL Flow Tables
FlowToday
Monthly FlowTables
Support Tables
ASnums
CountryCodes
Colors
Etc.

TOPIC = 1 topic (3 words)

1. RAW DATA COLLECTION

?

Argus

Flexible open-source software packet sensors to generate network flow records at line rate, for operations, performance and security.

Comprehensive, not statistical, bi-directional, with many flow models allowing you to track any network traffic, not just 5-tuple IP traffic.

Support for large scale collection, data processing, storage and archiving, sharing, vizualization, with analytics, aggregation, geospatial, netspatial analysis.

Argus

(author: Carter Bullard)

argus

Using Argus
Getting Argus
Argus Wiki
Development
Documentation
Publications
Support
Links
News

Documentation - Manuals

Man page documentation for argus.

argus	generate flow records from packet data
argus.conf	argus system configuration file

Man page documentation for radium, the argus data collection and distribution system.

radium	argus data collection, analytics and distribution
radium.conf	radium system configuration file

Man page documentation for argus data clients.

ra	read, filter and print argus data
rarc	ra* program configuration file
rabins	process argus data into structured 'bins'
racluster	aggregate argus data
racluster.conf	racluster configuration file
raconvert	convert ascii flow data into argus record format
racount	tally objects in argus data stream
radump	decode user data buffers using tcpdump decoders
raevent	read argus generated events
rafilteraddr	high performance argus data filtering
ragraph	time series graphing (rrd-tool based)
ragrep	regular expression matching from captured user data
rahisto	frequency distribution analysis for argus data metrics
ralabel	semantic enahancemet / metadata tagging
ralabel.conf	ralabel configuration file
ranonymize	argus data anonymization
ranonymize.conf	ranonymize configuration file
rapath	print topology information derived from argus data
rapolicy	continuous access control policy verification
rasort	sort argus data
rasplit	split argus data into structured OS based files
rasql	read native argus data from mysql database tables
rasqlinsert	insert and read argus data from/to mysql data tables
rastream	argus data stream block processing
rastrip	argus data manipulation and compression

Argus Attributes

–N [io]<num>, [io]<start-end>, [io]<start+num>
Process the first **<num>** records, the inclusive range **<start - end>**, or process <num + 1> records starting at index number **<start>**. The optional 1st character indicates whether the specification is applied to the input or the output stream of records, the default is input. If applied to the input, these are the range of records that match the input filter.

–p <digits>
Print **<digits>** number of units of precision for floating point values.

–q Run in quiet mode. Configure Ra to not print out the contents of records. This can be used for a number of maintenance tasks, where you would be interested in the outcome of a program, or its progress, say with the -D option, without printing each input record.

–r [-l <[type:]file[::soffset[:eoffset]] ...>]
Read **<type>** data from **<files>** in the order presented on the commandline. "–" denotes stdin. Ra supports reading **argus** type data (default), **cisco** and **ft**, flow-tools type data. If you want to read a set of files and then, when done, read stdin, use multiple occurences of the *-r* option. Ra can read **gzip(1)**, **bzip2(1)** and **compress(1)** compressed data files. Use the optional byte offset specification for reading data from a specific offset in the file.

Examples are:
-r file1 file2 read argus records from file1, then file2.
-r file.gz read argus records from gzip compressed file.
-r file::34876 read argus records starting at byte offset 34876
-r cisco:file read cisco netflow records from file
-r ft:file read flow-tools based records

–R <dir dir ...>
Recursively decend the directory and process all the regular files that are encountered. The function does not decend to links, or directories that begin with '.'. The feature, like the -r command, does not do any file type checking.

–s <[-][[+[#]]field[:len[:format]] ...>
Specify the **fields** to print. Ra uses a default printing field list, by specifying a field you can replace this list completely, or you can modify the existing default print list, using the optional '-' and '+[#]' form of the command. The optional 'format' specification, uses **sprintf.1** sytax to format the value. The available fields to print are:

srcid	argus source identifier.
stime	record start time
ltime	record last time.
trans	aggregation record count.
flgs	flow state flags seen in transaction.
seq	argus sequence number.
dur	record total duration.
runtime	total active flow run time. This value is generated through aggregation, and is the sum of the records duration.
mean	average duration of aggregated records.
stddev	standard deviation of aggregated duration times.
sum	total accumulated durations of aggregated records.
min	minimum duration of aggregated records.
max	maximum duration of aggregated records.
smac	source MAC addr.
dmac	destination MAC addr.
soui	oui portion of the source MAC addr.

doui	oui portion of the destination MAC addr.
saddr	source IP addr.
daddr	destination IP addr.
proto	transaction protocol.
sport	source port number.
dport	destination port number.
stos	source TOS byte value.
dtos	destination TOS byte value.
sdsb	source diff serve byte value.
ddsb	destination diff serve byte value.
sco	source IP address country code.
dco	destination IP address country code.
sttl	src -> dst TTL value.
dttl	dst -> src TTL value.
sipid	source IP identifier.
dipid	destination IP identifier.
smpls	source MPLS identifier.
dmpls	destination MPLS identifier.
pkts	total transaction packet count.
spkts	src -> dst packet count.
dpkts	dst -> src packet count.
bytes	total transaction bytes.
sbytes	src -> dst transaction bytes.
dbytes	dst -> src transaction bytes.
appbytes	total application bytes.
sappbytes	src -> dst application bytes.
dappbytes	dst -> src application bytes.
load	bits per second.
sload	source bits per second.
dload	destination bits per second.
loss	pkts retransmitted or dropped.
sloss	source pkts retransmitted or dropped.
dloss	destination pkts retransmitted or dropped.
ploss	percent pkts retransmitted or dropped.
psloss	percent source pkts retransmitted or dropped.
pdloss	percent destination pkts retransmitted or dropped.
sgap	source bytes missing in the data stream. Available after argus-3.0.4
dgap	destination bytes missing in the data stream. Available after argus-3.0.4
rate	pkts per second.
srate	source pkts per second.
drate	destination pkts per second.
dir	direction of transaction
sintpkt	source interpacket arrival time (mSec)
sintdist	source interpacket arrival time distribution
sintpktact	source active interpacket arrival time (mSec)
sintdistact	source active interpacket arrival time (mSec)
sintpktidl	source idle interpacket arrival time (mSec)
sintdistidl	source idle interpacket arrival time (mSec)
dintpkt	destination interpacket arrival time (mSec)
dintdist	destination interpacket arrival time distribution
dintpktact	destination active interpacket arrival time (mSec)
dintdistact	destination active interpacket arrival time distribution (mSec)
dintpktidl	destination idle interpacket arrival time (mSec)

Argus Attributes

ra.1.pdf

dintdistidl destination idle interpacket arrival time distribution
sjit source jitter (mSec).
sjitact source active jitter (mSec).
sjitidle source idle jitter (mSec).
djit destination jitter (mSec).
djitact destination active jitter (mSec).
djitidle destination idle jitter (mSec).
state transaction state
suser source user data buffer.
duser destination user data buffer.
swin source TCP window advertisement.
dwin destination TCP window advertisement.
svlan source VLAN identifier.
dvlan destination VLAN identifier.
svid source VLAN identifier.
dvid destination VLAN identifier.
svpri source VLAN priority.
dvpri destination VLAN priority.
srng start time for the filter timerange.
erng end time for the filter timerange.
stcpb source TCP base sequence number
dtcpb destination TCP base sequence number
tcprtt TCP connection setup round-trip time, the sum of 'synack' and 'ackdat'.
synack TCP connection setup time, the time between the SYN and the SYN_ACK packets.
ackdat TCP connection setup time, the time between the SYN_ACK and the ACK packets.
tcpopt The TCP connection options seen at initiation. The *tcpopt* indicator consists of a fixed length field, that reports presence of any of the TCP options that argus tracks The format is:

M - Maximum Segment Size
w - Window Scale
s - Selective ACK OK
S - Selective ACK
e - TCP Echo
E - TCP Echo Reply
T - TCP Timestamp
c - TCP CC
N - TCP CC New
O - TCP CC Echo
S - Source Explicit Congestion Notification
D - Destination Explicit Congestion Notification

inode ICMP intermediate node.
offset record byte offset in file or stream.
spktsz histogram for the src packet size distribution
smaxsz maximum packet size for traffic transmitted by the src.
dpktsz histogram for the dst packet size distribution
dmaxsz maximum packet size for traffic transmitted by the dst.
sminsz minimum packet size for traffic transmitted by the src.
dminsz minimum packet size for traffic transmitted by the dst.

Examles are:
-s saddr print only the source address.
-s bytes removes the bytes field from list.

Current GLORIAD-US Deployment of Argus

Seattle Force-10 Router

Chicago Force-10 Router

10G SPAN port

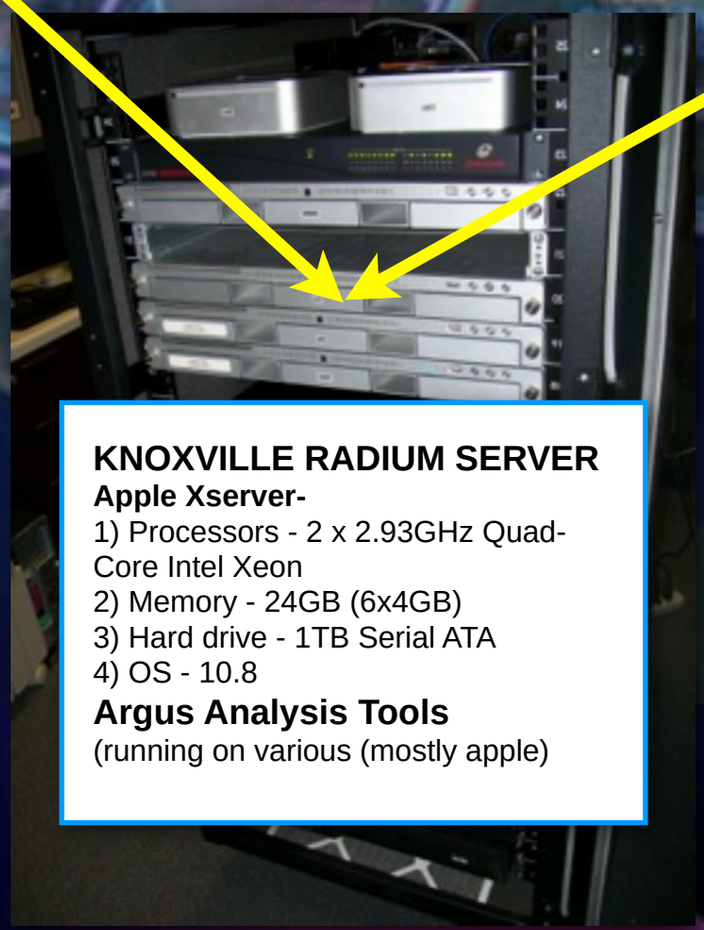
10G SPAN port

SEATTLE ARGUS NODE

DELL R410 servers -
1) Processors - 2 x Intel xeon X55670, 2.93GHz (Quad cores)
2) Memory - 8 GB (4 x 2GB) UDDIMMs
3) Hard drive - 500GB SAS
4) Intel 82599EB 10G NIC
5) FreeBSD 9.1
6) NetMap Ring Buffer
7) running argus daemon sending data to radium server in Knoxville

CHICAGO ARGUS NODE

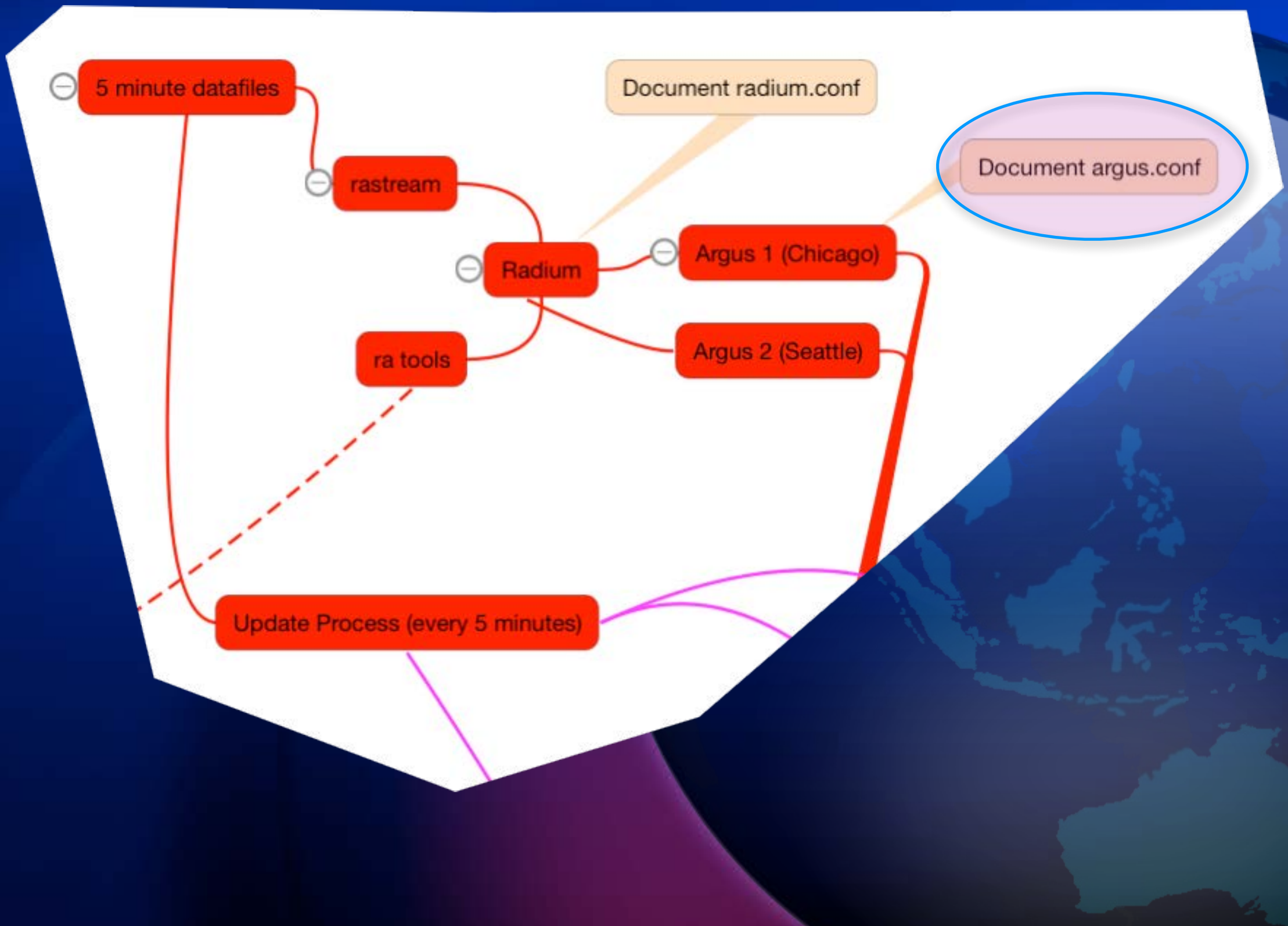
DELL R410 servers -
1) Processors - 2 x Intel xeon X55670, 2.93GHz (Quad cores)
2) Memory - 8 GB (4 x 2GB) UDDIMMs
3) Hard drive - 500GB SAS
4) Intel 82599EB 10G NIC
5) FreeBSD 9.1
6) NetMap Ring Buffer
7) running argus daemon sending data to radium server in Knoxville



KNOXVILLE RADIUM SERVER
Apple Xserver-
1) Processors - 2 x 2.93GHz Quad-Core Intel Xeon
2) Memory - 24GB (6x4GB)
3) Hard drive - 1TB Serial ATA
4) OS - 10.8

Argus Analysis Tools
(running on various (mostly apple)

Current GLORIAD-US Deployment of Argus



ARGUS DAEMON CONFIG FILE

1. argus.conf resides in /etc directory (by default)

2. directs argus to interface port(s), defines flow-key (default: standard 5-tuple for tcp), other attributes

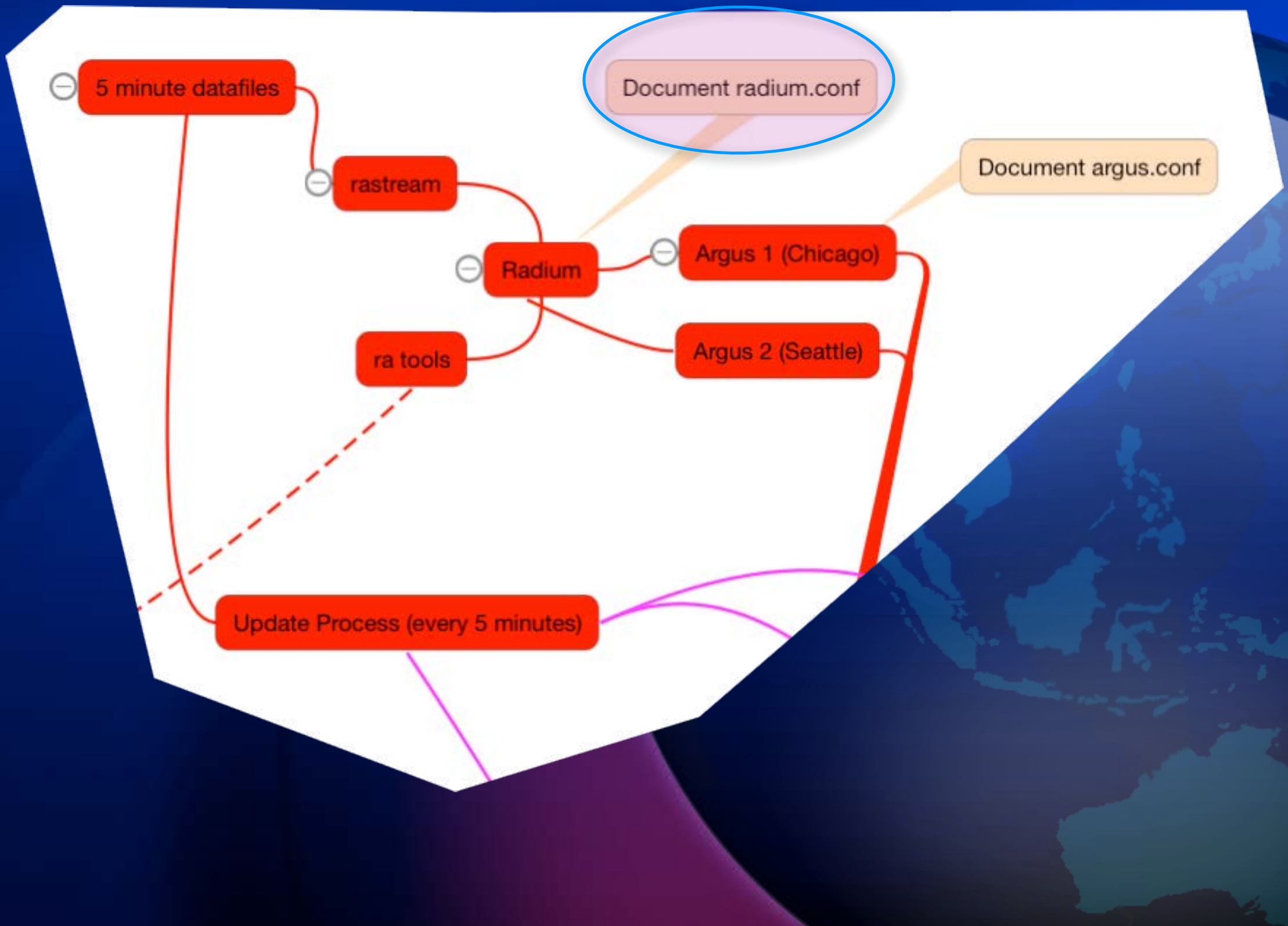
SELECTED ATTRIBUTES FROM /ETC/ARGUS.CONF

```
# Argus Software
# Copyright (c) 2000-2012 QoSient, LLC
# All rights reserved.
#
#Example  argus.conf
#
# Argus will open this argus.conf if installed as /etc/argus.conf.
# It will also search for this file as argus.conf in directories
# specified in $ARGUSPATH, or $ARGUSHOME, $ARGUSHOME/lib,
# or $HOME, $HOME/lib, and parse it to set common configuration
# options.  All values in this file can be overriden by command
# line options, or other files of this format that can be read in
# using the -F option.
#

ARGUS_FLOW_TYPE="Bidirectional"
ARGUS_FLOW_KEY="CLASSIC_5_TUPLE"


ARGUS_DAEMON=yes

#ARGUS_MONITOR_ID=`hostname`    // IPv4 address returned
ARGUS_MONITOR_ID=A.B.C.D // IPv4 address
#ARGUS_MONITOR_ID=2435          // Number
#ARGUS_MONITOR_ID="PW"         // String


ARGUS_ACCESS_PORT=40000

#ARGUS_BIND_IP="::1,127.0.0.1"
#ARGUS_BIND_IP="127.0.0.1"
ARGUS_BIND_IP="A.B.C.D"
```

?

```
#ARGUS_INTERFACE=any
#ARGUS_INTERFACE=ind:all
#ARGUS_INTERFACE=ind:en0/192.168.0.68,en2/192.168.2.1
#ARGUS_INTERFACE=ind:en0/"en0",en2/19234
#ARGUS_INTERFACE=en0
ARGUS_INTERFACE=ix0


ARGUS_FLOW_STATUS_INTERVAL=5


ARGUS_MAR_STATUS_INTERVAL=300

ARGUS_GENERATE_PACKET_SIZE=yes


ARGUS_GENERATE_JITTER_DATA=yes


ARGUS_GENERATE_MAC_DATA=yes

ARGUS_GENERATE_APPBYTE_METRIC=yes

ARGUS_GENERATE_TCP_PERF_METRIC=yes

#ARGUS_CAPTURE_DATA_LEN=16

ARGUS_ENV="PCAP_MEMORY=500000"
```

Current GLORIAD-US Deployment of Argus



RADIUM DAEMON CONFIG FILE

1. Radium normally runs on another (not argus probe) machine

2. default location for radium.conf is in /etc

SELECTED ATTRIBUTES FROM /ETC/RADIUM.CONF

```
#
#  Radium Software
#  Copyright (c) 2000-2012 QoSient, LLC
#  All rights reserved.
#
# Radium will open this radium.conf if its installed as /etc/
radium.conf.
# It will also search for this file as radium.conf in directories
# specified in $RADIUMPATH, or $RADIUMHOME, $RADIUMHOME/lib,
# or $HOME, $HOME/lib, and parse it to set common configuration
# options.  All values in this file can be overriden by command
# line options, or other files of this format that can be read in
# using the -F option.

RADIUM_DAEMON=yes


#RADIUM_ARGUS_SERVER=amon:12345
RADIUM_ARGUS_SERVER=argus://chicago.gloriad.org:40000
RADIUM_ARGUS_SERVER=argus://seattle.gloriad.org:40000
#RADIUM_ARGUS_SERVER=argus-tcp://thoth
#RADIUM_ARGUS_SERVER=argus-udp://apophis:562
#RADIUM_ARGUS_SERVER=cisco://192.168.0.4:9699
#RADIUM_ARGUS_SERVER=bluemac-fbsd.gloriad.org
```

?

```
#RADIUM_CISCONETFLOW_PORT=9996


#RADIUM_USER_AUTH="user/auth"
#RADIUM_AUTH_PASS="password"

RADIUM_ACCESS_PORT=561


# RADIUM_OUTPUT_FILE=/var/log/radium/radium.out


#
# Data transformation/processing is done on the complete set
# of input records, and all output from this radium node is
# transformed.  This makes cataloging and tracking the
# transformational nodes a bit easier.
#
# This example enables data classification/labeling.
# This function is enabled with a single radium configuration
# keyword RADIUM_CLASSIFIER, and then a ralabel() configuration
# file is provided.
#
# Commandline equivalent   none

RADIUM_CLASSIFIER_FILE=/etc/ralabel.conf
```

SELECTED ATTRIBUTES FROM /ETC/RALABEL.CONF

```
#  Argus Client Software
#  Copyright (c) 2000-2012 QoSient, LLC
#  All rights reserved.
#
# RaLabel Configuration
#

# Addresss Based Country Code Classification
#    Address based country code classification leverages the feature
#    where ra* clients cant print country codes for the IP addresses
#    that are in a flow record.  Country codes are generated from the ARIN
#    delegated address space files.  Specify the location of your
#    DELEGATED_IP file here, or in your .rarc file (which is default).

RALABEL_ARIN_COUNTRY_CODES=yes
RA_DELEGATED_IP="/usr/local/argus/delegated-ipv4-latest"

# BIND Based Classification
#    BIND services provide address to name translations, and these
#    reverse lookup strategies can provide FQDN labels, or domain
#    labels that can be added to flow.  The IP addresses that can be
#    'labeled' are the saddr, daddr, or inode.  Keywords "yes" and "all"
#    are synonomous and result in labeling all three IP addresses.
#
#    Use this strategy to provide transient semantic enhancement based
#    on ip address values.
#

#RALABEL_BIND_NAME="all"

# Port Based Classification
#    Port based classifications involves simple assignment of a text
#    label to a specific port number.  While IANA standard classifications
#    are supported throught the Unix /etc/services file assignments,
#    and the basic "src port" and "dst port" ra* filter schemes,
#    this scheme is used to enhance/modify that labeling strategy.
#    The text associated with a port number is placed in the metadata
#    label field, and is searched using the regular expression searching
#    strategies that are available to label matching.

RALABEL_IANA_PORT=yes
RALABEL_IANA_PORT_FILE="/usr/local/argus/iana-port-numbers

# Flow Filter Based Classification
#    Flow filter based classification uses the standard flow
#    filter strategies to provide a general purpose labeling scheme.
#    The concept is similar to racluster()'s fall through matching
#    scheme.  Fall through the list of filters, if it matches, add the
#    label.  If you want to continue through the list, once there is
#    a match,  add a "cont" to the end of the matching rule.
#

#RALABEL_ARGUS_FLOW=yes
#RALABEL_ARGUS_FLOW_FILE="/usr/local/argus/ralabel.gloapp.conf"

# GeoIP Based Labeling
#    The labeling features can use the databases provided by MaxMind
#    using the GeoIP LGPL libraries.  If your code was configured to use
#    these libraries, then enable the features here.
#
#    GeoIP provides a lot of support for geo-location, configure support
#    by enabling a feature and providing the appropriate binary data files.
#    ASN reporting is done from a separate set of data files, obtained from
#    MaxMind.com, and so enabling this feature is independent of the
#    traditional city data available.
#

RALABEL_GEOIP_ASN=yes
RALABEL_GEOIP_ASN_FILE="/usr/local/share/GeoIP/GeoIPASNum.dat"

#
#    Data for city relevant data is enabled through enabling and configuring
#    the city database support.  The types of data available are:
#       country_code, country_code3, country_name, region, city,
postal_code,
#       latitude, longitude, metro_code, area_code and continent_code.
#       time_offset is also available.
#
RALABEL_GEOIP_CITY="saddr,daddr,inode:lat,lon"
RALABEL_GEOIP_CITY_FILE="/usr/local/share/GeoIP/GeoIPCity.dat"
```

EXAMPLES OF LIVE LABELS

```
3. ssh
ratop -S ::1:561                                                                                             2013/11/05.21:15:08 EST
         StartTime    Flgs  Proto          SrcAddr  Sport   Dir          DstAddr  Dport  TotPkts    TotBytes State sCo dCo   sAS   dAS
   21:14:50.320030  *         tcp   129.107.255.16.59316    -       202.122.36.3.34357    49714    75301252   CLO  CN  US  7497 18515
   21:14:50.086723  *         tcp  128.143.231.211.ssh      -    140.109.170.251.42206    19798    30006692   CLO  TW  US  9264   225
   21:14:50.371469  *         tcp   129.107.255.17.59315    -       202.122.36.3.47442    19328    29227072   CLO  CN  US  7497 18515
   21:14:50.009653  *         tcp   129.107.255.17.59821    -       202.122.36.3.39004    17727    26817746   CLO  CN  US  7497 18515
   21:14:50.159932  *         tcp    130.14.250.10.50407    -     137.132.19.118.54947    16531    23771578   CLO  SG  US  7472    70
   21:14:50.766046  M s       tcp   159.93.228.243.37684   ->    169.228.130.225.53357    15790    19133604   CON  RU  US  2875  7377
   21:14:51.525183  M s       tcp   159.93.228.243.37682   ->    169.228.130.225.53357    13431    17424622   CON  RU  US  2875  7377
   21:14:52.124732  *         tcp   128.117.29.212.http     -    140.109.172.163.45450    12767    19374514   CLO  TW  US  9264   194
   21:14:52.245710  M         tcp     128.55.46.90.57308   ->     194.190.165.65.1094     12362      867116   CON  US  RU   292  2643
   21:14:51.514313  M         tcp    147.8.178.130.56177   ->     194.199.21.150.http     12295      800794   CON  HK  FR  4528  2200
   21:14:50.336254  M s       tcp   159.93.228.247.43589   ->    169.228.130.226.32835    12153    14282350   CON  RU  US  2875  7377
   21:14:54.113525  M         tcp   159.226.149.17.33874   ->      130.14.250.12.50114    12144      966880   CON  CN  US  7497    70
   21:14:49.998830  M s       tcp   159.93.228.243.37683   ->    169.228.130.225.53357    10830    11804892   CON  RU  US  2875  7377
   21:14:53.065429  *         tcp    128.142.37.35.43526   ->     194.190.165.47.1094     10743      803122   CON  CH  RU   513  2643
   21:14:52.288472  M s       tcp   159.93.228.247.43590   ->    169.228.130.226.32835     9845    14036262   CON  RU  US  2875  7377
   21:14:52.762579  * s       tcp    192.31.99.198.40000  <?>     160.36.208.213.61007     9726     5736668   CON  US  US 20388 19957
   21:14:51.960069  * d       tcp   160.36.208.213.61007   ->      192.31.99.198.40000     9694     5746528   CON  US  US 19957 20388
   21:14:52.178440  M         tcp     124.16.129.9.53505   ->       130.14.29.30.44933     9535    14471290   CON  CN  US  7497    70
   21:14:51.080279  M s       tcp   159.93.228.247.43588   ->    169.228.130.226.32835     9466    11346256   CON  RU  US  2875  7377
   21:14:53.789316  M         tcp    147.8.178.130.56371   ->     194.199.21.150.http      9396      631488   CON  HK  FR  4528  2200
   21:14:50.080722  *         tcp    130.14.250.12.50003    -     137.132.19.118.56634     9213    13248294   CLO  SG  US  7472    70
   21:14:51.159213  *         tcp    140.247.177.6.55616   ->    194.190.165.172.1094      9114      651410   CON  US  RU  1742  2643
   21:14:50.858417  M         tcp     124.16.129.9.53504   ->       130.14.29.30.43858     9067    13763034   CON  CN  US  7497    70
   21:14:54.427932  M s       tcp   159.93.228.243.37681   ->    169.228.130.225.53357     8981    12940854   CON  RU  US  2875  7377
   21:14:50.613704  *         tcp    130.14.250.12.50060    -     137.132.19.118.45774     8075    11611850   CLO  SG  US  7472    70
   21:14:51.424252  M s       tcp   159.93.228.247.43587   ->    169.228.130.226.32835     7788    10682412   CON  RU  US  2875  7377
   21:14:49.723572  *         tcp   159.226.149.17.33874   ->      130.14.250.12.50114     7577      595726   CON  CN  US  7497    70
   21:14:52.312510  *         tcp   159.93.228.247.58442   ->     200.136.80.172.24251     7572    11494296   CON  RU  BR  2875  1251
   21:14:49.710296  M s       tcp   159.93.228.247.43583   ->    169.228.130.226.32835     7542     9913276   CON  RU  US  2875  7377
   21:14:50.127426  *         tcp    130.14.29.111.http     -       202.6.241.90.23017     7471    11340978   CLO  SG  US 23767    70
   21:14:49.954618  M s       tcp   159.93.228.244.38845   ->    169.228.130.224.60467     7357     7701190   CON  RU  US  2875  7377
   21:14:52.143130  M s       tcp   159.93.228.247.43584   ->    169.228.130.226.32835     7118     9342620   CON  RU  US  2875  7377
   21:14:49.989587  M s       tcp   159.93.228.244.38839   ->    169.228.130.224.60467     7080     8643720   CON  RU  US  2875  7377
   21:14:51.068949  M s       tcp   159.93.228.247.43591   ->    169.228.130.226.32835     7066     7664716   CON  RU  US  2875  7377
RaCursesLoop() Processing.
```

EXAMPLES OF OTHER LABELS

3. ssh

ratop -S ::1:561 2013/11/05.21:20:41 EST

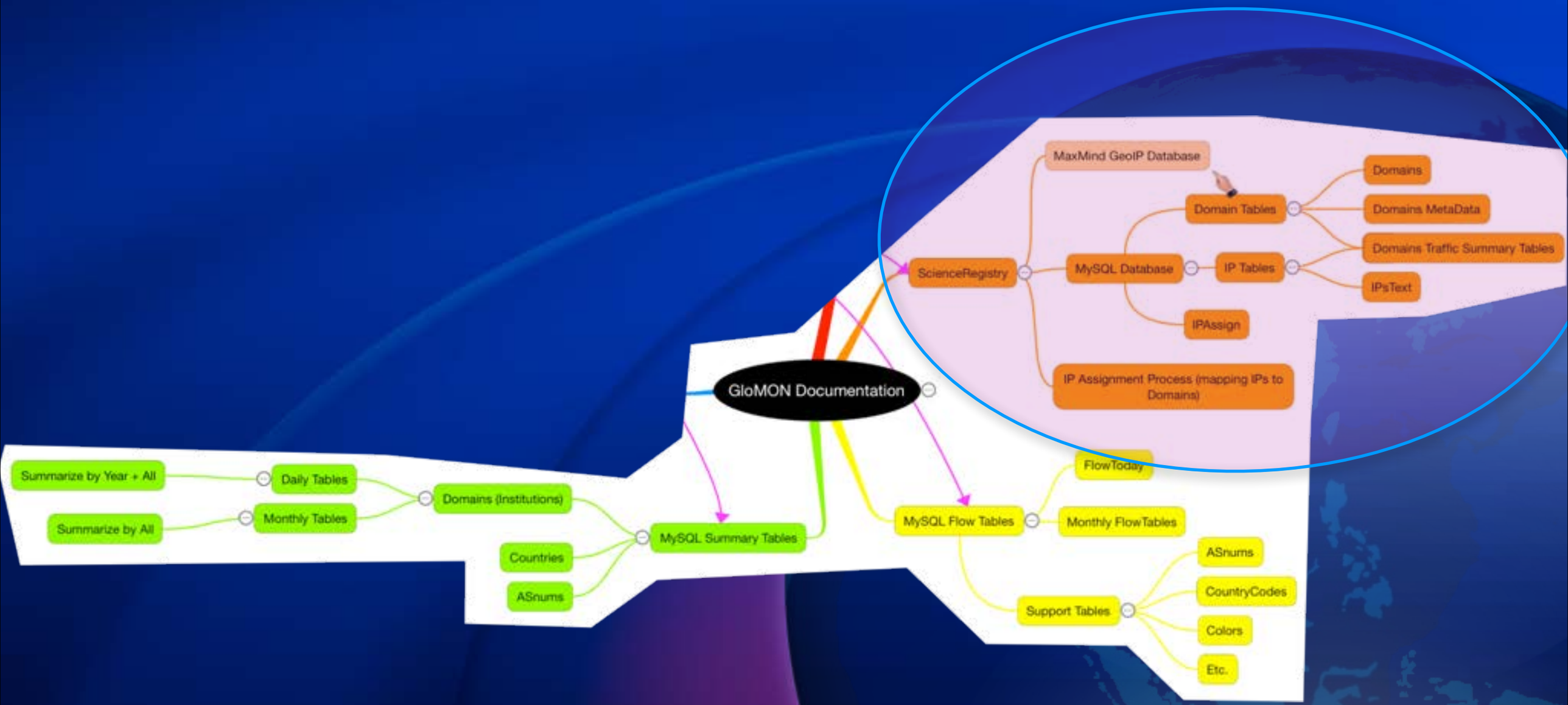
StartTime	Flgs	Proto	SrcAddr	Sport	Dir	DstAddr	Dport	TotPkts	TotBytes	State	Label
21:20:00.915067	*	tcp	128.114.119.133.http		-	140.109.55.234.2350		59293	85169846	CLO	flow=app:11
21:19:57.023159	*	tcp	128.143.231.211.ssh		-	140.109.170.251.42206		57673	87513662	CLO	flow=app:31
21:19:59.811703	*	tcp	129.107.255.17.58183		?>	202.122.36.3.41515		54615	82647866	FIN	flow=app:1002
21:19:59.531160	M	udp	203.237.34.11.44647		<->	128.61.104.20.18481		32665	33433619	CON	flow=app:1004
21:19:56.572028	*	tcp	129.107.255.17.58988		-	202.122.36.3.34314		29850	45133383	FIN	flow=app:1002
21:20:00.791646	M d	tcp	202.127.22.51.57817		->	130.14.29.30.58762		27321	27415338	CON	flow=app:1002
21:19:57.700763	M	tcp	128.55.46.90.36624		->	194.190.165.140.1094		26630	1865588	CON	flow=app:218
21:19:57.706276	M	tcp	124.16.129.9.52579		->	130.14.29.30.60310		22326	33863956	CON	flow=app:1002
21:19:58.239347	*	tcp	128.117.29.212.http		-	140.109.172.163.45450		21382	32449188	CLO	flow=app:11
21:19:59.162650	M	tcp	159.226.149.17.33874		->	130.14.250.12.50114		19789	1598258	CON	flow=app:1002
21:19:56.712249	M	tcp	202.127.22.51.57817		->	130.14.29.30.58762		19182	1373348	CON	flow=app:1002
21:19:59.006432	M	tcp	124.16.129.9.52587		->	130.14.29.30.25479		19062	28921826	CON	flow=app:1002
21:19:59.129735	*	tcp	130.14.250.10.50156		-	137.132.19.118.36892		18020	25912760	CLO	flow=app:1002
21:19:58.304419	* g	tcp	192.31.99.198.40000		<?>	160.36.208.213.61007		17654	10439504	CON	flow=app:1002
21:19:57.076626	* r	tcp	160.36.208.213.61007		->	192.31.99.198.40000		17580	10411788	CON	flow=app:1002
21:20:00.664363	*	tcp	128.142.37.35.33601		->	194.190.165.142.1095		17434	1233220	CON	flow=app:1002
21:19:57.916497	M	tcp	124.16.129.9.53505		->	130.14.29.30.44933		16958	25729196	CON	flow=app:1002
21:19:59.162843	*	tcp	130.14.250.13.50004		-	137.132.19.118.58346		16626	23908188	CLO	flow=app:1002
21:19:59.501640	*	udp	203.237.34.11.44647		<->	128.61.104.20.18481		16180	16491872	CON	flow=app:1004
21:19:57.007037	M s	tcp	124.16.129.9.52579		->	130.14.29.30.60310		15378	17041356	CON	flow=app:1002
21:19:59.938138	*	tcp	130.14.250.10.50407		-	137.132.19.118.54947		14469	20806422	CLO	flow=app:1002
21:19:57.730341	*	tcp	128.55.46.90.36624		->	194.190.165.140.1094		13306	932164	CON	flow=app:218
21:20:00.986900	M s	tcp	124.16.129.9.52587		->	130.14.29.30.25479		12808	14149681	CON	flow=app:1002
21:19:58.617566	M	tcp	147.8.178.130.56164		->	194.199.21.150.http		12679	828008	CON	flow=app:11
21:19:57.041706	*	tcp	130.14.29.111.http		-	202.6.241.90.23017		12389	18806502	CLO	flow=app:11
21:19:57.783120	M	tcp	147.8.178.130.56240		->	194.199.21.150.http		12332	806150	CON	flow=app:11
21:19:59.136900	M s	tcp	124.16.129.9.53505		->	130.14.29.30.44933		11855	12878300	CON	flow=app:1002
21:20:00.981456	*	tcp	159.93.228.241.43394		->	18.12.6.93.40348		11721	17792478	CON	flow=app:1002
21:19:58.703508	M	tcp	147.8.178.130.56342		->	194.199.21.150.http		11651	760040	CON	flow=app:11
21:20:01.328839	*	tcp	159.93.228.241.43392		->	18.12.6.93.40348		11375	17267250	CON	flow=app:1002
21:19:57.385239	M	tcp	147.8.178.130.56022		->	194.199.21.150.http		11175	737484	CON	flow=app:11

RaCursesLoop() Processing.

2. DATABASE ORGANIZATION, STORAGE AND RETRIEVAL

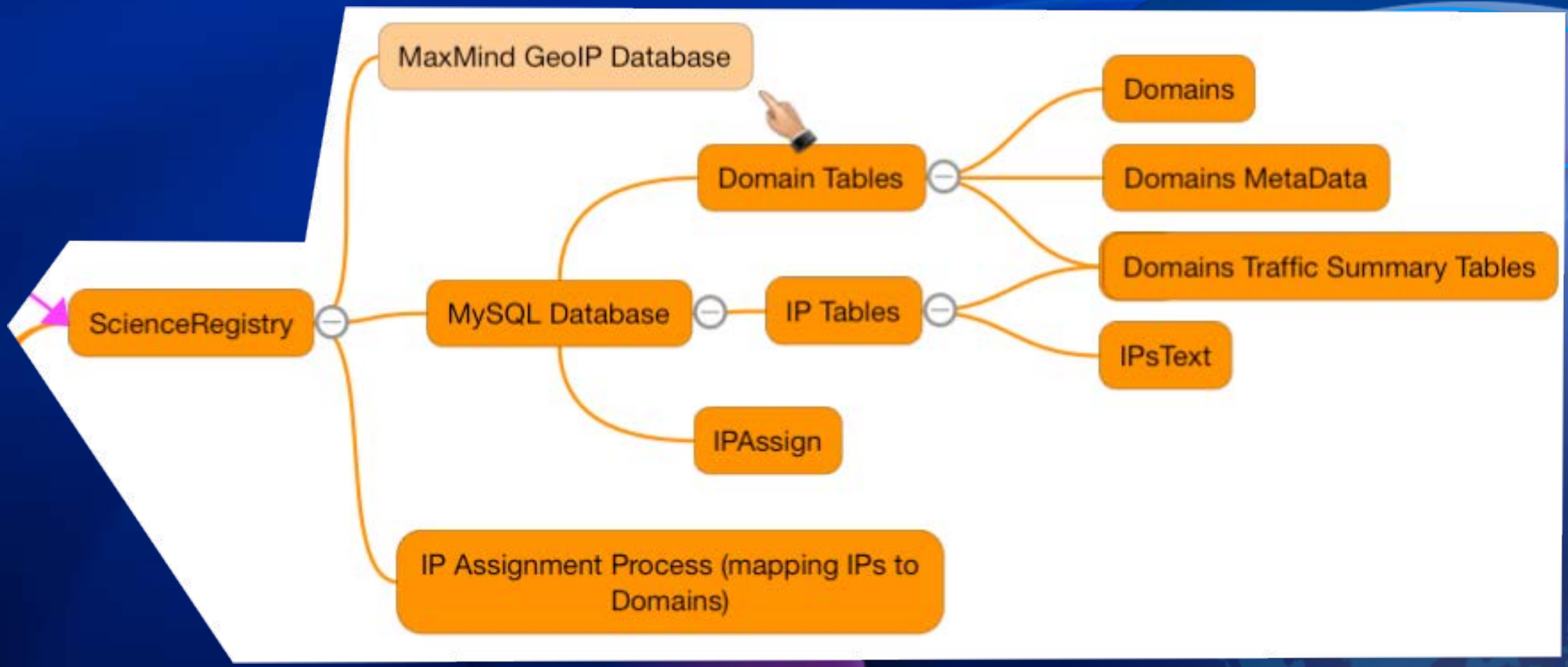
?

Database Organization, Storage and Retrieval



2.1 GLOBAL SCIENCE REGISTRY

Global Science Registry



GLOBAL SCIENCE REGISTRY DEFINED

1. information system describing all global science/ education systems routed across GLORIAD (or any R&E networks)

2. process for mapping IP addresses (ranges of IPs or specific IPs) to science registry records

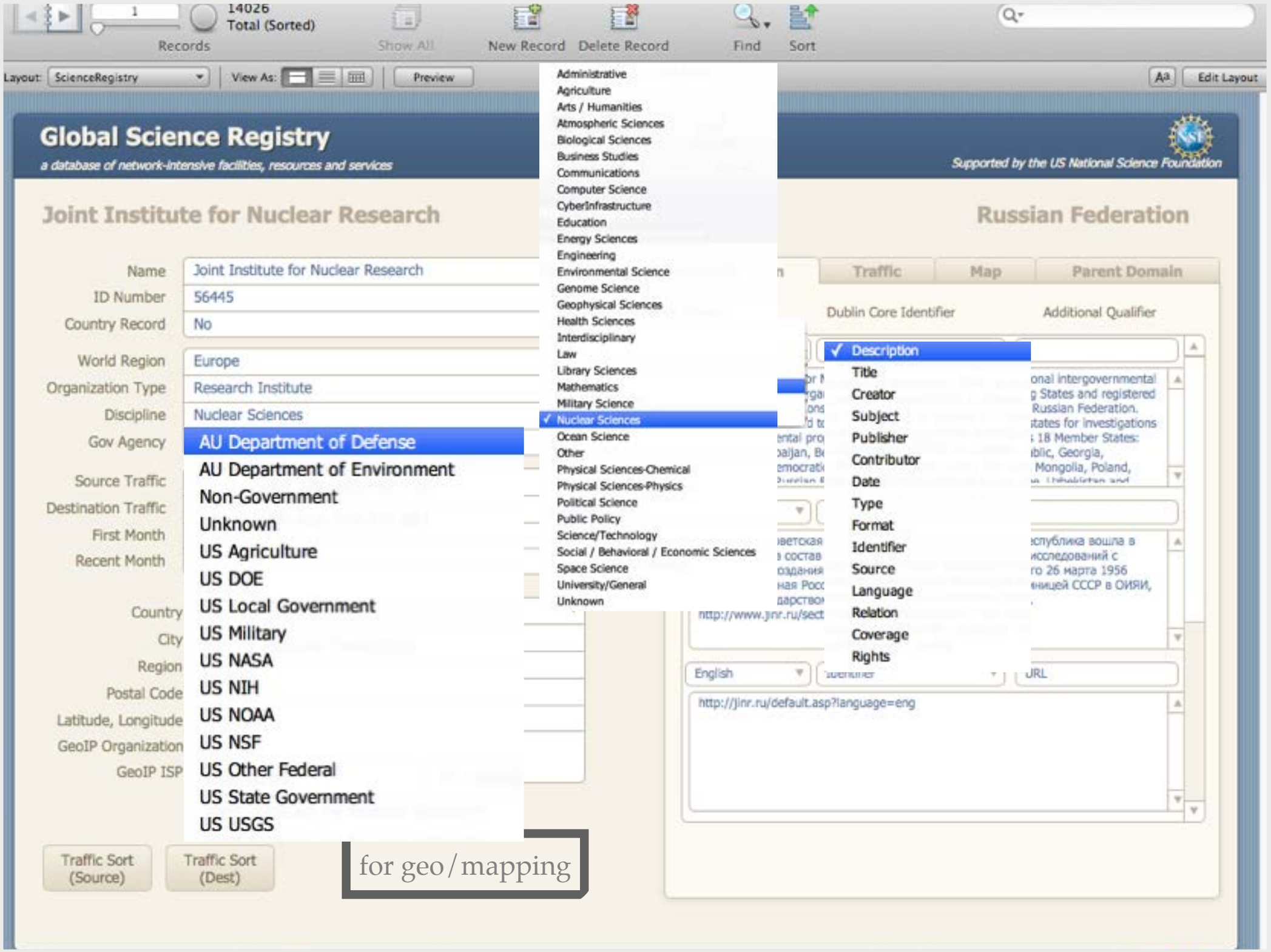
?

DATABASE

GLOBAL SCIENCE REGISTRY DATABASE

1. Simple MySQL Structure (primary table + metadata table + a few related tables)

2. Primary Application written in FileMaker Pro (using ODBC to connect to the back-end MySQL database)


Records
14026
Total (Sorted)
Show All
New Record
Delete Record
Find
Sort
Layout: ScienceRegistry
View As:
Preview
Edit Layout
Global Science Registry
a database of network-intensive facilities, resources and services
Supported by the US National Science Foundation
Joint Institute for Nuclear Research
Russian Federation
Name
Joint Institute for Nuclear Research
ID Number
56445
Country Record
No
World Region
Europe
Organization Type
Research Institute
Discipline
Nuclear Sciences
Gov Agency
AU Department of Defense
AU Department of Environment
Non-Government
Unknown
US Agriculture
US DOE
US Local Government
US Military
US NASA
US NIH
US NOAA
US NSF
US Other Federal
US State Government
US USGS
Source Traffic
Destination Traffic
First Month
Recent Month
Country
City
Region
Postal Code
Latitude, Longitude
GeoIP Organization
GeoIP ISP
Traffic Sort (Source)
Traffic Sort (Dest)
Administrative
Agriculture
Arts / Humanities
Atmospheric Sciences
Biological Sciences
Business Studies
Communications
Computer Science
CyberInfrastructure
Education
Energy Sciences
Engineering
Environmental Science
Genome Science
Geophysical Sciences
Health Sciences
Interdisciplinary
Law
Library Sciences
Mathematics
Military Science
Nuclear Sciences
Ocean Science
Other
Physical Sciences-Chemical
Physical Sciences-Physics
Political Science
Public Policy
Science/Technology
Social / Behavioral / Economic Sciences
Space Science
University/General
Unknown
Traffic
Map
Parent Domain
Dublin Core Identifier
Additional Qualifier
Description
Title
Creator
Subject
Publisher
Contributor
Date
Type
Format
Identifier
Source
Language
Relation
Coverage
Rights
English
URL
http://jinr.ru/default.asp?language=eng
for geo/mapping

Records: 1 of 14026 Total (Sorted) | Show All | New Record | Delete Record | Find | Sort

Layout: ScienceRegistry | View As: | Preview | Aa | Edit Layout

Global Science Registry

a database of network-intensive facilities, resources and services

Supported by the US National Science Foundation

Joint Institute for Nuclea

Russian Federation

Data from summary tables re-computed each evening

Name	Joint Institute for N
ID Number	56445
Country Record	No
World Region	Europe
Organization Type	Research Institute
Discipline	Nuclear Sciences
Gov Agency	
Source Traffic	90,056,11
Destination Traffic	582,111,954,351,952
First Month	2001-08
Recent Month	2013-08

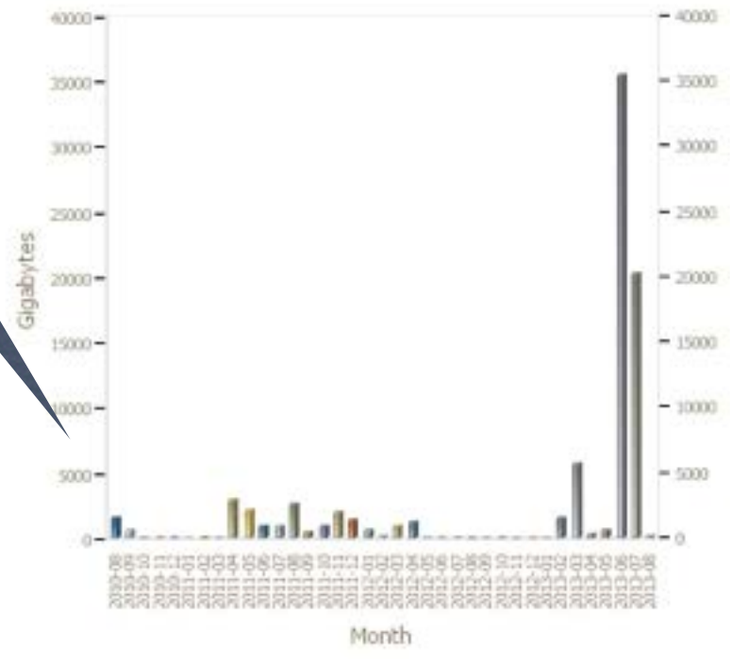
Country	RU	Russian Federation
City	Dubna	
Region	47	
Postal Code		
Latitude, Longitude	56.733299	37.166698
GeoIP Organization	Joint Institute for Nuclear Research	
GeoIP ISP	Joint Institute for Nuclear Research	

Traffic Sort (Source) | Traffic Sort (Dest)

Description | Traffic | Map | Parent Domain

Destination | Source

Last 3 Years Traffic from Joint Institute for Nuclear Research



1 Records 14026 Total (Sorted) Show All New Record Delete Record Find Sort

Layout: ScienceRegistry View As: Preview Aa Edit Layout

Global Science Registry

a database of network-intensive facilities, resources and services

Supported by the US National Science Foundation

Joint Institute for Nuclear Research

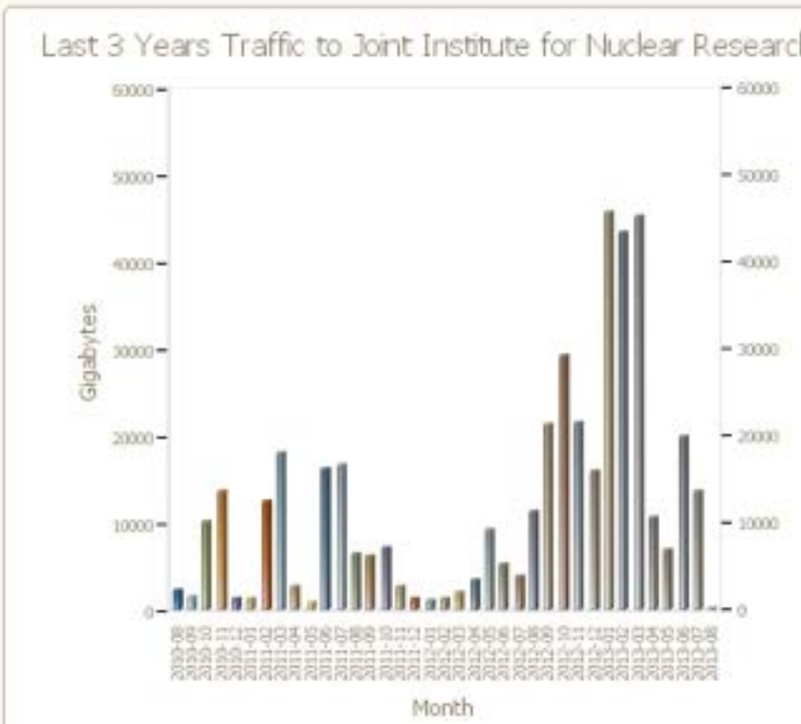
Russian Federation

Name	Joint Institute for Nuclear Research
ID Number	56445
Country Record	No
World Region	Europe
Organization Type	Research Institute
Discipline	Nuclear Sciences
Gov Agency	
Source Traffic	90,056,113,608,895
Destination Traffic	582,111,954,351,952
First Month	2001-08
Recent Month	2013-08
Country	RU Russian Federation
City	Dubna
Region	47
Postal Code	
Latitude, Longitude	56.733299 37.166698
GeoIP Organization	Joint Institute for Nuclear Research
GeoIP ISP	Joint Institute for Nuclear Research

Traffic Sort (Source) Traffic Sort (Dest)

Description | Traffic | Map | Parent Domain

Destination | Source



Global Science Registry

a database of network-intensive facilities, resources and services

Supported by the US National Science Foundation

Joint Institute for Nuclear Research

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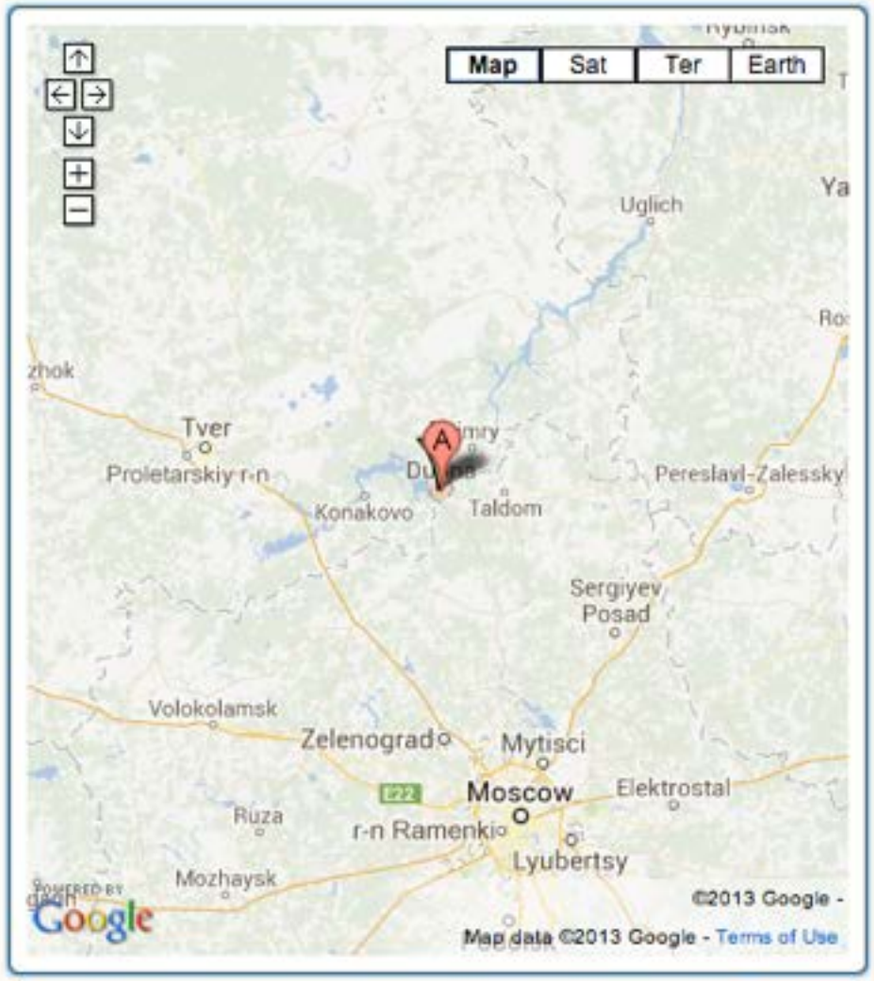
Name	Joint Institute for Nuclear Research
ID Number	56445
Country Record	No
World Region	Europe
Organization Type	Research Institute
Discipline	Nuclear Sciences
Gov Agency	
Source Traffic	90,056,113,608,895
Destination Traffic	582,111,954,351,952
First Month	2001-08
Recent Month	2013-08
Country	RU Russian Federation
City	Dubna
Region	47
Postal Code	
Latitude, Longitude	56.733299 37.166698
GeoIP Organization	Joint Institute for Nuclear Research
GeoIP ISP	Joint Institute for Nuclear Research

Traffic Sort (Source) Traffic Sort (Dest)

Description Traffic Map Parent Domain



DATA STRUCTURE OF ?

DOMAINS-RELATED TABLES

```
mysql> describe pflow.domains;
+--------------+------------------+------+-----+-------------------+-----------------------------+
| Field        | Type             | Null | Key | Default           | Extra                       |
+--------------+------------------+------+-----+-------------------+-----------------------------+
| domainid     | int(11)          | NO   | PRI | NULL              | auto_increment              |
| organization | char(140)        | YES  | MUL | NULL              |                             |
| shortlabel   | char(80)         | YES  | MUL | NULL              |                             |
| isp          | char(100)        | YES  |     | NULL              |                             |
| city         | char(50)         | YES  |     | NULL              |                             |
| regioncode   | char(2)          | YES  |     |                   |                             |
| postalcode   | char(6)          | YES  |     |                   |                             |
| ccode        | char(2)          | YES  | MUL | ??                |                             |
| latitude     | decimal(9,6)     | YES  |     | NULL              |                             |
| longitude    | decimal(9,6)     | YES  |     | NULL              |                             |
| createtime   | timestamp        | NO   |     | CURRENT_TIMESTAMP |                             |
| modifytime   | timestamp        | NO   | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
| cnt          | int(11)          | YES  |     | 0                 |                             |
| pdomainid    | int(11)          | YES  |     | 0                 |                             |
| rdomainid    | int(11)          | YES  | MUL | NULL              |                             |
| orgclass     | tinyint(4)       | NO   |     | 1                 |                             |
| worldclass   | tinyint(4)       | NO   |     | 1                 |                             |
| govid        | smallint(6)      | YES  |     | NULL              |                             |
| discipline   | tinyint(4)       | NO   | MUL | 1                 |                             |
| createdby    | char(15)         | YES  |     | Perl              |                             |
| modifiedby   | char(15)         | YES  |     | Perl              |                             |
| geoorg       | char(140)        | YES  |     | NULL              |                             |
| geocity      | char(50)         | YES  |     | NULL              |                             |
| geoccode     | char(2)          | YES  | MUL | NULL              |                             |
| countryrec   | enum('Yes','No') | NO   |     | No                |                             |
| sbytes       | bigint(20)       | YES  |     | NULL              |                             |
| dbytes       | bigint(20)       | YES  |     | NULL              |                             |
| minmonth     | char(7)          | YES  |     | NULL              |                             |
| maxmonth     | char(7)          | YES  |     | NULL              |                             |
+--------------+------------------+------+-----+-------------------+-----------------------------+
```

Dublin Core Metadata Table

```
3. ssh
ssh    ssh
mysql> describe pflow.domains_dcore;
+------------+----------------------------------------------------------------------------------------------------------------------------------------------+------+-----+---------------------+----------------------------+
| Field      | Type                                                                                                                                         | Null | Key | Default             | Extra                      |
+------------+----------------------------------------------------------------------------------------------------------------------------------------------+------+-----+---------------------+----------------------------+
| domainid   | int(10) unsigned                                                                                                                             | NO   | MUL | NULL                |                            |
| keyid      | int(10) unsigned                                                                                                                             | NO   | PRI | NULL                | auto_increment             |
| language   | char(2)                                                                                                                                      | YES  |     | NULL                |                            |
| dublin     | enum('Title','Creator','Subject','Description','Publisher','Contributor','Date','Type','Format','Identifier','Source','Language','Relation','Coverage','Rights') | YES  |     | NULL                |                            |
| qualifier  | varchar(100)                                                                                                                                 | YES  |     | NULL                |                            |
| descript   | text                                                                                                                                         | YES  | MUL | NULL                |                            |
| createtime | timestamp                                                                                                                                    | YES  |     | 0000-00-00 00:00:00 |                            |
| modifytime | timestamp                                                                                                                                    | YES  | MUL | NULL                | on update CURRENT_TIMESTAMP |
+------------+----------------------------------------------------------------------------------------------------------------------------------------------+------+-----+---------------------+----------------------------+
8 rows in set (0.00 sec)

mysql> 
```

Dublin Core – Wikipedia, the free encyclopedia

en.wikipedia.org/wiki/Dublin_Core

Reader

Dublin Core – Wikipedia, the free encyclopedia

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Português
Русский
Slovenščina

Dublin Core

From Wikipedia, the free encyclopedia

The **Dublin Core metadata terms** are a set of vocabulary terms which can be used to describe resources for the purposes of discovery. The terms can be used to describe a full range of web resources (video, images, web pages, etc.), physical resources such as books and objects like artworks.[1] The full set of Dublin Core metadata terms can be found on the Dublin Core Metadata Initiative (DCMI) website.[2] The original set of 15 classic[3] metadata terms, known as the Dublin Core Metadata Element Set[4] are endorsed in the following standards documents:

- IETF RFC 5013[5]

http://dublincore.org

Background [edit]

"Dublin" refers to Dublin, Ohio, USA where the work originated during the 1995 invitational OCLC/NCSA Metadata Workshop,[8] hosted by the Online Computer Library Center (OCLC), a library consortium based in Dublin, and the National Center for Supercomputing Applications (NCSA). "Core" refers to the metadata terms as "broad and generic being usable for describing a wide range of resources".[4] The semantics of Dublin Core were established and are maintained by an international, cross-disciplinary group of professionals from librarianship, computer science, text encoding, museums, and other related fields of scholarship and practice.

The **Dublin Core Metadata Initiative** (DCMI)[9] provides an open forum for the development of interoperable online metadata standards for a broad range of purposes and of business models. DCMI's activities include consensus-driven working groups, global conferences and workshops, standards liaison, and educational efforts to promote widespread acceptance of metadata standards and practices. In 2008, DCMI

Supplementary Tables in pflow database

```
mysql> describe ccodes;
+------------+-----------+------+-----+-------------------+-----------------------------+
| Field      | Type      | Null | Key | Default           | Extra                       |
+------------+-----------+------+-----+-------------------+-----------------------------+
| code       | char(2)   | NO   | PRI |                   |                             |
| country    | char(50)  | NO   | MUL |                   |                             |
| worldclass | tinyint(4 |
| color      | char(6)   |
| modifytime | timestamp |
+------------+-----------+
```

```
mysql> describe worldclass;
+-----------+-----------+------+-----+-------------------+-----------------------------+
| Field     | Type      | Null | Key | Default           | Extra                       |
+-----------+-----------+------+-----+-------------------+-----------------------------+
| worldid   | tinyint(4)| NO   | PRI | NULL              | auto_increment              |
| wclass    | char(50)  | YES  | UNI | NULL              |                             |
| mapto     | char(50)  | YES  | MUL | NULL              |                             |
                                                                  te CURRENT_TIMESTAMP |
+-----------+-----------+------+-----+-------------------+-----------------------------+
```

```
mysql> describe orgclass;
+--------------+-----------+------+-----+-------------------+-----------------------------+
| Field        | Type      | Null | Key | Default           | Extra                       |
+--------------+-----------+------+-----+-------------------+-----------------------------+
| orgid        | tinyint(4)| NO   | PRI | NULL              | auto_increment              |
| organization | char(50)  | YES  | UNI | NULL              |                             |
| mapto        | char(50)  | YES  | MUL | NULL              |                             |
| modifytime   | timestamp |
+--------------+-----------+
```

```
mysql> describe disciplines;
+-----------+-----------+------+-----+-------------------+-----------------------------+
| Field     | Type      | Null | Key | Default           | Extra                       |
+-----------+-----------+------+-----+-------------------+-----------------------------+
| discid    | smallint(6)| NO  | PRI | NULL              | auto_increment              |
| discipline| char(50)  | YES  | UNI | NULL              |                             |
| master    | char(50)  | YES  |     | NULL              |                             |
                                                                  ENT_TIMESTAMP |
+-----------+-----------+------+-----+-------------------+-----------------------------+
```

```
mysql> describe govagencies;
+------------+----------------------+------+-----+-------------------+-----------------------------+
| Field      | Type                 | Null | Key | Default           | Extra                       |
+------------+----------------------+------+-----+-------------------+-----------------------------+
| govid      | smallint(5) unsigned | NO   | PRI | NULL              | auto_increment              |
| ccode      | char(2)              | YES  | MUL | NULL              |                             |
| agency     | char(50)             | YES  |     | NULL              |                             |
| mapto      | char(50)             | YES  | MUL | NULL              |                             |
| modifytime | timestamp            | YES  | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
+------------+----------------------+------+-----+-------------------+-----------------------------+
```

Traffic-related Supplementary Tables

```
mysql> describe domains_month_source;
+-----------+--------------+------+-----+---------+-------+
| Field     | Type         | Null | Key | Default | Extra |
+-----------+--------------+------+-----+---------+-------+
| source    | int(11)      | NO   | MUL | NULL    |       |
| flowdate  | char(7)      | NO   | MUL | NULL    |       |
| gigabytes | double(15,5) | YES  |     | NULL    |       |
+-----------+--------------+------+-----+---------+-------+
3 rows in set (0.00 sec)

mysql> describe domains_month_dest;
+-----------+--------------+------+-----+---------+-------+
| Field     | Type         | Null | Key | Default | Extra |
+-----------+--------------+------+-----+---------+-------+
| dest      | int(11)      | NO   | MUL | NULL    |       |
| flowdate  | char(7)      | NO   | MUL | NULL    |       |
| gigabytes | double(15,5) | YES  |     | NULL    |       |
+-----------+--------------+------+-----+---------+-------+
3 rows in set (0.00 sec)
```

DATA STRUCTURE OF IP ADDRESS-RELATED TABLES

?

Pflow.IPS Table

```
mysql> describe ips;
+------------+------------------+------+-----+-------------------+-----------------------------+
| Field      | Type             | Null | Key | Default           | Extra                       |
+------------+------------------+------+-----+-------------------+-----------------------------+
| keyid      | int(10) unsigned | NO   | PRI | NULL              | auto_increment              |
| ip         | varbinary(16)    | NO   | UNI | NULL              |                             |
| ipa        | varchar(39)      | YES  | MUL | NULL              |                             |
| createtime | timestamp        | NO   | MUL | CURRENT_TIMESTAMP |                             |
| modifytime | timestamp        | NO   | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
| domainid   | int(10) unsigned | NO   | MUL | NULL              |                             |
| asnum      | int(10) unsigned | NO   | MU                                                     |
| ccode      | char(2)          | NO   |                                                        |
+------------+------------------+------+-----+-------------------+-----------------------------+
```

Key into the Domains table

Pflow.IPSText Table

```
mysql> describe ipstext;
+--------------+---------------------+------+-----+-------------------+-----------------------------+
| Field        | Type                | Null | Key | Default           | Extra                       |
+--------------+---------------------+------+-----+-------------------+-----------------------------+
| keyid        | int(10) unsigned    | NO   | PRI | NULL              |                             |
| ip           | varbinary(16)       | NO   | UNI | NULL              |                             |
| ipname       | varchar(100)        | YES  | MUL | NULL              |                             |
| createtime   | timestamp           | YES  | MUL | CURRENT_TIMESTAMP |                             |
| modifytime   | timestamp           | YES  | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
| locationid   | int(11)             | YES  |     | NULL              |                             |
| regioncode   | char(2)             | YES  |     | NULL              |                             |
| city         | varchar(50)         | YES  |     | NULL              |                             |
| postalcode   | char(6)             | YES  |     | NULL              |                             |
| latitude     | decimal(9,6)        | YES  |     | NULL              |                             |
| longitude    | decimal(9,6)        | YES  |     | NULL              |                             |
| isp          | varchar(100)        | YES  |     |                   |                             |
| organization | varchar(100)        | YES  |     | NU                |                             |
| ccode        | char(2)             | YES  |     | NU                |                             |
| ipa          | varchar(39)         | YES  | MUL | NU                |                             |
| domainid     | int(10) unsigned    | NO   | MUL | 0                 |                             |
| asnum        | int(10) unsigned    | NO   |     |                   |                             |
| sbytes       | bigint(20) unsigned | YES  |     |                   |                             |
| dbytes       | bigint(20) unsigned | YES  |     |                   |                             |
| minmonth     | char(7)             | YES  |     |                   |                             |
| maxmonth     | char(7)             | YES  |     |                   |                             |
| olddomainid  | int(10) unsigned    | NO   |     |                   |                             |
+--------------+---------------------+------+-----+-------------------+-----------------------------+
```

Note: Can be

Key into the ASNUMS table

Default values for many c… added from GeoIP (MaxMind) databa… new IPs are encountered.

Pflow.ASNUMS Table

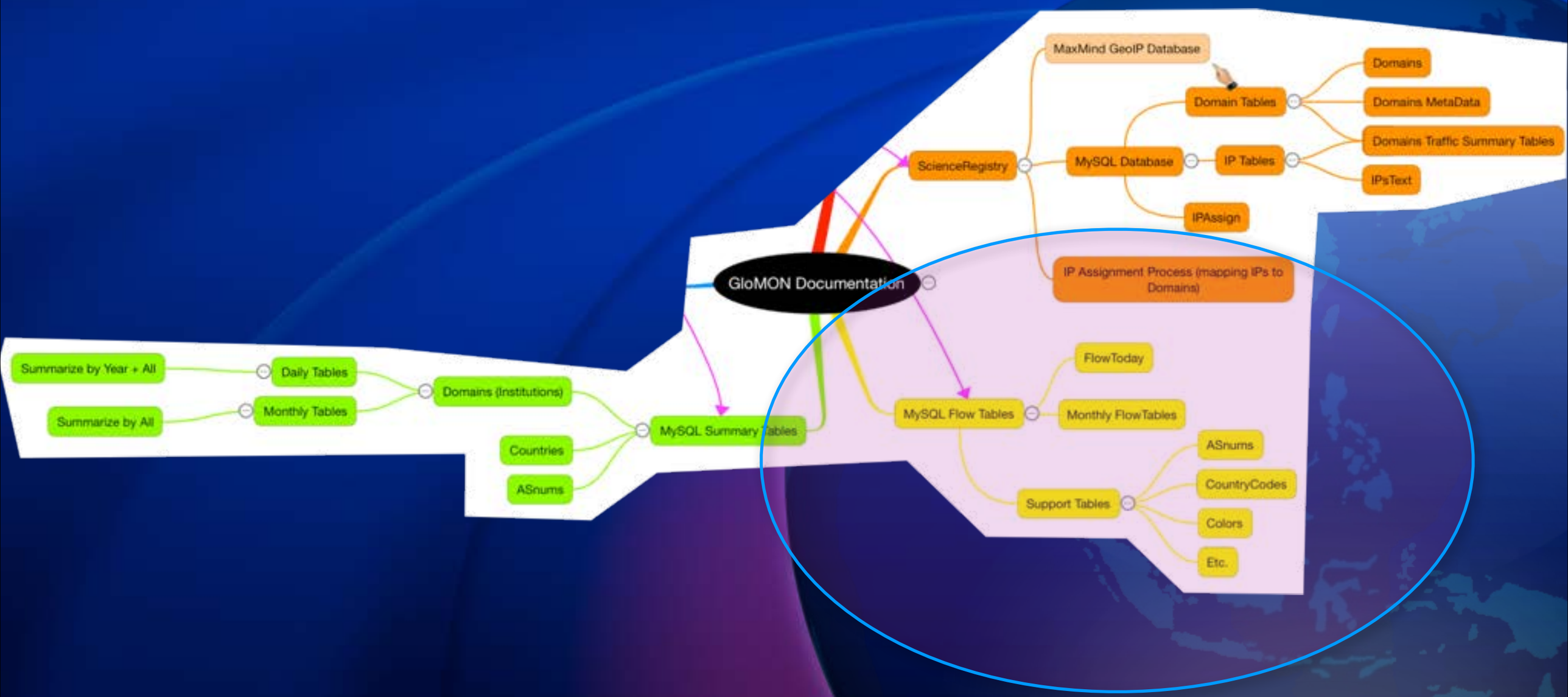
```
mysql> describe asnums;
+-------------+------------------------------------------------------------------------------------------------------------
--------------------+------+-----+-------------------+-----------------------------+
| Field       | Type
                    | Null | Key | Default           | Extra                       |
+-------------+------------------------------------------------------------------------------------------------------------
--------------------+------+-----+-------------------+-----------------------------+
| asnum       | int(10)
                    | NO   | PRI | 0                 |                             |
| asname      | char(80)
                    | NO   |     | NULL              |                             |
| ccode       | char(2)
                    | YES  | MUL | NULL              |                             |
| bytestoday_s | bigint(20)
                    | YES  |     | 0                 |                             |
| bytestoday_d | bigint(20)
                    | YES  |     | 0                 |                             |
| bytesyear_s | bigint(20)
                    | YES  |     | 0                 |                             |
| bytesyear_d | bigint(20)
                    | YES  |     | 0                 |                             |
| createdby   | char(15)
                    | YES  |     | Perl              |                             |
| modifiedby  | char(15)
                    | YES  |     | Perl              |                             |
| createtime  | timestamp
                    | NO   |     | CURRENT_TIMESTAMP |                             |
| modifytime  | timestamp
                    | YES  | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
| orgclass    | enum('Unknown','Corporate','Academy of Science','Government','University','Other')
                    | YES  |     | Unknown           |                             |
| usgov       | enum('DOE','NASA','USGS','NIH','MILITARY','NOAA','Agriculture','NSF','Other Federal','State Government
','Local Government') | YES  |     | NULL              |                             |
+-------------+------------------------------------------------------------------------------------------------------------
--------------------+------+-----+-------------------+-----------------------------+
```

Pflow.IPSDNS Table

```
mysql> describe ipsdns;
+------------+------------------+------+-----+-------------------+-----------------------------+
| Field      | Type             | Null | Key | Default           | Extra                       |
+------------+------------------+------+-----+-------------------+-----------------------------+
| keyid      | int(10) unsigned | NO   | PRI | NULL              |                             |
| ipa        | varchar(39)      | NO   | UNI | NULL              |                             |
| dns        | varchar(100)     | YES  |     | NULL              |                             |
| createtime | timestamp        | NO   | MUL | CURRENT_TIMESTAMP |                             |
| modifytime | timestamp        | NO   | MUL | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
+------------+------------------+------+-----+-------------------+-----------------------------+
5 rows in set (0.00 sec)
```

Separate process updates DNS values for newly-encountered IP addresses.

Database Organization, Storage and Retrieval



Flow Tables

- Keep all flows > 100Kbytes in length (but keep separate disk archive of **all** argus data)
- (~ 99% of traffic; 1% of flow records)
- Keep a trimmed past-24 hour table
- Monthly Tables since 1999-06
- MySQL MyISAM using Merge tables to give yearly and total (all) groupings
- Process every 5 minutes to load latest summarized argus data
- Re-engineered (and reloaded) all tables (repeatedly) after beginning work with argus

Structure of Flow Tables

4. ssh

```
mysql> describe flow_today;
+------------+-----------------------------------------------------------------------------------------+------+-----+---------+----------------+
| Field      | Type                                                                                    | Null | Key | Default | Extra          |
+------------+-----------------------------------------------------------------------------------------+------+-----+---------+----------------+
| keyid      | int(10) unsigned                                                                        | NO   | PRI | NULL    | auto_increment |
| ip_s       | int(10) unsigned                                                                        | NO   | MUL | 0       |                |
| ip_d       | int(10) unsigned                                                                        | NO   | MUL | 0       |                |
| protocol   | tinyint(3) unsigned                                                                     | NO   |     | 0       |                |
| port_s     | smallint(5) unsigned                                                                    | NO   |     | 0       |                |
| port_d     | smallint(5) unsigned                                                                    | NO   |     | 0       |                |
| createtime | datetime(6)                                                                             | YES  | MUL | NULL    |                |
| starttime  | datetime(6)                                                                             | YES  | MUL | NULL    |                |
| endtime    | datetime(6)                                                                             | YES  |     | NULL    |                |
| trans      | int(10) unsigned                                                                        | NO   |     | 0       |                |
| bytes      | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| bytes_s    | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| bytes_d    | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| appbytes   | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| appbytes_s | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| appbytes_d | bigint(20) unsigned                                                                     | NO   |     | 0       |                |
| packets    | int(10) unsigned                                                                        | NO   |     | 0       |                |
| packets_s  | int(10) unsigned                                                                        | NO   |     | 0       |                |
| packets_d  | int(10) unsigned                                                                        | NO   |     | 0       |                |
| retrans    | int(10) unsigned                                                                        | NO   |     | 0       |                |
| retrans_s  | int(10) unsigned                                                                        | NO   |     | 0       |                |
| retrans_d  | int(10) unsigned                                                                        | NO   |     | 0       |                |
| jitter_s   | float(9,4) unsigned                                                                     | NO   |     | 0.0000  |                |
| jitter_d   | float(9,4) unsigned                                                                     | NO   |     | 0.0000  |                |
| tcprtt     | float(9,6) unsigned                                                                     | NO   |     | 0.000000 |                |
| ttl_s      | tinyint(3) unsigned                                                                     | YES  |     | NULL    |                |
| ttl_d      | tinyint(3) unsigned                                                                     | YES  |     | NULL    |                |
| win_s      | int(10) unsigned                                                                        | NO   |     | 0       |                |
| win_d      | int(10) unsigned                                                                        | NO   |     | 0       |                |
| hops_s     | tinyint(3) unsigned                                                                     | NO   |     | 0       |                |
| hops_d     | tinyint(3) unsigned                                                                     | NO   |     | 0       |                |
| smaxsz     | smallint(3) unsigned                                                                    | NO   |     | 0       |                |
| dmaxsz     | smallint(3) unsigned                                                                    | NO   |     | 0       |                |
| tcpflags   | char(8)                                                                                 | YES  |     |         |                |
| tcpopt     | set('M','w','s','S','e','E','T','c','N','0','1','2')                                   | YES  |     |         |                |
| vlanid_s   | smallint(5) unsigned                                                                    | YES  |     | 0       |                |
| vlanid_d   | smallint(5) unsigned                                                                    | YES  |     | 0       |                |
| dom_s      | int(10) unsigned                                                                        | YES  | MUL | NULL    |                |
| dom_d      | int(10) unsigned                                                                        | YES  | MUL | NULL    |                |
| cc_s       | char(2)                                                                                 | YES  | MUL | NULL    |                |
| cc_d       | char(2)                                                                                 | YES  | MUL | NULL    |                |
| as_s       | int(10) unsigned                                                                        | YES  |     | NULL    |                |
| as_d       | int(10) unsigned                                                                        | YES  |     | NULL    |                |
| network_s  | smallint(5) unsigned                                                                    | NO   |     | 0       |                |
| network_d  | smallint(6) unsigned                                                                    | NO   |     | 0       |                |
| router     | char(2)                                                                                 | YES  |     |         |                |
| appid      | smallint(5) unsigned                                                                    | YES  |     | NULL    |                |
| as_prev    | int(10) unsigned                                                                        | YES  |     | NULL    |                |
| as_next    | int(10) unsigned                                                                        | YES  |     | NULL    |                |
| classid_s  | int(11)                                                                                 | YES  |     | 0       |                |
| classid_d  | int(11)                                                                                 | YES  |     | NULL    |                |
| direction  | enum(' -',' I',' o',' ?','<->','<-',' ->','<I>','<I',' I>','<o>','<o',' o>','<?>','<?',' ?>') | YES  |     | NULL    |                |
| mac_s      | smallint(5) unsigned                                                                    | NO   |     | 0       |                |
| mac_d      | smallint(5) unsigned                                                                    | NO   |     | 0       |                |
+------------+-----------------------------------------------------------------------------------------+------+-----+---------+----------------+
54 rows in set (0.00 sec)
```

Monthly/Annual Flow Tables

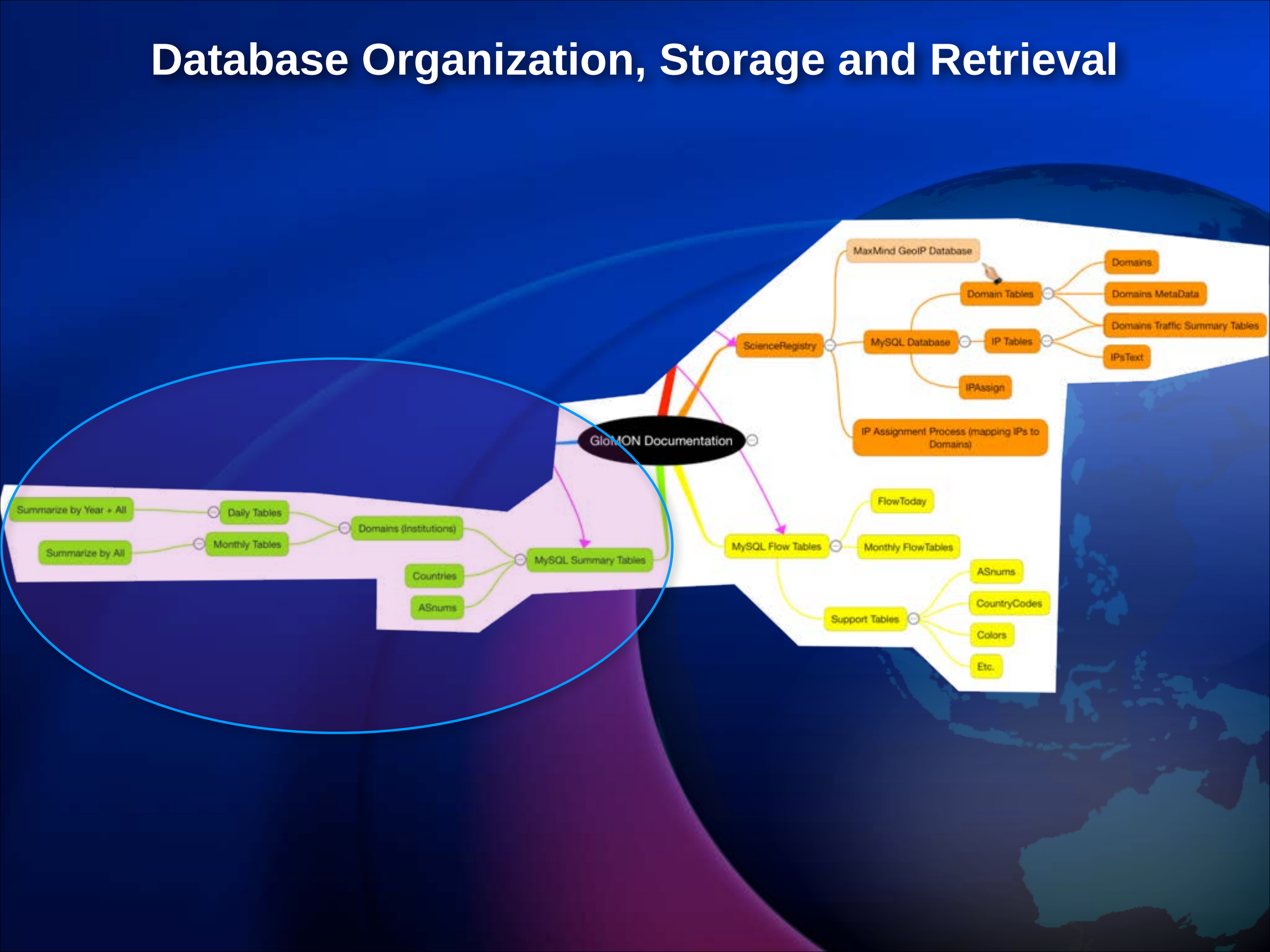
4. ssh

```
mysql> show tables like 'flow%';
+-------------------------+
| Tables_in_pflow (flow%) |
+-------------------------+
| flow1999                |
| flow199901              |
| flow199902              |
| flow199903              |
| flow199904              |
| flow199905              |
| flow199906              |
| flow199907              |
| flow199908              |
| flow199909              |
| flow199910              |
| flow199911              |
| flow199912              |
| flow2000                |
| flow200001              |
| flow200002              |
| flow200003              |
| flow200004              |
| flow200005              |
| flow200006              |
| flow200007              |
| flow200008              |
| flow200009              |
| flow200010              |
| flow200011              |
| flow200012              |
| flow2001                |
| flow200101              |
| flow200102              |
| flow200103              |
| flow200104              |
| flow200105              |
| flow200106              |
| flow200107              |
| flow200108              |
| flow200109              |
```

Monthly Flow Tables (MyISAM)
Today: ~1 million records/day = 30 million record tables

Annual Flow Table (Merge Table)

Database Organization, Storage and Retrieval



Summary Tables

- Necessary for querying database
- Computed/updated at time flow records are written (i.e., every 5 minutes)
- Have found 3 essential summary groupings - by country, by asnum and by domain (institution/facility)

Why?

Raw Flow Data

```
mysql> use pflow;
Database changed
mysql> select count(*) from flowall;
+------------+
| count(*)   |
+------------+
| 1747235091 |
+------------+
1 row in set (0.03 sec)
```

1.7 billion records

Summary Flow Data

```
mysql> use sum_domains;
Database changed
mysql> select count(*) from ddall;
+-----------+
| count(*)  |
+-----------+
| 115006884 |
+-----------+
1 row in set (0.03 se

mysql> use sum_asnums;
Database changed
mysql> select count(*) from ddall;
+----------+
| count(*) |
+----------+
| 40999154 |
+----------+
1 row in set (0.03 se

mysql> use sum_countries;
Database changed
mysql> select count(*) from ddall;
+----------+
| count(*) |
+----------+
|  3120293 |
+----------+
1 row in set (0.03 se
```

115 million records

41 million records

3 million records

sum_domains, sum_asnums, sum_countries

Daily Summary Tables

dd2012
dd201201
dd201202
dd201203
dd201204
dd201205
dd201206
dd201207
dd201208
dd201209
dd201210
dd201211
dd201212
dd2013
dd201301
dd201302
dd201303
dd201304
dd201305
dd201306
dd201307
dd201308
dd201309
dd201310
dd201311
dd201312

Monthly Summary Tables

mm2012
mm201201
mm201202
mm201203
mm201204
mm201205
mm201206
mm201207
mm201208
mm201209
mm201210
mm201211
mm201212
mm2013
mm201301
mm201302
mm201303
mm201304
mm201305
mm201306
mm201307
mm201308
mm201309
mm201310
mm201311
mm201312

sum_countries

```
mysql> describe dd201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | date                 | NO   | MUL | NULL    |       |
| source   | char(2)              | NO   | MUL | NULL    |       |
| dest     | char(2)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| world_s  | tinyint(4)           | YES  | MUL | 1       |       |
| world_d  | tinyint(4)           | YES  | MUL | 1       |       |
+----------+----------------------+------+-----+---------+-------+
13 rows in set (0.01 sec)
```

```
mysql> describe mm201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | char(7)              | NO   | MUL | NULL    |       |
| source   | char(2)              | NO   | MUL | NULL    |       |
| dest     | char(2)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| world_s  | tinyint(4)           | YES  | MUL | 1       |       |
| world_d  | tinyint(4)           | YES  | MUL | 1       |       |
+----------+----------------------+------+-----+---------+-------+
13 rows in set (0.00 sec)
```

sum_asnums

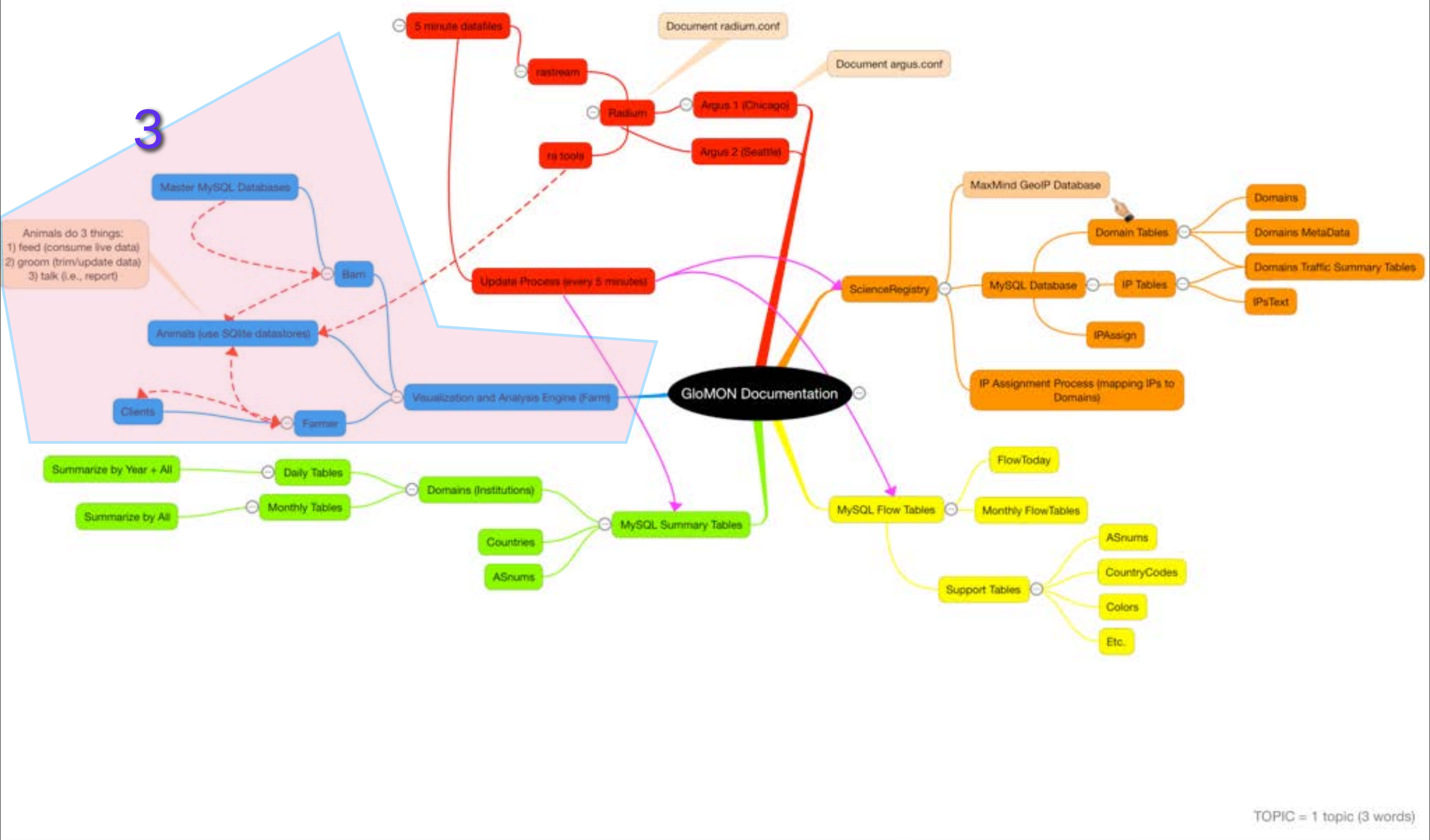
```
mysql> describe dd201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | date                 | NO   | MUL | NULL    |       |
| source   | int(10)              | NO   | MUL | NULL    |       |
| dest     | int(10)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| cc_s     | char(2)              | YES  | MUL | ??      |       |
| cc_d     | char(2)              | YES  | MUL | ??      |       |
+----------+----------------------+------+-----+---------+-------+
13 rows in set (0.01 sec)
```

```
mysql> describe mm201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | char(7)              | NO   | MUL | NULL    |       |
| source   | int(10)              | NO   | MUL | NULL    |       |
| dest     | int(10)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| cc_s     | char(2)              | YES  | MUL | ??      |       |
| cc_d     | char(2)              | YES  | MUL | ??      |       |
+----------+----------------------+------+-----+---------+-------+
13 rows in set (0.00 sec)
```

sum_domains

```
mysql> use sum_domains;
Database changed
mysql> describe dd201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | date                 | NO   | MUL | NULL    |       |
| source   | int(11)              | NO   | MUL | NULL    |       |
| dest     | int(11)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| cc_s     | char(2)              | NO   | MUL | NULL    |       |
| cc_d     | char(2)              | NO   | MUL | NULL    |       |
| org_s    | tinyint(4)           | YES  | MUL | 1       |       |
| org_d    | tinyint(4)           | YES  | MUL | 1       |       |
| gov_s    | tinyint(4)           | YES  |     | 1       |       |
| gov_d    | tinyint(4)           | YES  |     | 1       |       |
| disc_s   | smallint(6)          | YES  | MUL | 1       |       |
| disc_d   | smallint(6)          | YES  | MUL | 1       |       |
| world_s  | tinyint(4)           | YES  |     | 1       |       |
| world_d  | tinyint(4)           | YES  |     | 1       |       |
+----------+----------------------+------+-----+---------+-------+
21 rows in set (0.00 sec)
```

```
mysql> use sum_domains;
Database changed
mysql> describe mm201401;
+----------+----------------------+------+-----+---------+-------+
| Field    | Type                 | Null | Key | Default | Extra |
+----------+----------------------+------+-----+---------+-------+
| flowdate | char(7)              | NO   | MUL | NULL    |       |
| source   | int(11)              | NO   | MUL | NULL    |       |
| dest     | int(11)              | NO   | MUL | NULL    |       |
| protocol | tinyint(3) unsigned  | NO   | MUL | 0       |       |
| appid    | smallint(5) unsigned | YES  | MUL | NULL    |       |
| bytes    | bigint(20)           | NO   |     | NULL    |       |
| packets  | bigint(20) unsigned  | NO   |     | 0       |       |
| retrans  | bigint(20) unsigned  | NO   |     | 0       |       |
| appbytes | bigint(20) unsigned  | NO   |     | 0       |       |
| flows    | int(10) unsigned     | NO   |     | 0       |       |
| trans    | int(10) unsigned     | NO   |     | 0       |       |
| cc_s     | char(2)              | NO   | MUL | NULL    |       |
| cc_d     | char(2)              | NO   | MUL | NULL    |       |
| org_s    | tinyint(4)           | YES  | MUL | 1       |       |
| org_d    | tinyint(4)           | YES  | MUL | 1       |       |
| gov_s    | tinyint(4)           | YES  |     | 1       |       |
| gov_d    | tinyint(4)           | YES  |     | 1       |       |
| disc_s   | smallint(6)          | YES  | MUL | 1       |       |
| disc_d   | smallint(6)          | YES  | MUL | 1       |       |
| world_s  | tinyint(4)           | YES  |     | 1       |       |
| world_d  | tinyint(4)           | YES  |     | 1       |       |
+----------+----------------------+------+-----+---------+-------+
21 rows in set (0.01 sec)
```



TOPIC = 1 topic (3 words)

Technologies

- Argus as passive monitor (formerly packeteer and then nprobe) running on top of pf_ring (or freebsd's netmap or using endace cards)
- Mysql and SQLite as underlying database (exploring alternatives now) along with BerkeleyDB
- Perl/POE/IKC for back-end "cooperative multitasking" server
- RunRev's LiveCode for front-end client development (we formerly used Flash) (someday this should be html5 apps (?))
- Generic Mapping Tools (GMT) for GIS, maps
- Gearman as job-queue server (for parallelizing certain tasks)
- Memcached as memory cache (speeding up certain data access and reducing load on mysql server)
- ChartDirector for graphics, LaTex for typesetting/report production
- Filemaker (via ODBC) for friendly database front-end to MySQL databases
- GitHub for source code development/distribution

Discussions

Technical Deployment

Uses

Shared Development Opportunities

Future Development

Technologies

ZeroMQ (+ msgpack)

freeBSD, macosx, linux

CPAN, miniCPAN, dZil

GitHub

Perl / POE (and farm concept)

MySQL and Sqlite (and FileMaker/ODBC as front-end)

Argus

ChartDirector

RunRev LiveCode

MemCache (Redis)

LaTex

Cisco provided network gear

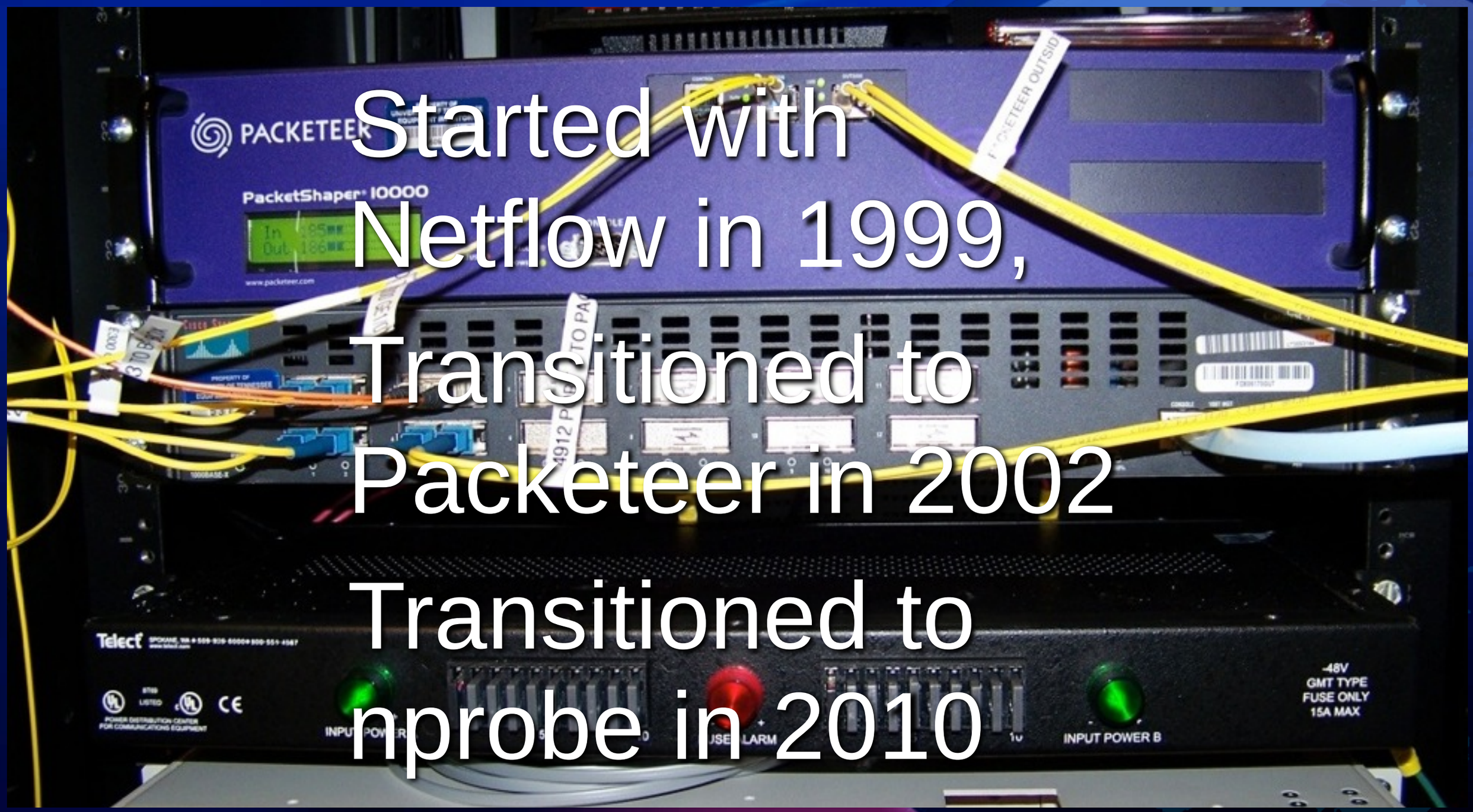
Flash and PaperVision3d

Generic Mapping Tools (GMT)

Cisco UCS Blade Servers

Cisco/Intel Xeon Phi Coprocessor

Former Metrics Data Sources



Started with Netflow in 1999,

Transitioned to Packeteer in 2002

Transitioned to nprobe in 2010

“Taj” 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 (ixgbe driver). 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.

2012 Transition to Argus

http://www.qosient.com/argus/

We moved from linux/pf_ring to freeBSD/netmap

The two screenshots above illustrate data generated from the Taj project’s “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).

Near-future GLORIAD-US Deployment of Argus

SEATTLE ARGUS NODE

DELL R410 servers -
1) Processors - 2 x Intel xeon X55670, 2.93GHz (Quad cores)
2) Memory - 8 GB (4 x 2GB) UDDIMMs
3) Hard drive - 500GB SAS
4) Intel 82599EB 10G NIC
5) OS - FreeBSD 9.1
6) modified for NETMAP
7) running argus daemon sending data to radium server in Knoxville

Seattle Force-10 Router

10G SPAN port

(use taps instead)

Chicago Force-10 Router

10G SPAN port

(use taps instead)

CISCO SYSTEMS

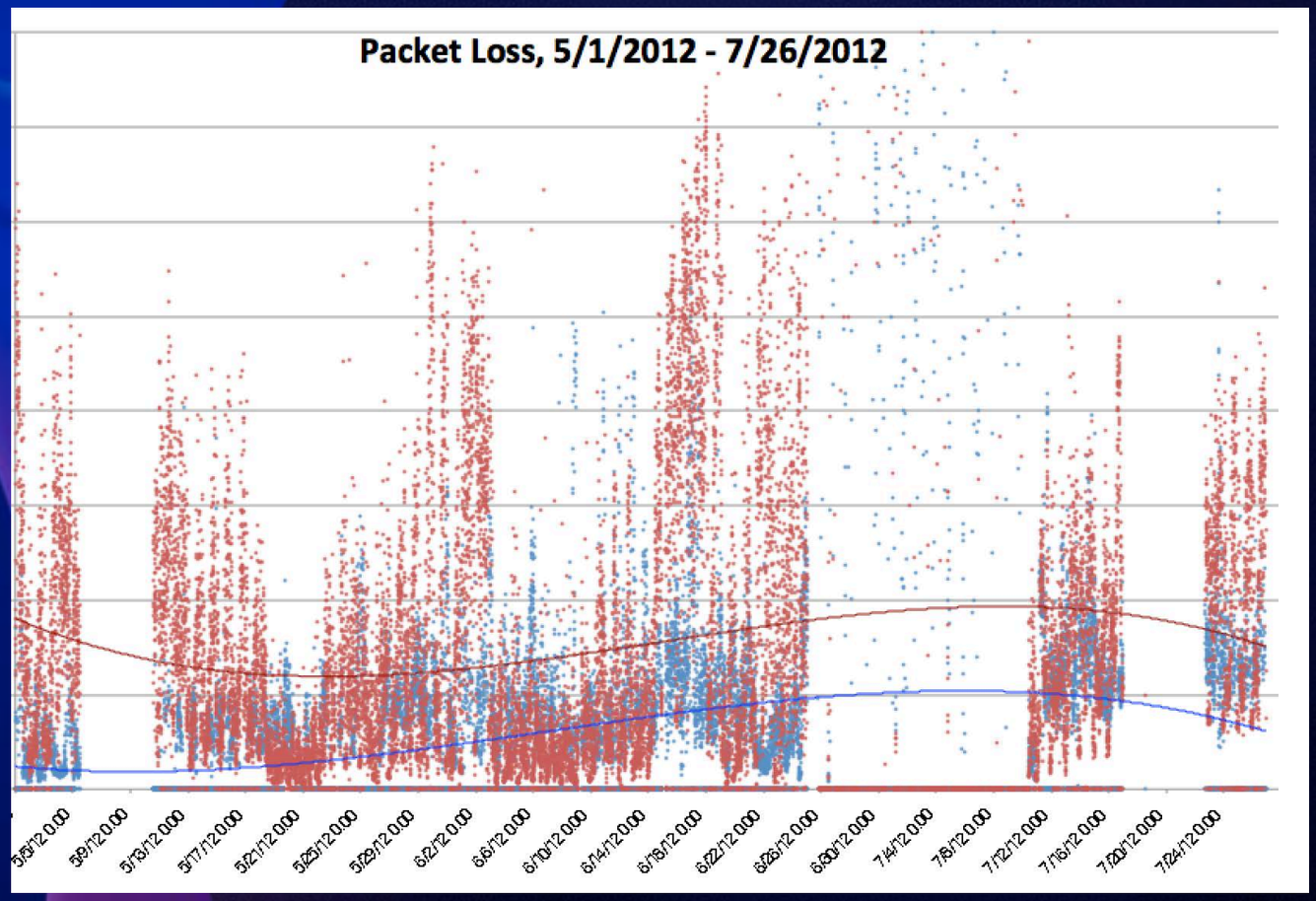
CHICAGO ARGUS NODE

DELL R410 servers -
1) Processors - 2 x Intel xeon X55670, 2.93GHz (Quad cores)
2) Memory - 8 GB (4 x 2GB) UDDIMMs
3) Hard drive - 500GB SAS
4) Intel 82599EB 10G NIC
5) OS - FreeBSD 9.1
6) modified for NETMAP
7) running argus daemon sending data to radium server in Knoxville

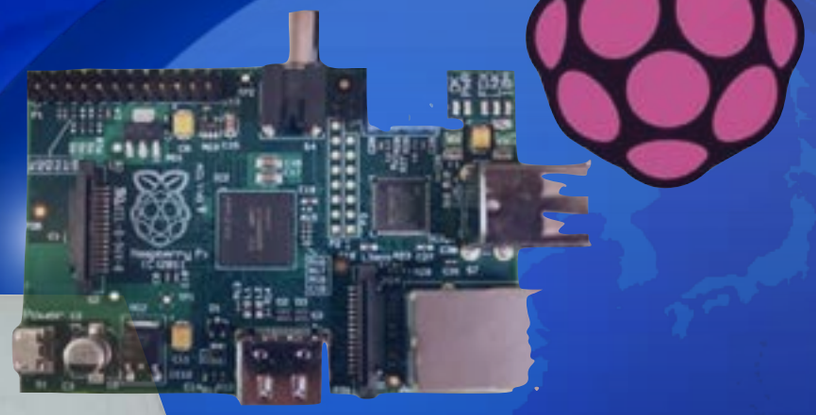
- Local Storage
- Local Analysis H ardware
- Ability to handle much more capacity

Why all this power?

- Preparing the data for this graph from 250G argus archive (which helped a large international R&E network systemically address a huge performance problem) took me 3 days with our current setup
- We want any of our partners to be able do this in 3 minutes (or less)
- We want “room” to better research the area of performance, operations and security analytics with our international partners



But we're still designing for lesser needs as well (targeting single 1G and 10G networks)



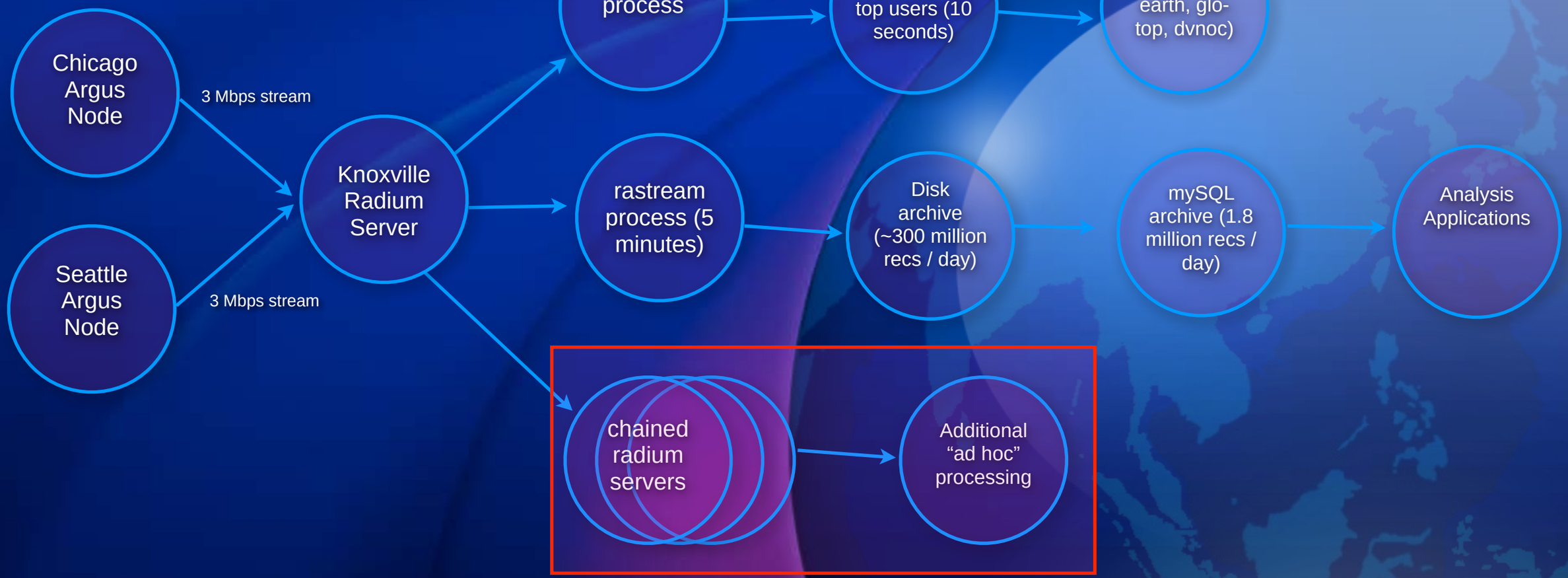
MacOSX

Linux

FreeBSD

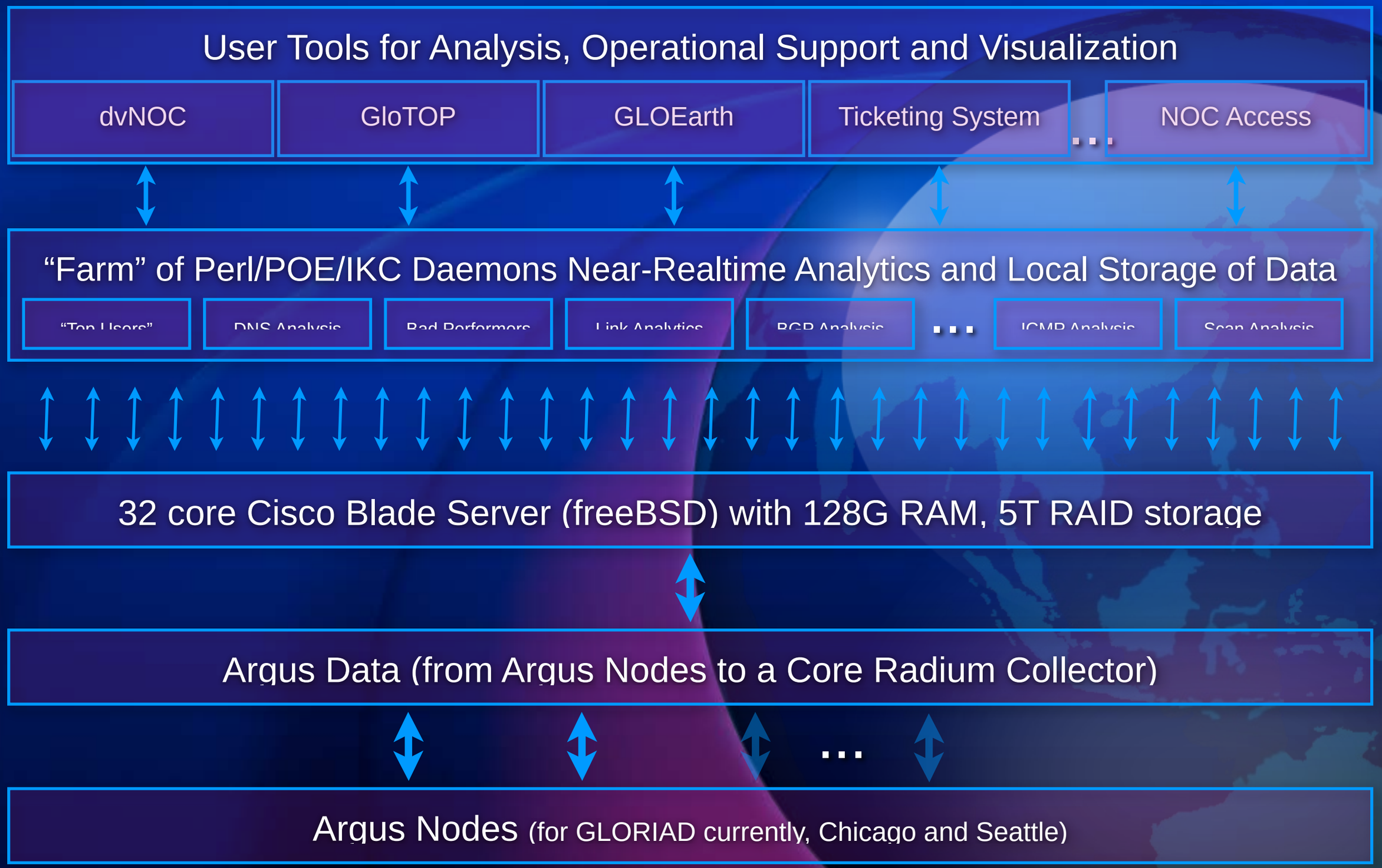
Current Process

New Process


Chicago Argus Node
Seattle Argus Node
3 Mbps stream
3 Mbps stream
Knoxville Radium Server
racluster process
rastream process (5 minutes)
chained radium servers
mysql archive of top users (10 seconds)
Disk archive (~300 million recs / day)
Additional "ad hoc" processing
Live Apps (glo-earth, glo-top, dvnoc)
mySQL archive (1.8 million recs / day)
Analysis Applications

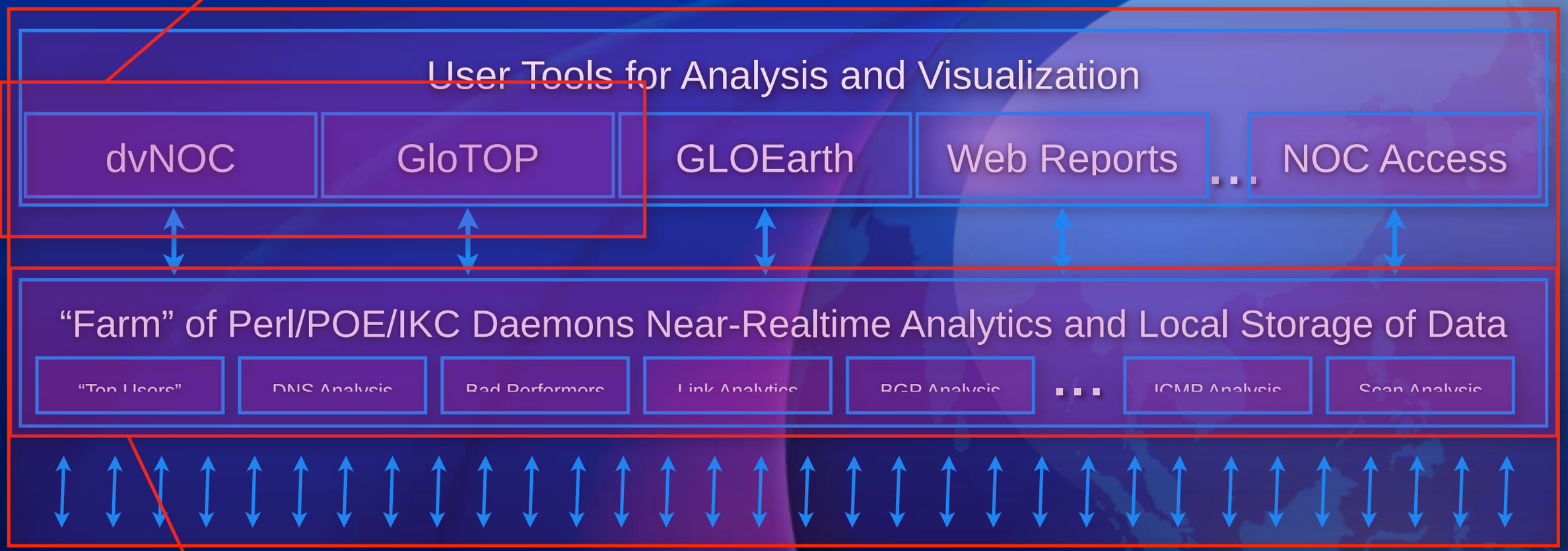
New Process

(Dec/2012-Jan/2013)



More detail ..

- Built with Runrev LiveCode
- Multi-platform (Mac, Windows, Linux, iOS, Android)
- Event-driven, graphic/media rich applications



- Perl POE event-loop, event-driven programming for "cooperative multi-tasking"
- IKC for inter-kernel communications between "animals"
- Daemonized (fast)
- Use MySQL (or any other) for long-term storage; SQLlite for local (fast) in-memory database
- Each "animal" on the "farm" is autonomous and very specialized
- Most read from a single argus RABINS stream

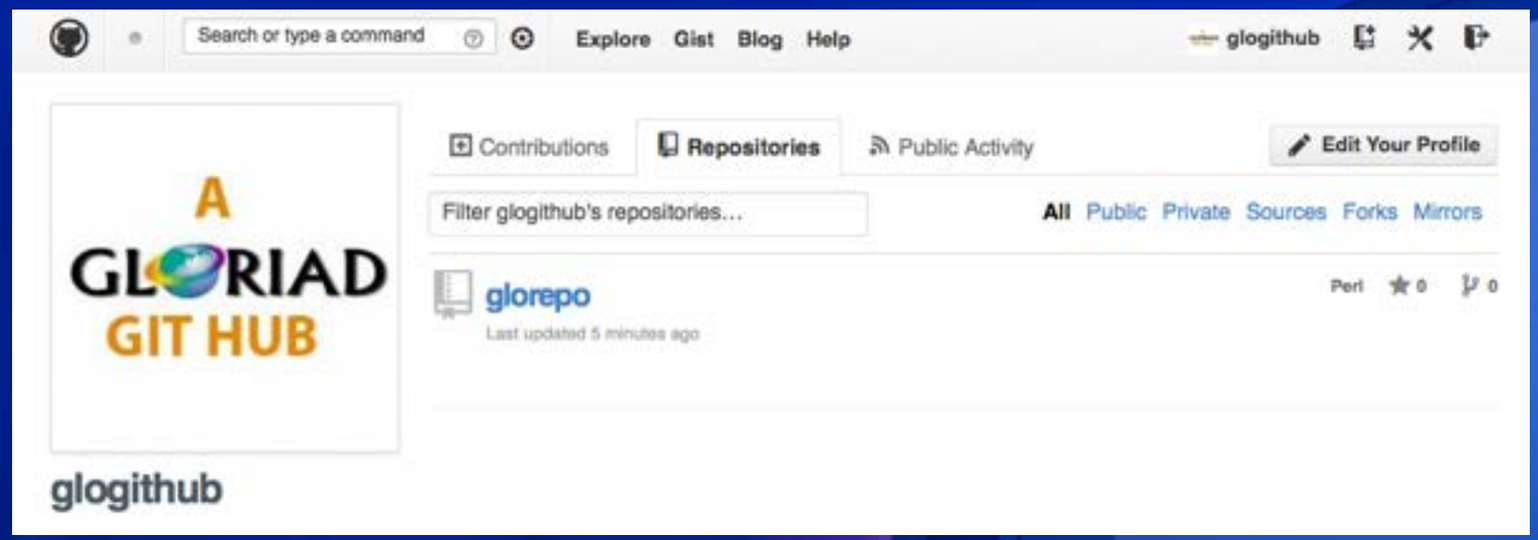
All of the software, tools, data specifications, etc. are being "Github'd"

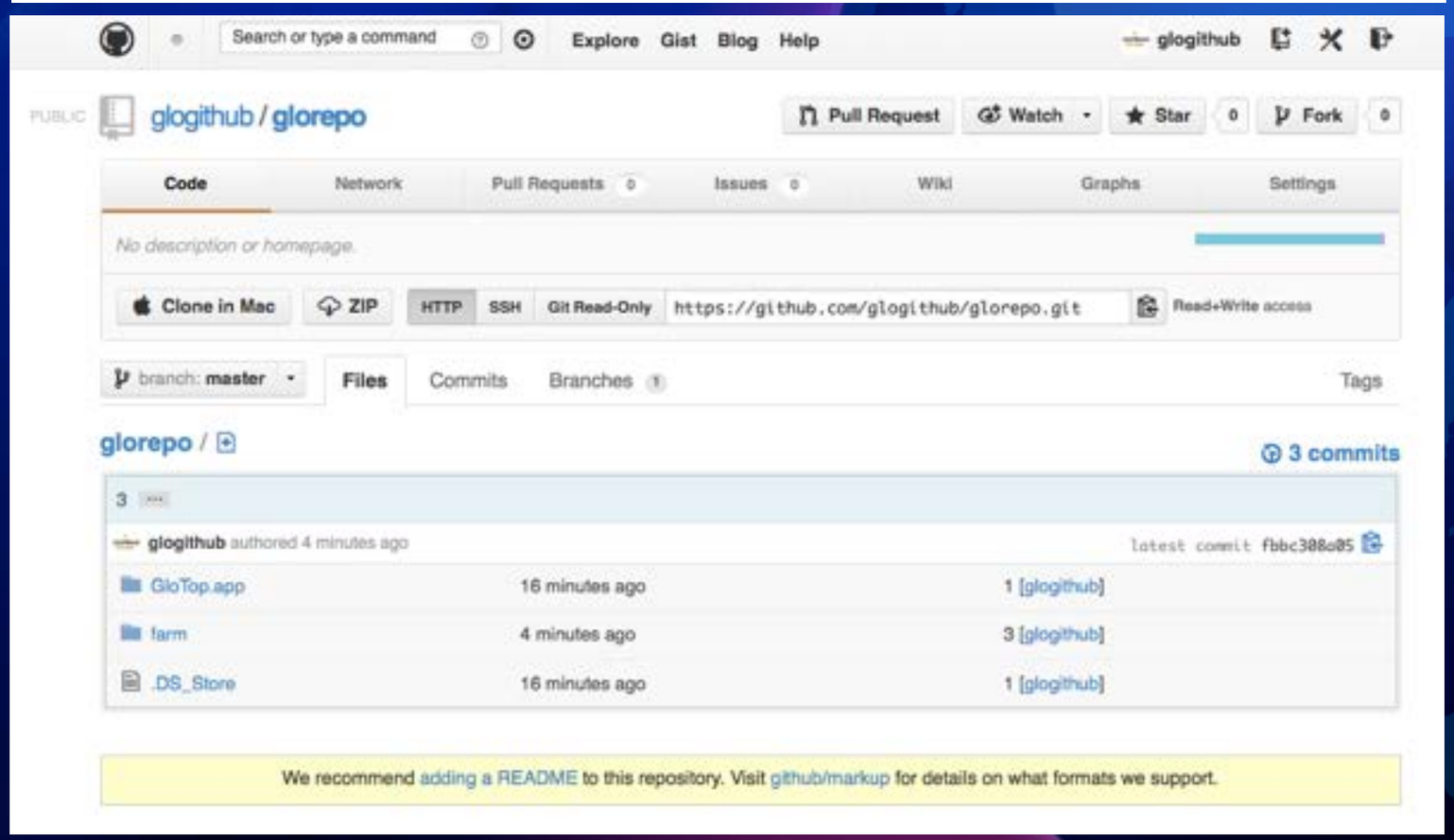
(right thing to do (argus, perl, mysql, sqlite are all open)

and

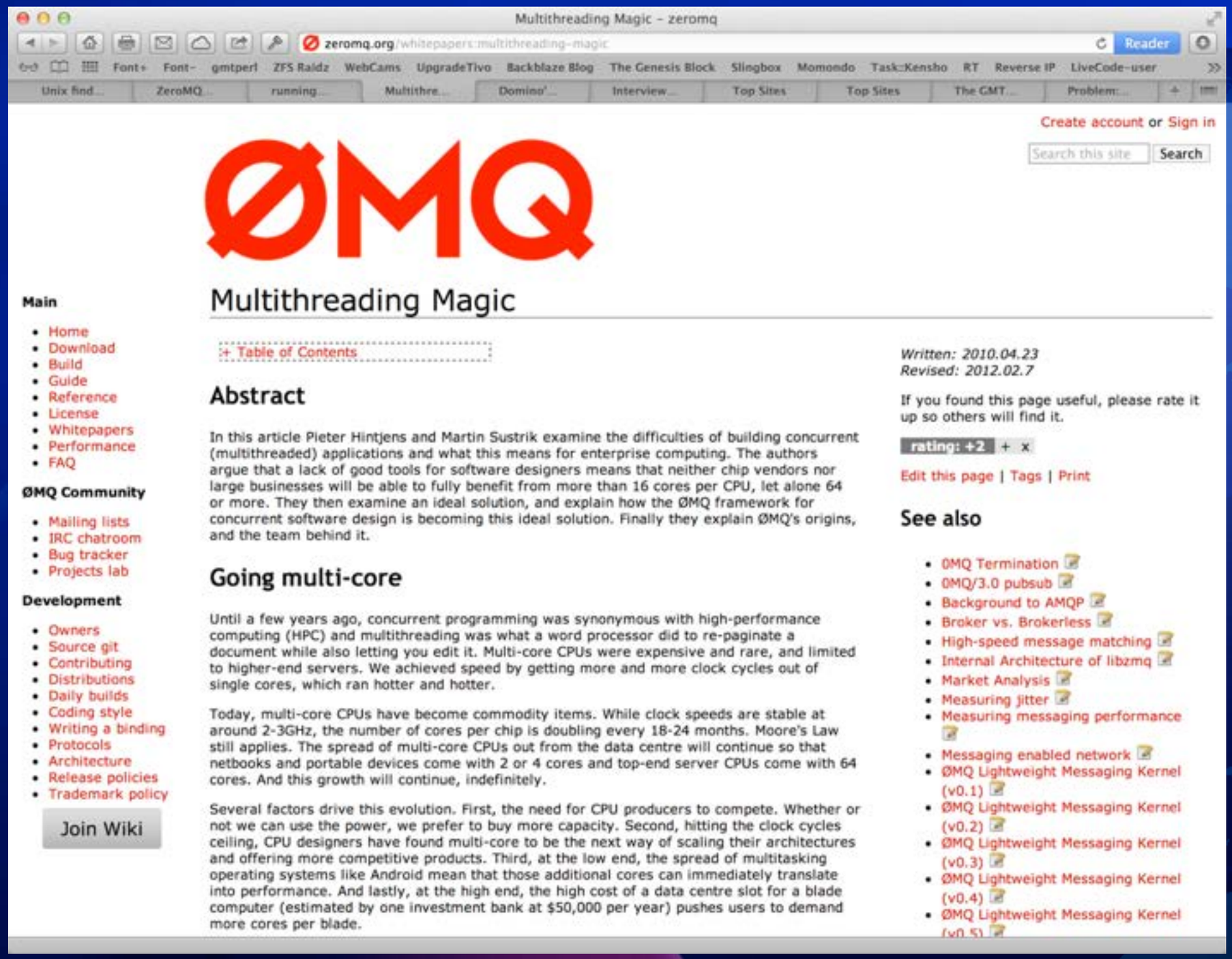
we want people to help us ..)

GLORIAD github





ZeroMQ is huge part of our future



http://zeromq.org/whitepapers:multithreading-magic

Simple Dataflow Model

“Operationalizing” this Data

RT for gloriad.org

Logged in as gcole | Logout

- Home
- Simple Search
- **Tickets**
- Tools
- Approval

Found 13 tickets

New ticket in ChinaNetO Search

New Search · Edit Search · Advanced · **Show Results** · Bulk Update

Spreadsheet · RSS · iCal · Editable text

#	Subject Requestors	Status Created	Queue Told	Owner Last Updated	Priority Time Left
5	Dramatic Increase in Observed ASnums incoming from CSTnet network. root@rt.gloriad.org	new 30 hours ago	USNetOps	Nobody 30 hours ago	50 0
6	**Retransmits 1.66 % on Internet2 -> CSTnet flow of 51,928,896 bytes** root@rt.gloriad.org	new 30 hours ago	USNetOps	Nobody 30 hours ago	50 0
11	**Dramatic Increase in Observed ASnums incoming from CSTnet network.** root@rt.gloriad.org	new 29 hours ago	USNetOps	Nobody 29 hours ago	50 0
16	**New AS Number: AS 15270 -- not seen in at least 365 days** root@rt.gloriad.org	new 29 hours ago	USNetOps	Nobody 29 hours ago	50 0
20	**High Retransmits on Link CSTnet. Retransmit % is currently 1.53 %** root@rt.gloriad.org	new 29 hours ago	USNetOps	Nobody 29 hours ago	50 0
25	CRITICAL: Likely Link Failure of KREOnet2 network. root@rt.gloriad.org	new 29 hours ago	USNetOps	Nobody 29 hours ago	50 0
28	High Retransmits on Link RBnet. Retransmit % is currently 0.95 % root@rt.gloriad.org	new 29 hours ago	USNetOps	Nobody 29 hours ago	50 0
32	**High Retransmits on Link CSTnet. Retransmit % is currently 1.24 %** root@rt.gloriad.org	new 27 hours ago	USNetOps	Nobody 27 hours ago	50 0
38	**Retransmits 1.97 % on Internet2 -> CSTnet flow of 52,491,377 bytes** root@rt.gloriad.org	new 17 hours ago	USNetOps	Nobody 17 hours ago	50 0
39	**Retransmits 1.50 % on Internet2 -> CSTnet flow of 50,888,232 bytes** root@rt.gloriad.org	new 14 hours ago	USNetOps	Nobody 14 hours ago	50 0
40	**High Retransmits on Link RBnet. Retransmit % is currently 0.76 %** root@rt.gloriad.org	new 14 hours ago	USNetOps	Nobody 14 hours ago	50 0
41	Retransmits 1.61 % on NLR -> CSTnet flow of 54,610,438 bytes root@rt.gloriad.org	new 13 hours ago	USNetOps	Nobody 13 hours ago	50 0
62	**High Retransmits on Link CSTnet. Retransmit % is currently 0.75 %** root@rt.gloriad.org	new 2 hours ago	USNetOps	Nobody 2 hours ago	50 0

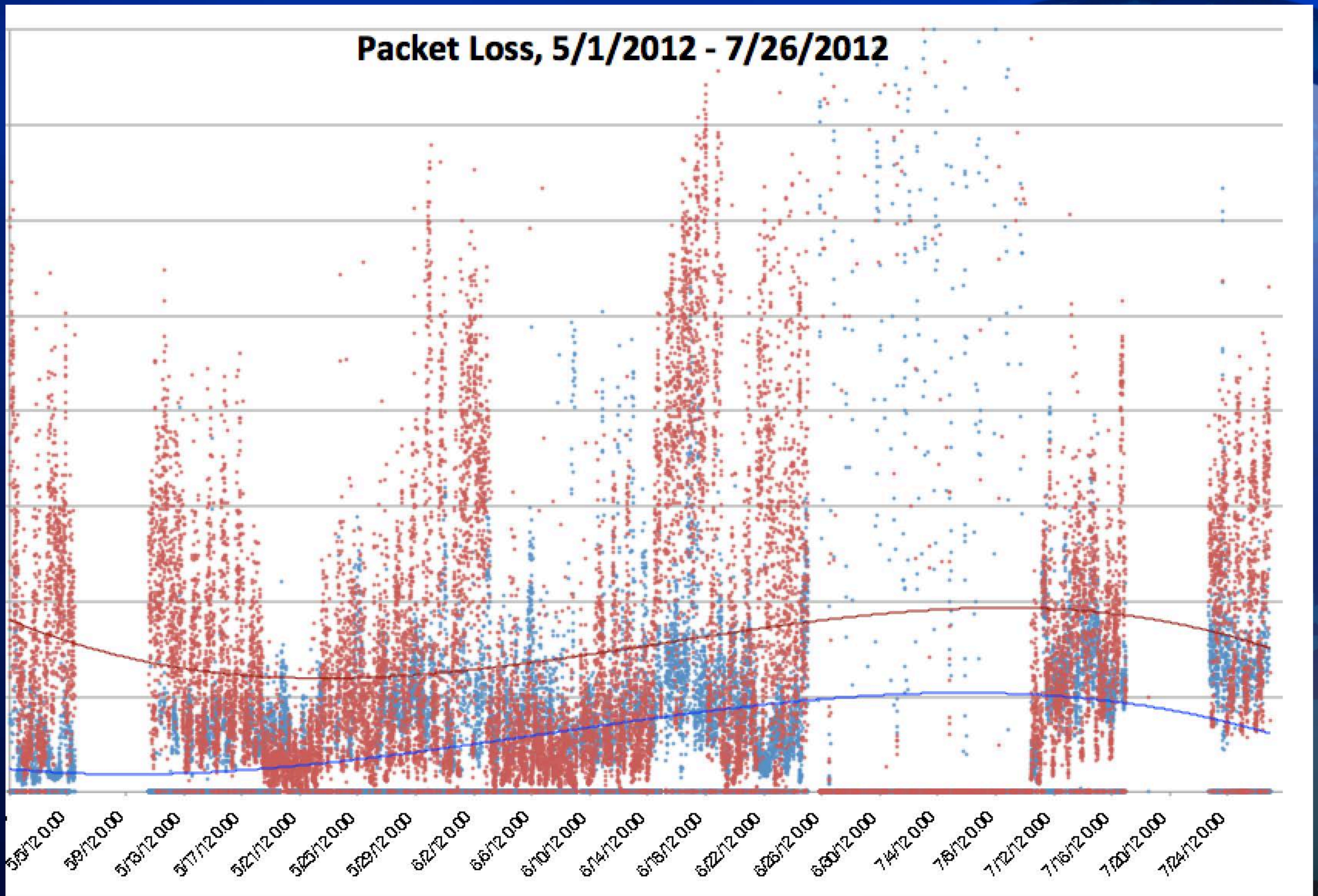
Don't refresh this page. Change

bar chart by Status Go

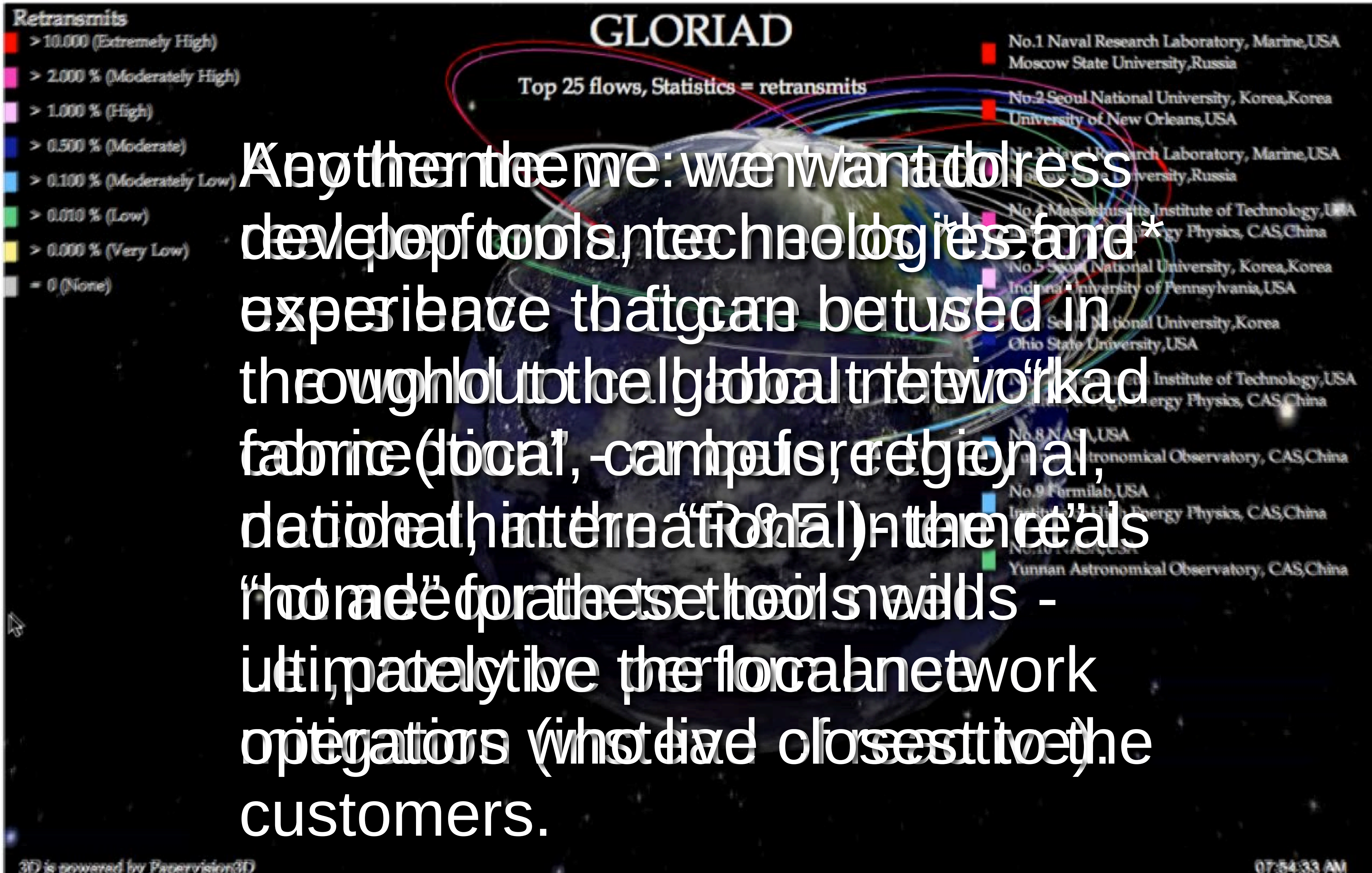
"REQUEST TRACKER"

FED BY DATA FROM MONITORING SYSTEMS

Poor-Performance Analysis



Performance Monitoring (in (near) real-time)



Another theme: we want to develop tools, technologies and experience that can be used throughout the global network fabric (local, campus, regional, national, international (R&E) - there's "home" for these tools will ultimately be the local network operators (who are closest to the customers.

New GloTop Application

GLORIAD

Current Top Users

United States

Time Period (US East Coast): 2012-08-24 21:50:10 - 2012-08-24 21:50:16

Funded by the US National Science Foundation

Source Institution	Dest Institution	Bytes	Bandwidth	Packets	Packet Loss
NCBI/US NLM (Bethesda, United States)	Shanghai Institute for Biological Scienc (Shanghai, China)	60.2 MB	96.3 Mbps	39845	0.0 %
The University of Hong Kong (Central District, Hong Kong)	University of California, Santa Cruz (Santa Cruz, United States)	9.4 MB	7.5 Mbps	12049	0.4 %
NCBI/US NLM (Bethesda, United States)	Agency for Sci, Tech Research (Singapore, Singapore)	7.2 MB	11.4 Mbps	4751	0.0 %
Oregon State System of Higher Education (Corvallis, United States)	National University of Singapore (Singapore, Singapore)	5.4 MB	8.6 Mbps	6232	24.4 %
Colorado State University (Fort Collins, United States)	Institute of Atmospheric Physics, CAS (Beijing, China)	5.2 MB	8.3 Mbps	3509	0.0 %
National Library of Medicine (Bethesda, United States)	National University of Singapore (Singapore, Singapore)	4.3 MB	3.4 Mbps	2867	0.0 %
Nanyang Technological University, Ce... (Singapore)	Rice University-Sesquinet (United States)	3.7 MB	3.0 Mbps	5001	0.0 %
Seoul National University (Seoul, Korea (South))	Georgia Institute of Technology (Atlanta, United States)	3.5 MB	2.8 Mbps	3793	0.0 %
National University of Singapore (Singapore, Singapore)	University of Pennsylvania (Philadelphia, United States)	3.5 MB	2.8 Mbps	3107	59.6 %
Microsoft Corporation (United States)	National University of Singapore (Singapore)	3.0 MB	24.4 Mbps	3316	0.2 %
The Pennsylvania State University (State College, United States)	Nanyang Technological University, Ce... (Singapore, Singapore)	3.0 MB	4.8 Mbps	3027	29.6 %
Vanderbilt University (Nashville, United States)	Korea Advanced Institute of Science ... (Daejeon, Korea (South))	2.8 MB	4.5 Mbps	3100	0.0 %
National University of Singapore (Singapore, Singapore)	Temple University (Philadelphia, United States)	1.7 MB	1.3 Mbps	3857	0.0 %
University of California, San Diego (La Jolla, United States)	China Science Technology Network (Shanghai, China)	1.7 MB	4.4 Mbps	1142	0.0 %
Internet Systems Consortium (Redwood City, United States)	Hubei Medical University (Wuhan, China)	1.5 MB	1.2 Mbps	757	0.0 %
National University of Singapore (Singapore, Singapore)	Lawrence Livermore National Laboratory (Livermore, United State	1.4 MB	1.1 Mbps	1811	27.5 %
Georgetown University (Washington, United States)	Nanyang Technological University (, Singapore)	1.4 MB	2.2 Mbps	1572	0.0 %
Nanyang Technological University, Ce... (Singapore, Singapore)	SD Supercomputer Center (San Diego, United States)	1.1 MB	905.6 Kbps	2189	14.8 %
National Oceanic Atmospheric Administr (Boulder, United States)	Institute of Atmospheric Physics, CAS (Beijing, China)	976.1 KB	1.6 Mbps	643	0.0 %
Internet Archive (San Francisco, United States)	The Noor Group (Cairo, Egypt)	962.3 KB	855.4 Kbps	639	0.0 %

All Users

GLORIAD Partners

Canada China Egypt Hong Kong India Netherlands Nordic Russia Singapore S. Korea Taiwan

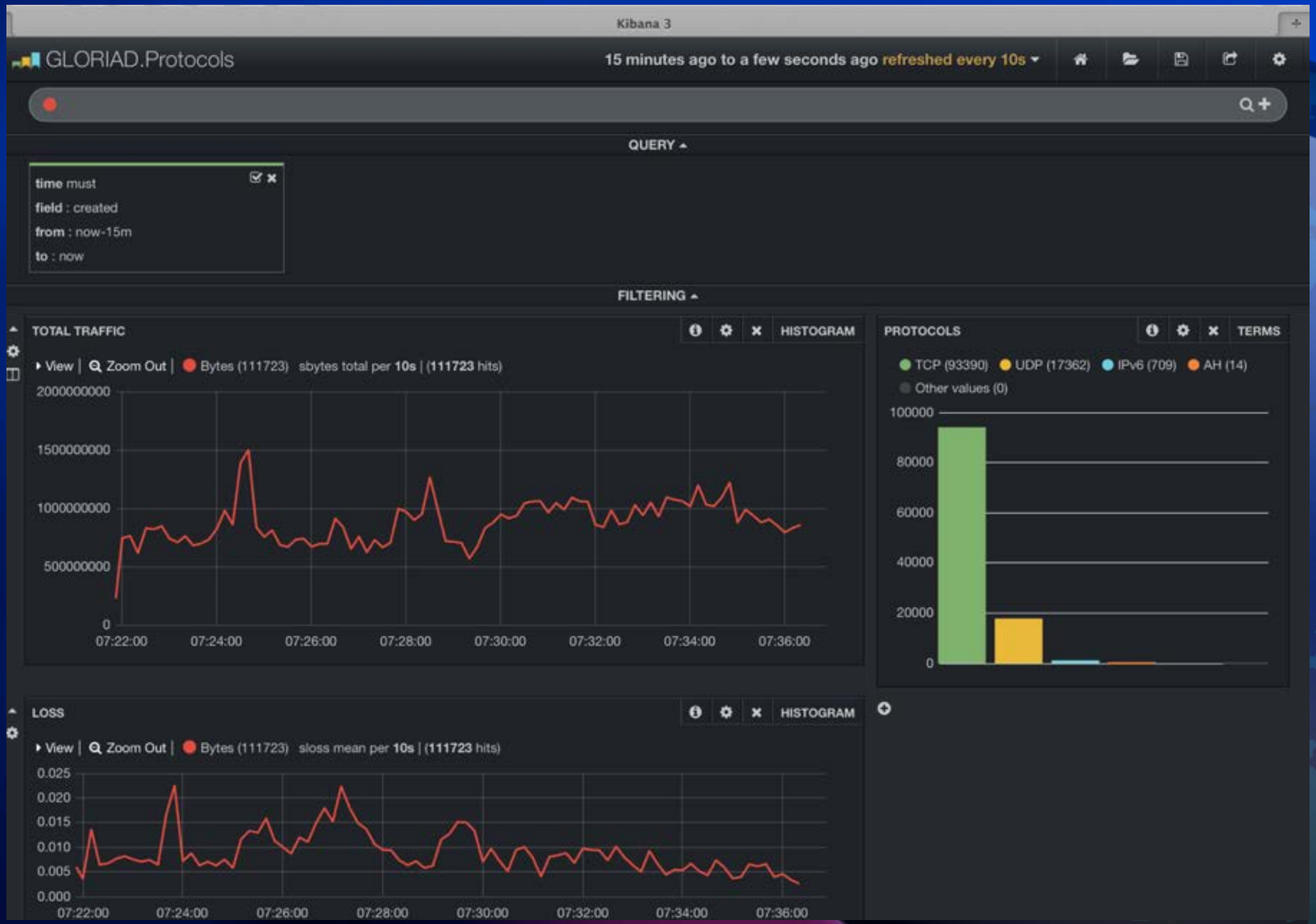
USA Organizations

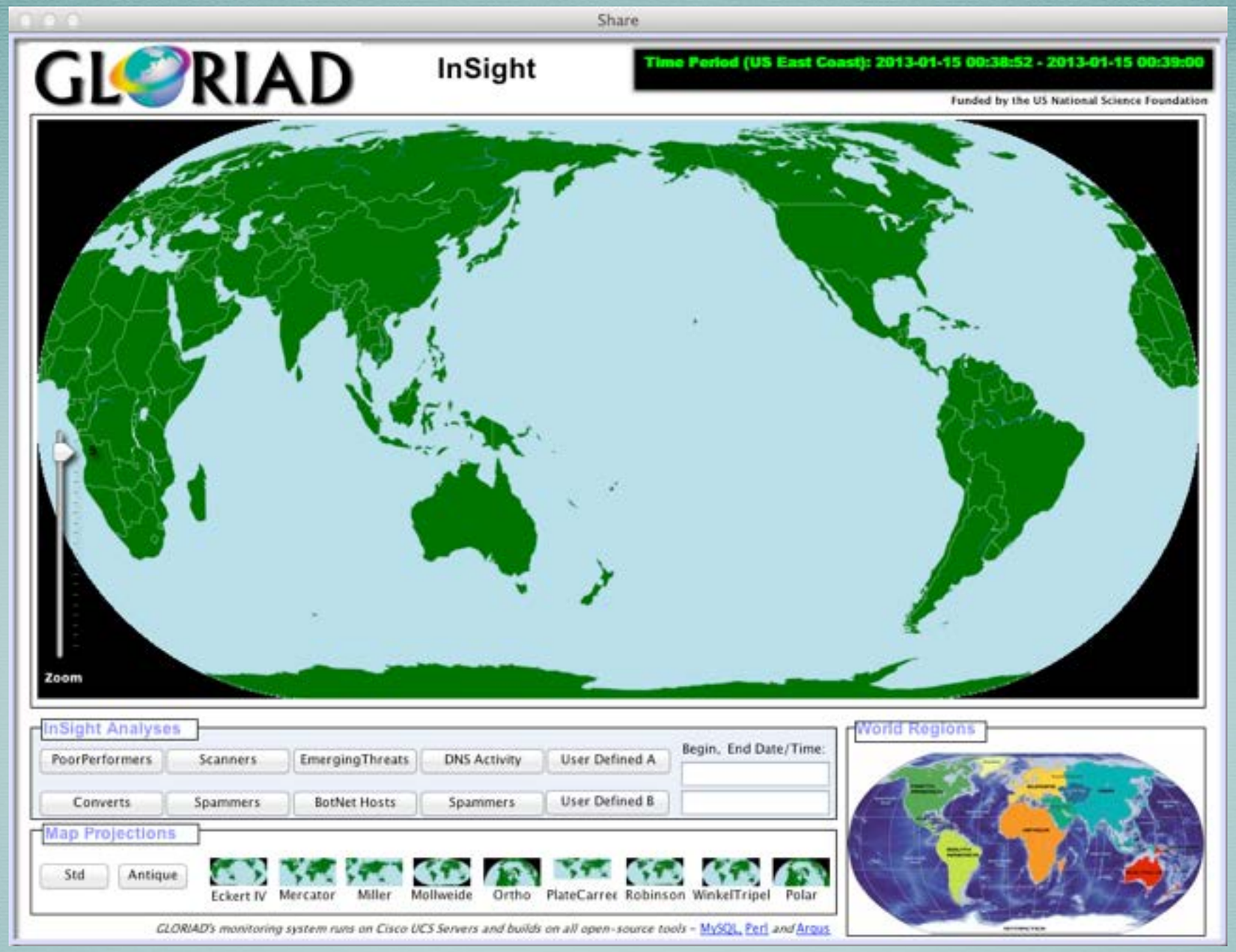
USA NSF (Univ) DOE NASA NIH NOAA USGS DoD

World Regions

GLORIAD's monitoring system builds on all open-source tools – MySQL, Perl and Argus

New ElasticSearch Services





Better define WAN to LAN cybersecurity; turn this into a global community effort

dvNOC System

- Joint effort by US, China, Korea, Nordic teams (and, now, new GLORIAD/Taj partners)
- Based on solid measurement infrastructure, information management and information sharing
- Fueled by the open-source Argus system of flow monitoring (5 second updates on all flows, 200-400 million flow-records/day; handles multi-G flow rates with room to spare)
- Focused on (1) understanding utilization, (2) improving performance systemically, (3) ensuring appropriate use, (4) distributing (decentralizing) operations and management of R&E networks

Summary

- Work builds on efforts since 1999
- Argus has offered us a huge number of advantages over our previous technologies (and we're still beginners with it)
- Data management problem is difficult but solvable
- We hope to encourage an open global, community effort to deploy common standards and tools addressing metrics for R&E network performance, operations and security

Final

- Wanted
  - Partners/ideas on sharing maintenance of a global geo/infrastructure database
  - Ideas for improvements
- Data Sharing
  - We share at domain (institution) level
  - Glad to talk about other needs/possibilities (we have good R&E network utilization data back to 1999; full argus archive since July 2012)

Thank you

gcole@gloriad.org