

The background consists of a dark red-to-purple gradient. On the right side, there is a semi-circular map of the world showing the continents. Overlaid on the left and top of the globe is a network structure of thick, semi-transparent purple lines forming a ring and connecting to various points, suggesting a global network or data flow.

Global Ring Network for Advanced Applications Development (GLORIAD)

Global Ring Network for Advanced Applications Development (GLORIAD)

Joint Engineering Team

August 16, 2005

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NSF IRNC Cooperative Agreement
University of Tennessee

\$4.2M/5 years, began January 1, 2005

Animation by Chinese Academy of Sciences
Computer Network Information Center



<http://www.gloriad.org/>

tyco / Telecommunications



NSF International Research Network Connections Program (IRNC)

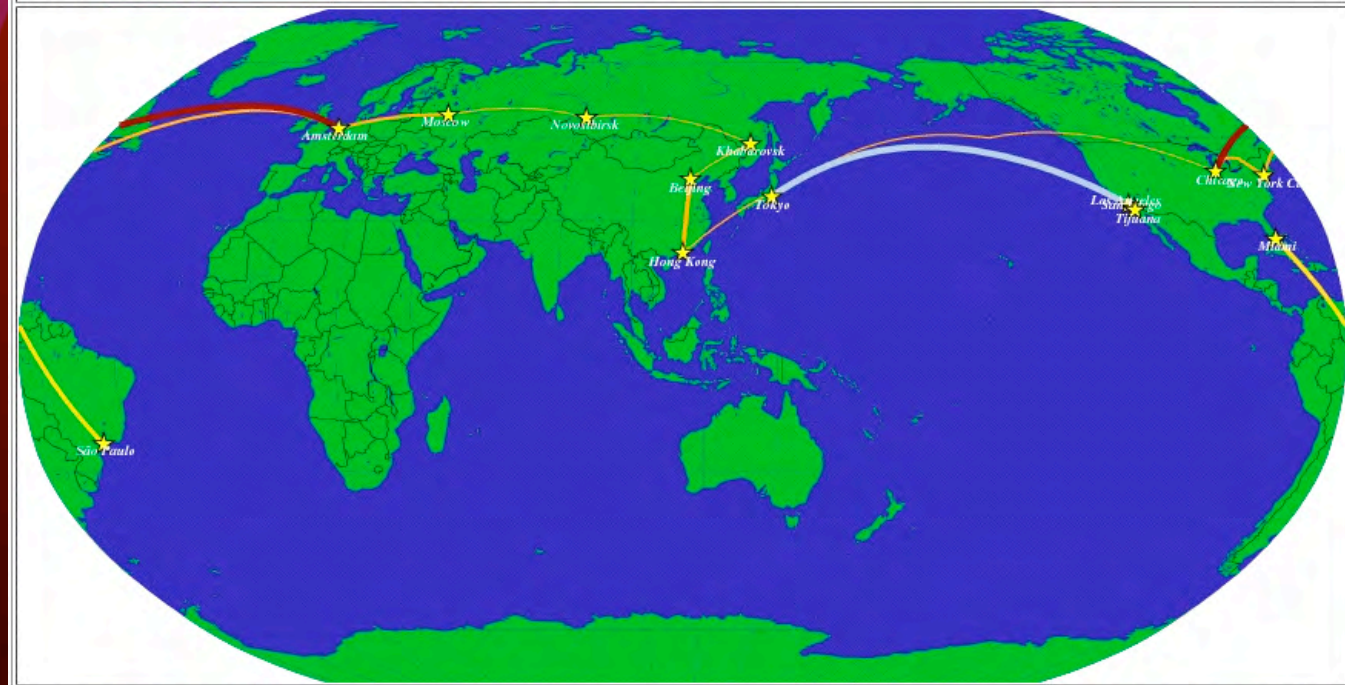
- 5 yr \$25M program to help advance international R&E network connections
- January 1, 2005 - December 31, 2009
- GLORIAD - US-Russia-China-Korea-Netherlands-Canada
- TransLight/Europe - US-Europe
- TransLight/PacificWave - connections for Asia/Pacific
- TransPAC2 - US-Japan/Asia
- WHREN-LILA - US-Latin America
- Follow-on to NSF HPIIS Program (1998-2004)

Global Cyberinfrastructure Inventory Map

Circuits Operational as of 2005-05-01 for Projects GLORIAD, TransLight, TransPAC2, WHREN

Entire World map centered on Hong Kong, China (Hong Kong)

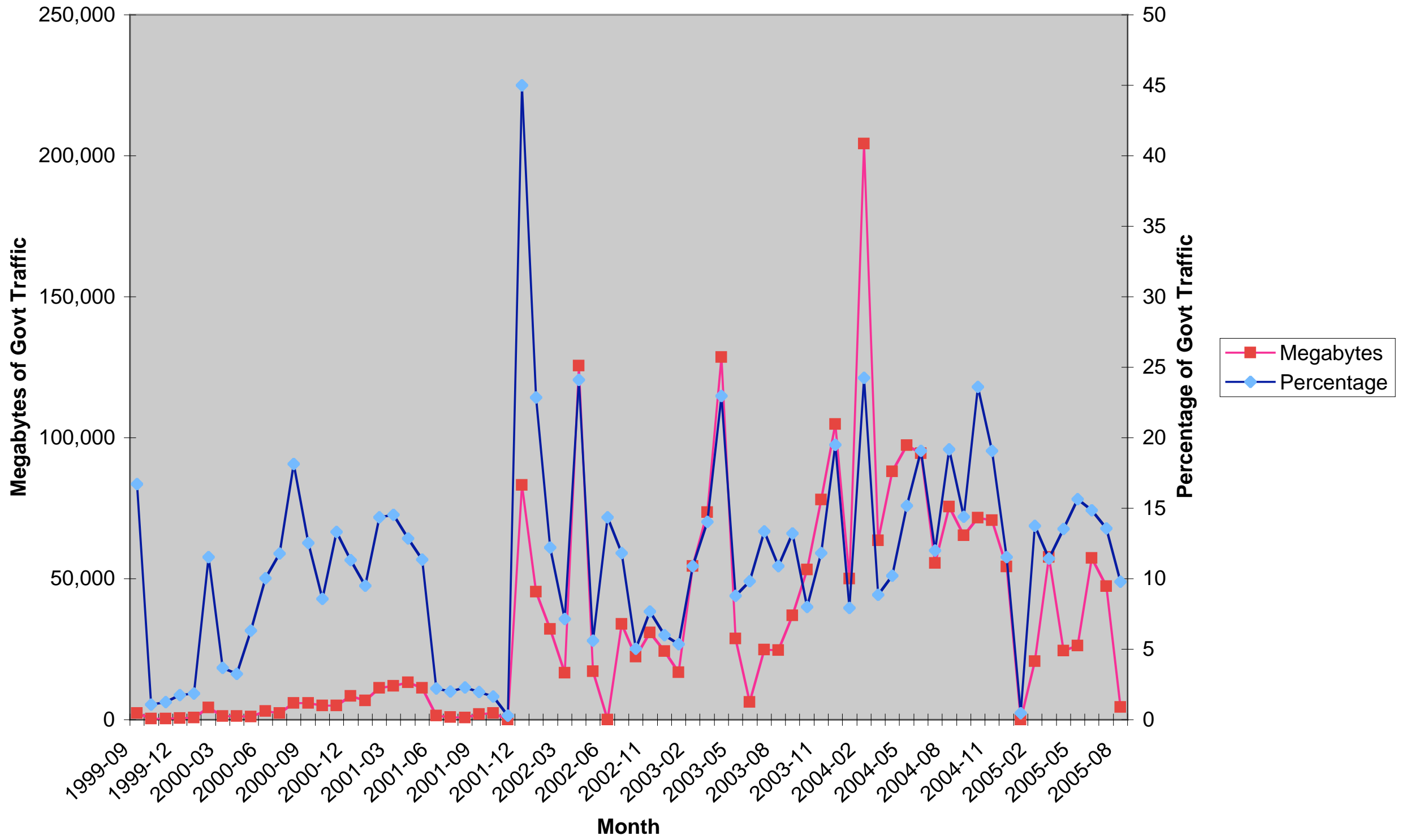
Legend GLORIAD TransLight TransPAC2 WHREN



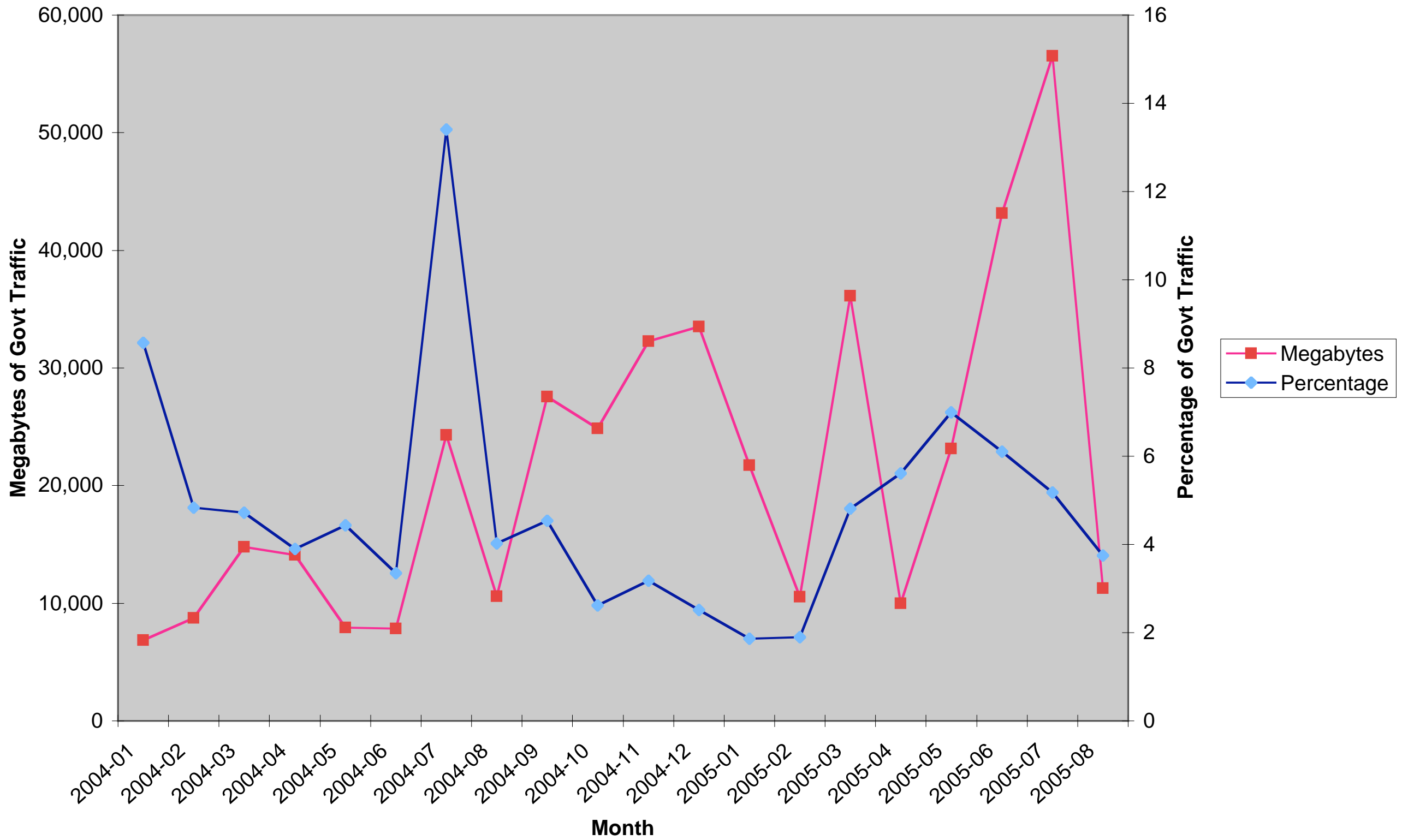
Objectives

- **Introducing GLORIAD**
- **Focus on Federal Network Use of GLORIAD**
- **Introducing Russian RBnet**
- **Introducing China CSTnet**

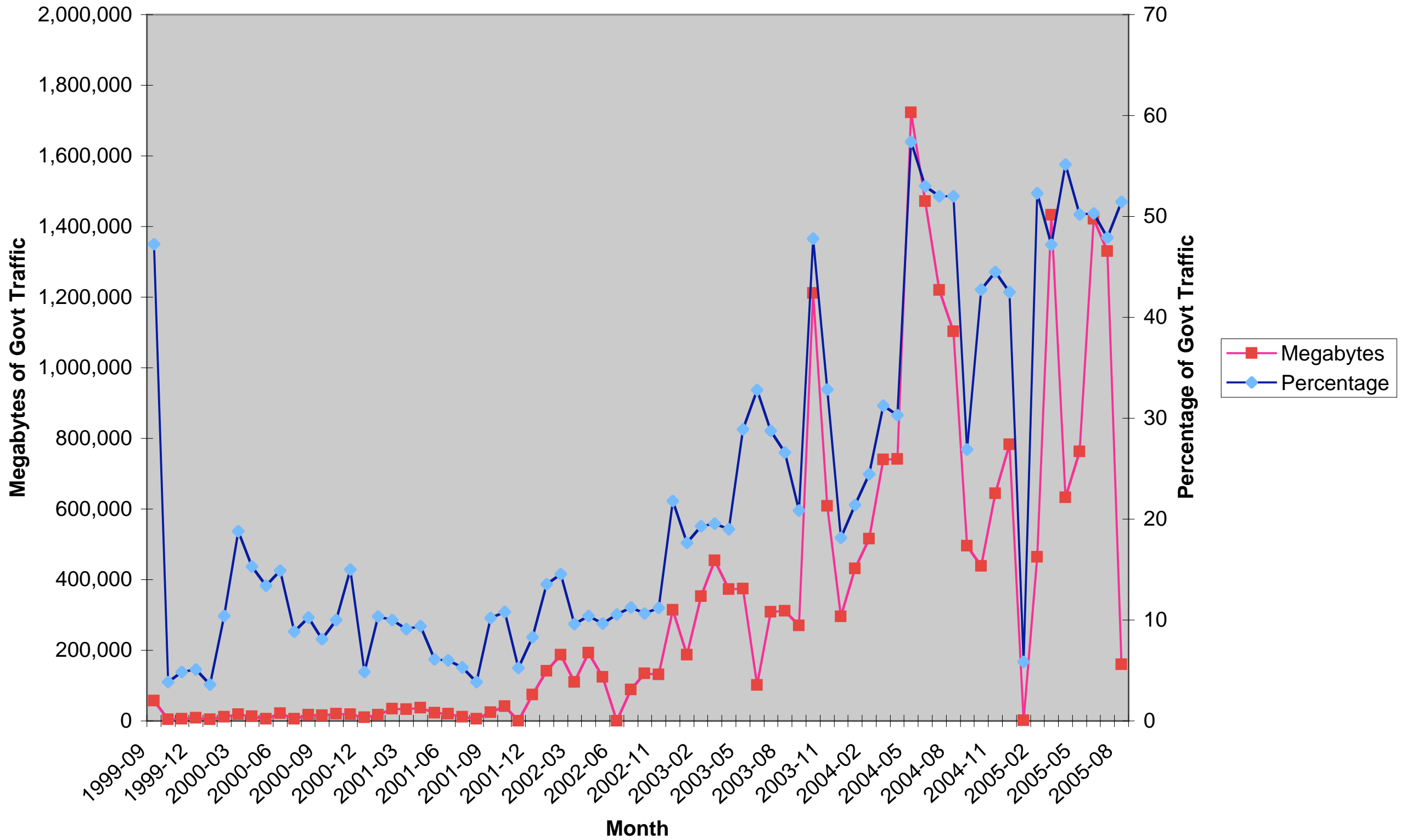
Russia to US Traffic



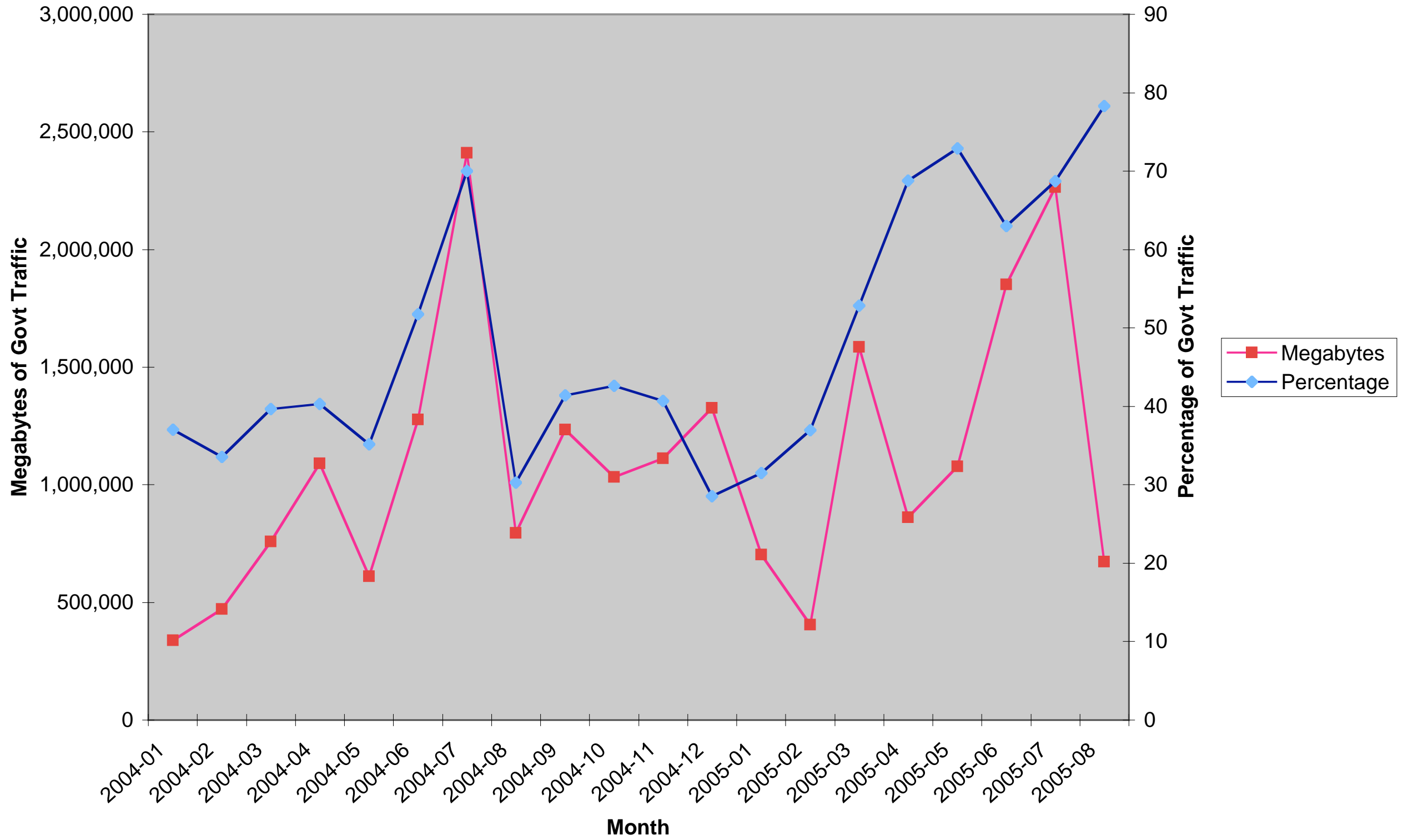
China to US Traffic



US to Russia Traffic



US to China Traffic



GLORIAD Top Users - Last 60 Minutes



The monitoring system is designed to provide network utilization data related to usage of the GLORIAD network.

Current utilization of the GLORIAD link is illustrated below and updated every 60 minutes. The table lists the top 30 users of the GLORIAD network during the past 60 minutes.

Top GLORIAD Users Period: last hour (since 2005-08-16 14:20:22 (GMT))						
Source Country	Source/Machine	Destination Country	Destination/Machine	Protocol	Megabytes	% Total
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.132._)	TCP-Other	5669.8	17.7
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	3156.6	9.8
China	China (unknown) (159.226.2._)	United States	LA State Univ (.csc.lsu.edu)	TCP-Other	1749.0	5.5
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	Russia	RU Space Science Internet (.iki.rssi.ru)	TCP-Other	1120.7	3.5
United States	Columbia University (.ldgo.columbia.edu)	China	China (unknown) (159.226.80._)	TCP-WWW	1063.2	3.3
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	Russia	RU Space Science Internet (.iki.rssi.ru)	TCP-Other	945.0	2.9
United States	Georgia Tech (.cc.gatech.edu)	Russia	Chernogolovka (.chg.ru)	TCP-Other	942.1	2.9
United States	Univ of Washington (.ast.cac.washington.edu)	China	Chinese Acad of Sciences (unknown) (159.226.116._)	UDP-Other	725.1	2.3
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	United States	United States (unknown) (159.226.162._)	TCP-Other	569.4	1.8
China	Chinese Acad of Sciences (unknown) (159.226.237._)	United Kingdom	UK Universities (.lut.ac.uk)	TCP-Other	442.9	1.4
Belgium	Belgium (unknown) (218.194.208._)	China	Chinese Acad of Sciences (unknown) (83.149.228._)	TCP-WWW	435.5	1.4
United States	Stanford Univ (.stanford.edu)	Russia	irk.ru (Irkutsk) (.iszf.irk.ru)	TCP-FTP	340.2	1.1

Cisco Donates IP/Telephony Equipment to GLORIAD

Cisco Systems agreed to donate \$75,000 in IP Telecommunications equipment for use in the GLORIAD network. Christopher Lee McGugan, Cisco's Senior Manager of Academic Research and Technology Initiatives, made the announcement on behalf of the company. McGugan stated, "GLORIAD marks a significant development in the realization of NSF's goal of a national Cyber-infrastructure that spans the globe, enabling global research and partnership in science."

- Home
- GLORIAD Apps
- GLORIAD Team Management Operations
- Monitoring System
- Top Users
- Graphs-24 hours
- Graphs-30 days
- Graphs-90 days
- Top Users - 10 Minutes
- Top Users - 60 Minutes
- Top Users - 3 Hours
- Top Users - 24 Hours
- Top Applications
- Throughput
- Connection Speed
- Efficiency
- Retransmits
- Round Trip Time
- Sponsors
- GLORIAD Classroom
- Education Outreach
- Email Listservers
- Chat Room
- Search Tools

GLORIAD's sponsors

include the US National Science Foundation, a consortium of science organizations and Ministries in Russia, the Chinese Academy of Sciences.

Telecommunications services are provided by Tyco Global Networks, Inc.

GLORIAD Top Users - Last 24 hours



The monitoring system is designed to provide network utilization data related to usage of the GLORIAD network.

Current utilization of the GLORIAD link is illustrated below and updated every 10 minutes. The table lists the top 30 users of the GLORIAD network during the past 24 hours.

Top GLORIAD Users Period: since yesterday (1 day) (since 2005-08-15 15:20:22 (GMT))

Source Country	Source/Machine	Destination Country	Destination/Machine	Protocol	Megabytes	% Total
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.132._)	TCP-Other	114129.0	17.6
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	38881.1	6.0
China	China (unknown) (159.226.2._)	United States	LA State Univ (.csc.lsu.edu)	TCP-Other	21725.6	3.4
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	Russia	RU Space Science Internet (.iki.rssi.ru)	TCP-Other	20183.8	3.1
China	China (unknown) (159.226.2._)	United States	LA State Univ (.csc.lsu.edu)	TCP-Other	14855.7	2.3
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	United States	United States (unknown) (159.226.162._)	TCP-Other	12788.8	2.0
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.117._)	TCP-Other	12004.5	1.9
United States	NASA Engin for Complex Sys (.ecs.nasa.gov)	Russia	RU Space Science Internet (.iki.rssi.ru)	TCP-Other	11947.8	1.8
United States	Penn State (.aset.psu.edu)	Russia	Chernogolovka (.chg.ru)	TCP-Other	10839.6	1.7
United States	Fermi Natl Lab (.fnal.gov)	Russia	RU Space Science Internet (193.232.212._)	TCP-WWW	8114.4	1.3
United States	UMD (.umiacs.umd.edu)	China	Chinese Acad of Sciences (unknown) (159.226.224._)	TCP-Other	5389.5	0.8

CANARIE Teams with GLORIAD to Test WDD

The CANARIE network of Canada has developed and prototyped a Wavelength Disk Drive (WDD). This novel concept treats a large-scale multi-wavelength network as though it were a large disk drive -with each wavelength being a separate track and special devices on the network (running the WDD software) acting as readywrite heads. CANARIE and GLORIAD will test capability of the WDD on GLORIAD to prove the concept in the ring around the northern hemisphere.

Home
GLORIAD Apps
GLORIAD Team
Management
Operations

Monitoring System

Top Users
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Graphs-90 days
Top Users - 10 Minutes
Top Users - 60 Minutes
Top Users - 3 Hours
Top Users - 24 Hours

Top Applications
Throughput
Connection Speed
Efficiency
Retransmits
Round Trip Time

Sponsors
GLORIAD Classroom
Education Outreach
Email Listservers
Chat Room
Search Tools

GLORIAD's sponsors

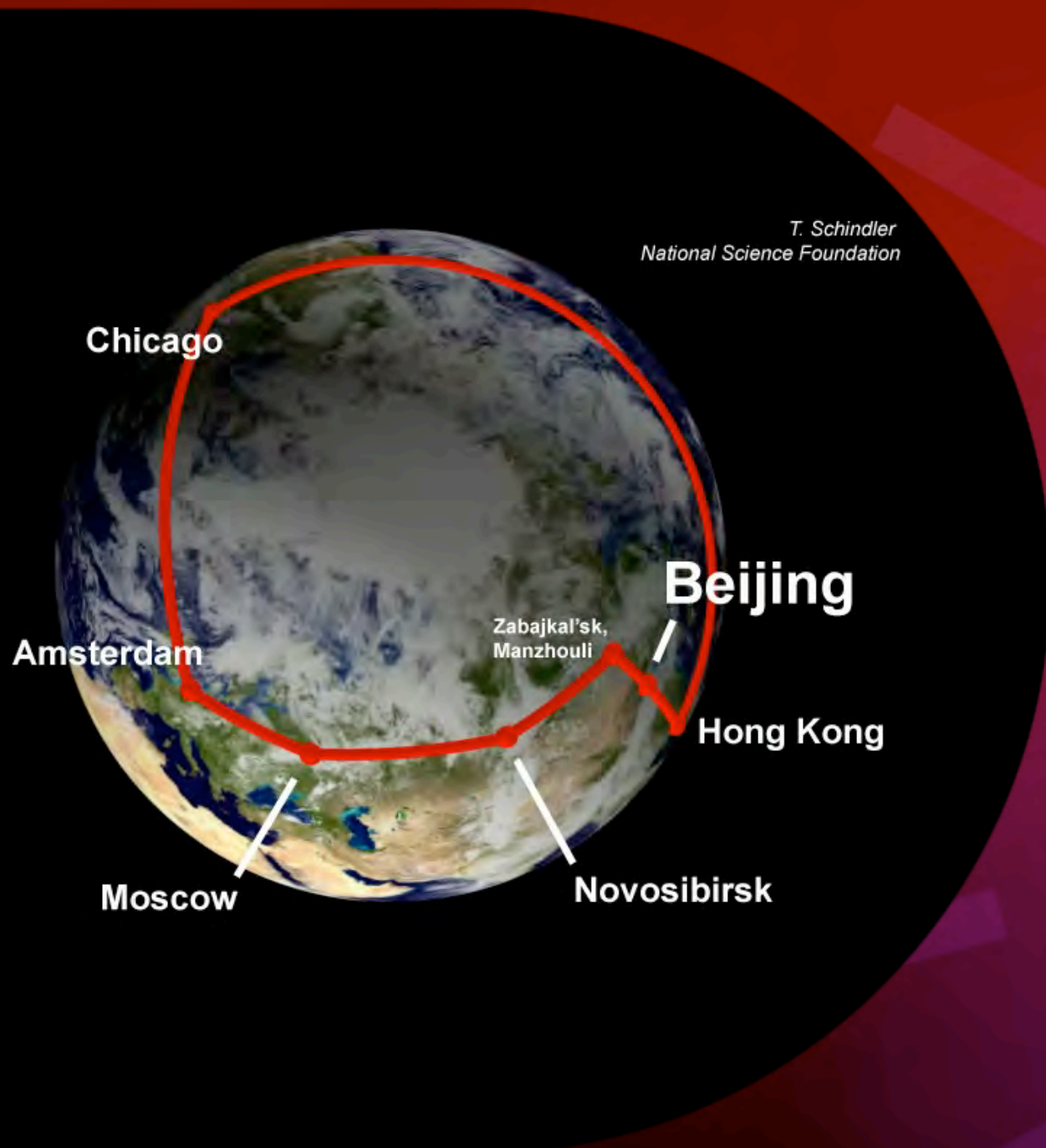
include the US National Science Foundation, a consortium of science organizations and Ministries in Russia, the Chinese Academy of Sciences.

Telecommunications services are provided by Tyco Global Networks, Inc.

Presentation

- **Background/History**
- **GLORIAD Today, Tomorrow**
- **Partners and Networks**
- **Measurement Program**
- **Application Areas**
- **Education/Outreach Activities**
- **Challenges, Issues**

GLORIAD



- ☉ An advanced S&E network “ring” around the northern hemisphere linking scholars, scientists, educators in Russia, US, China, Korea, Netherlands, Canada and others with special network services
- ☉ 155/622 Mbps today + 10G HK - KR - SEA, 10 Gbps ring in early 2007, Nx10G in 2008
- ☉ Hybrid circuit-(L1/L2) and packet-switched service (L3)
- ☉ Program to Develop/Deploy Advanced Cyberinfrastructure between partnering countries (and others) as effort to expand science, education and cultural cooperation and exchange
- ☉ A participant in/contributor to GLIF

Why?

- Leverage jointly developed/funded/operated S&E network to expand S&E cooperation between partnering countries (with initial emphasis on US-Russia-China-Korea-Netherlands-Canada)
- To support specific S&E applications not supported well by commodity or traditional R&E networks
- To enable communities to build their own specialized networks and for short durations of time
- To provide a test-bed for advanced network research
- To encourage compatible/complementary infrastructure development in closer step

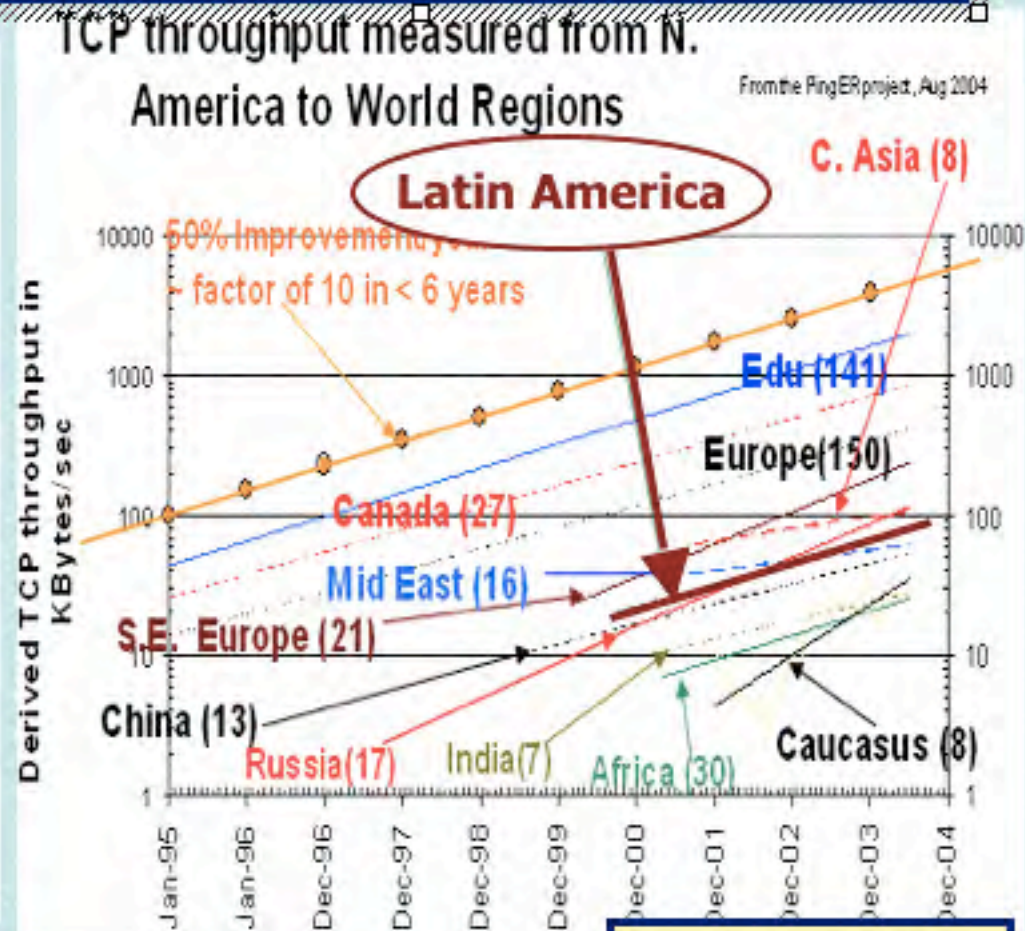
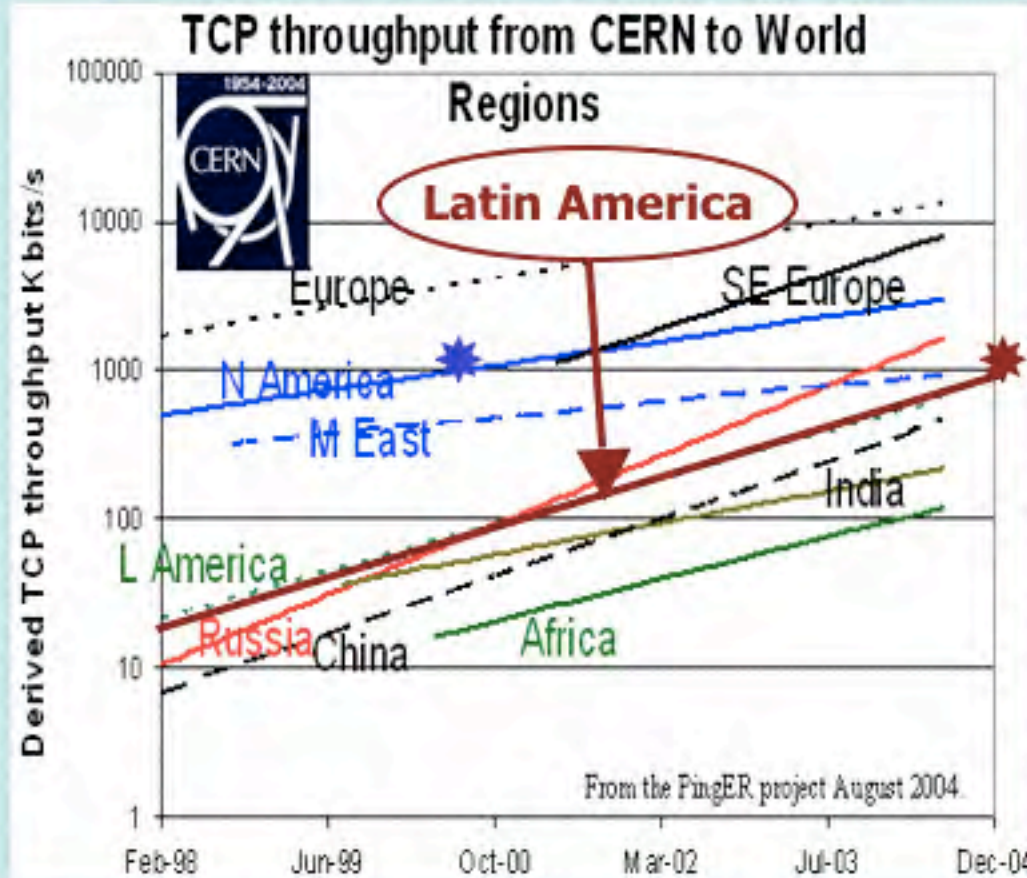
Develop Infrastructure in Closer Step

PingER: World View from SLAC, CERN



C. Asia, Russia, SE Europe,
L. America, M. East, China:
4-7 yrs behind
India, Africa: 7-8 yrs behind

S.E. Europe, Russia: **Catching up**
Latin Am., China: **Keeping up**
India, Mid-East, Africa: **Falling Behind**



R. Cottrell

Special Applications

- Need to move a terabyte of data quickly
- Need guaranteed 1.5 Gbps for high-definition uncompressed video for two hour session
- Need carefully managed/controlled “jitter” for steering a visualization (such as a “fly-through” application)
- Need a privately managed, secure network linking partners distributed around the globe
- Need to tie together large-scale computing resources with dedicated network services

Why?



Rita Colwell,
former NSF
Director,
Dec. 2003 press
release

“As part of the international community of science, we share common concerns that reach across national borders. As we all aim to strengthen our nations’ capabilities in research, we also aim to contribute to the cumulative knowledge that lifts the prospects of people everywhere.

This new network serves as both a physical and symbolic reminder of our common goal of solving problems and building a world of peace and prosperity.”

Dec. 21, 2003, NSF Press Release

Three Principles

- **Encourage Cooperation**
- **Advance a Common Infrastructure**
- **Move control towards the User**

GLORIAD First Steps

Began With US-Russia Internet Traffic
Exchange in December, 1993
(US-China followed shortly afterwards)

From: goldstein@nsf.gov
To: mak@merit.edu
Cc: steve@cise.cise.nsf.gov, nacr@icml.icp.net,
"Dr. Alexei P. PLATONOV, Director, ROSNIROS" <plat@kiae.su>,
Spartak Belyaev <bst@bstw.kiae.su>,
"Dr. Viacheslav Shkarupin" <slava@prs.isf.kiev.ua>, ncc@ripe.net,
ccirn@csa1.lbl.gov, RICHARD KC HSIEH <HSIEH@lhc.nlm.nih.gov>,
Andrej Mendkovich <KEL2BS@vms2.uni-c.dk>, IETF@CNRI.Reston.VA.US
Subject: Routing of FSU traffic on NSFNET Backbone Service, please begin
Reply-To: goldstein@nsf.gov
Date: Thu, 02 Dec 93 15:26:35 -0500
X-Orig-Sender: sgoldste@nsf.gov

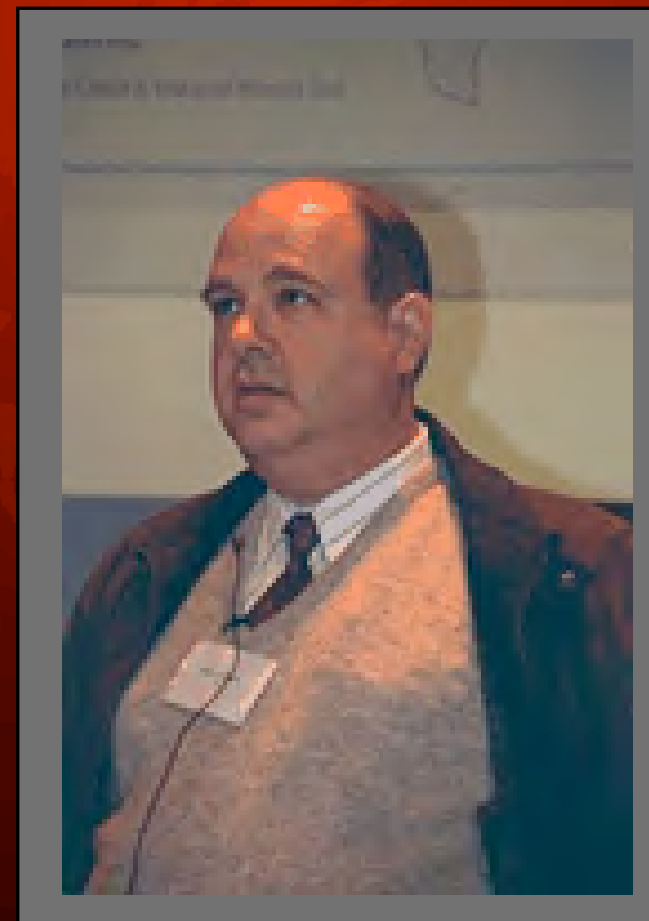
Dear Mark,

Following consideration of the issues by, and instructions received from the National Science Board, NSF asks that traffic from the countries of the former Soviet Union which satisfies the NSFNET Backbone Appropriate Use Policy guidelines be routed by the NSFNET Backbone Service, effective as (reasonably) soon as Merit can implement the changes.

Thank you,

Steve Goldstein
(for Steve Wolff)

	Program Director, Interagency & International Networking Coordination	
	Div. of Networking and Communications Research & Infrastructure	
	National Science Foundation	



Steve Goldstein
NSF Retired
US NSF “Grandfather” of International
Connections

Our Story ...

☉ Why tell it?

- ☉ explains the “why” and “how” of GLORIAD

- ☉ the experience and “lessons learned” may be useful for others involved in addressing digital divide issues

It all started with an email ...

From: [Natasha Bulashova \(natasha@uranus.ibioc.serpukhov.su\)](mailto:natasha@uranus.ibioc.serpukhov.su) Search Result 2
Subject: Gopher & Wais
Newsgroups: [comp.infosystems.gopher](https://www.iana.org/licenses/comp.infosystems.gopher) View: [Complete Thread \(5 articles\)](#)
Date: 1993-04-20 12:33:46 PST [Original Format](#)

Hello All!

If you have time for decision for my problem,
please write to me

1.I install gopher1.03 with wais-8-b5 in my
machine(BSD 4.3)

2.When installing ,I haven't error

3.I create mkdir /usr/gopher-data/vkm/yeasts.doc
and set my file-data=yeasts.doc

4.I create file in /usr /gopher-data/vkm/.IndexLink
IndexLink: Type=7
Name=Yeasts Index
Host=+
Port=+
Path=7/vkm/.indexes/index

5.Then I do
Waisindex -d index -export -t para /usr/gopher-data/vkm/yeasts.doc
(ok!)

6.I check search,using waissearch (ok!! find some documents)

7.I run daemon
gopherd -c -l /usr/log/infosys/gopher.log /usr/gopher-data

8.I run gopher,and I have menu:
1.Yeasts Index<?>
2.yeasts.doc

9!!!! I want find documents with word: abla
and i can see:
Nothing available <press Return>
This is my problem!(what kind my errors and what I must do
for decision this problem)

10. then I look my file gopher.log, where are only

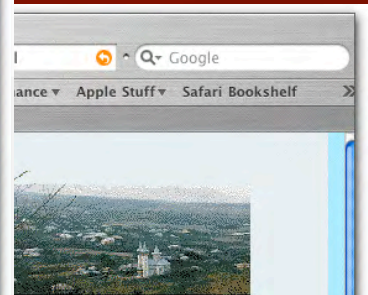
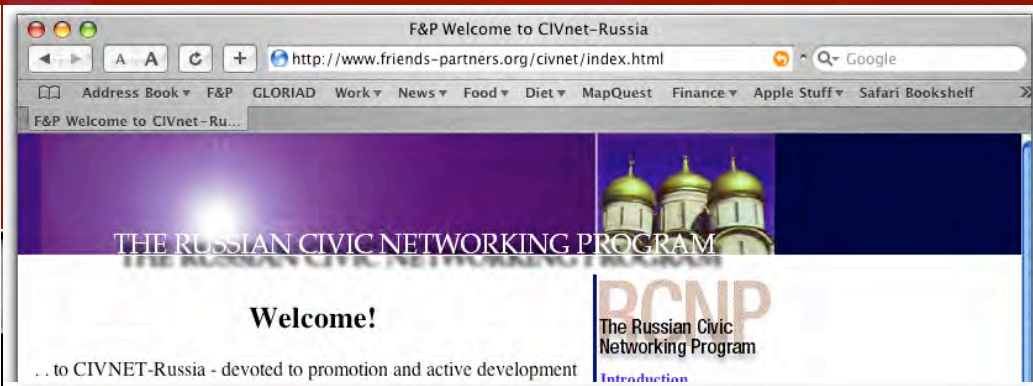
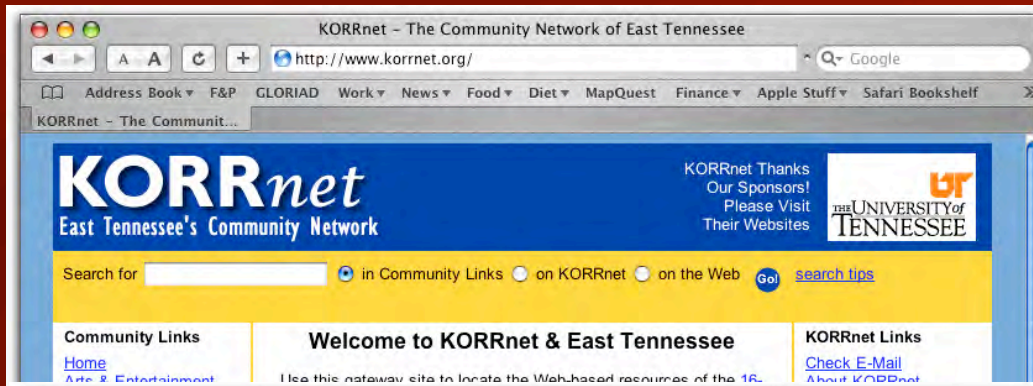
```
Tue Apr 20 10:31:27 1993 19939 stack.serpukhov.su:Root Connection
-- //----                --//----                :retrieved directory/vkm
```

please answer me e-mail:natasha@stack.serpukhov.su
natasha@uranus.ibioc.serpukhov.su

Thank you
Natasha

Computer Center,
Pushchino,
Moscow region,
Russia

“Friends & Partners” addressing *the divide* digitally



Launched Web-based community building project on January 19, 1994

since 1994 bringing together friends from around the world with an interest in countries of the former Soviet Union.

within 48 hours, 30,000 web accesses, 360

The following map shows the founding Chinese partners involved.

mission is to enhance mutual North America. The concept is to utilizing 'meeting place' where people can find mutual interest. We also hope that this which to integrate much of the explosive

orts of so many initiatives on the Internet ania to the world - as well as the many same goal of cooperation and friendship

n act of friendship - developed over the S. - individuals separated by thousands ng better understanding and exchange ng how new technologies might be used of projects created by the original ining together friends from around the

The original Friends and Partners effort has helped support a community of several thousand participants, handling many million information inquiries and email exchanges. It has been widely recognized and honored (including designation by one Internet publisher as one of the top 30 "must see" sites on the Internet) and the helpful support of such organizations as Sun Microsystems, NATO, the US State Department, the Soros Foundation (ISF), and, most recently, the Ford Foundation. Friends and Partners illustrates how the

History

- We “e-met” during April 1993
- US-Russia Friends & Partners program began January 1994
- Technical networking resulted from efforts at community networking (and recognition that we never had sufficient bandwidth for what we wanted to do)
- Focus always on local communications and information infrastructure

History

- **Early days: entire South Moscow region behind a single 19.2K modem**
- **Our first grant (from NATO) enabled bandwidth increase to 256 Kbps**
- **Sun Microsystems donated workstation equipment to both teams**
- **US State Department grant for Gore-Chernomyrdin Commission meeting helped launch the project activities more broadly**



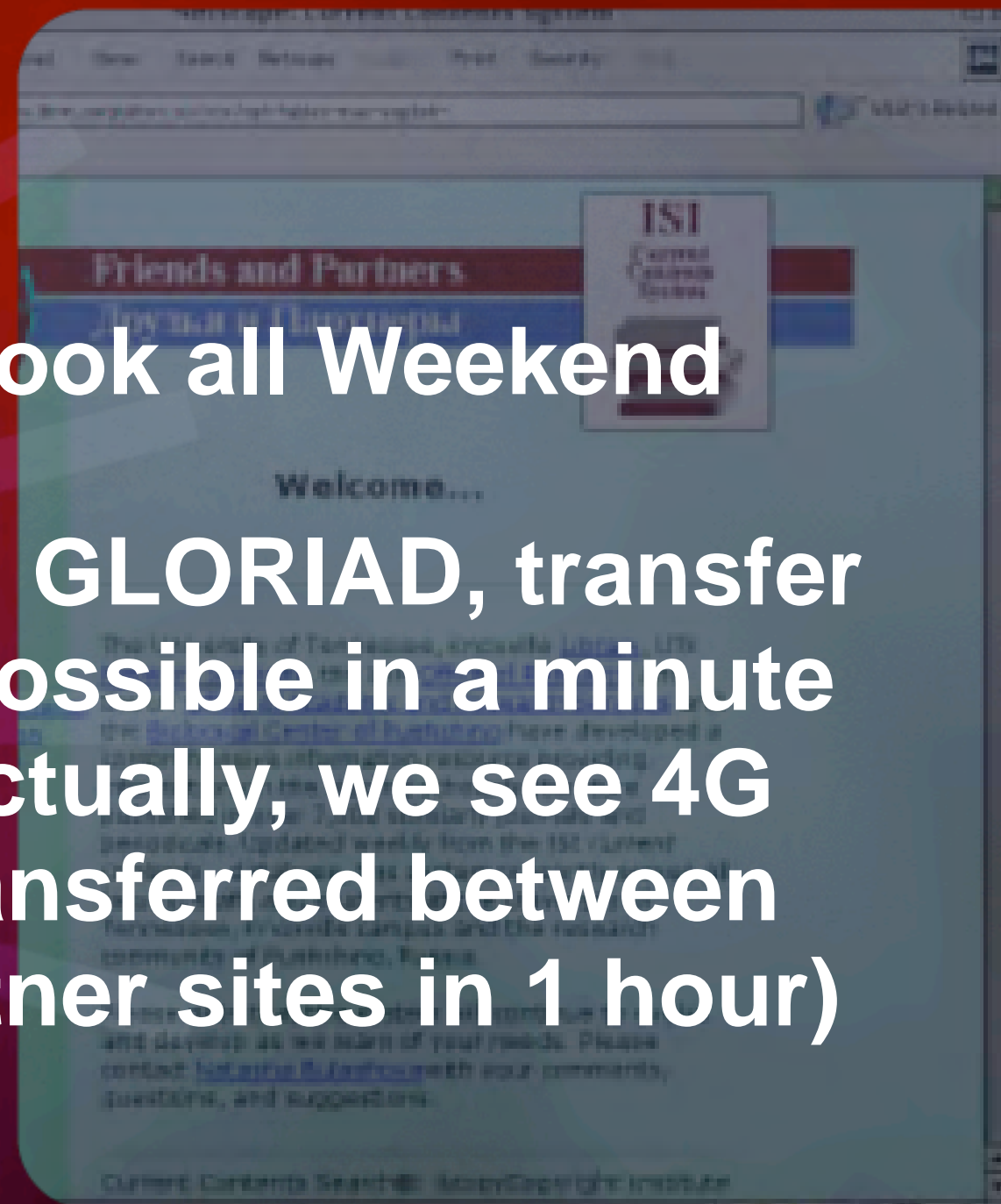
How to transfer 50M file

(Weekly: from Univ of TN to Pushchino)

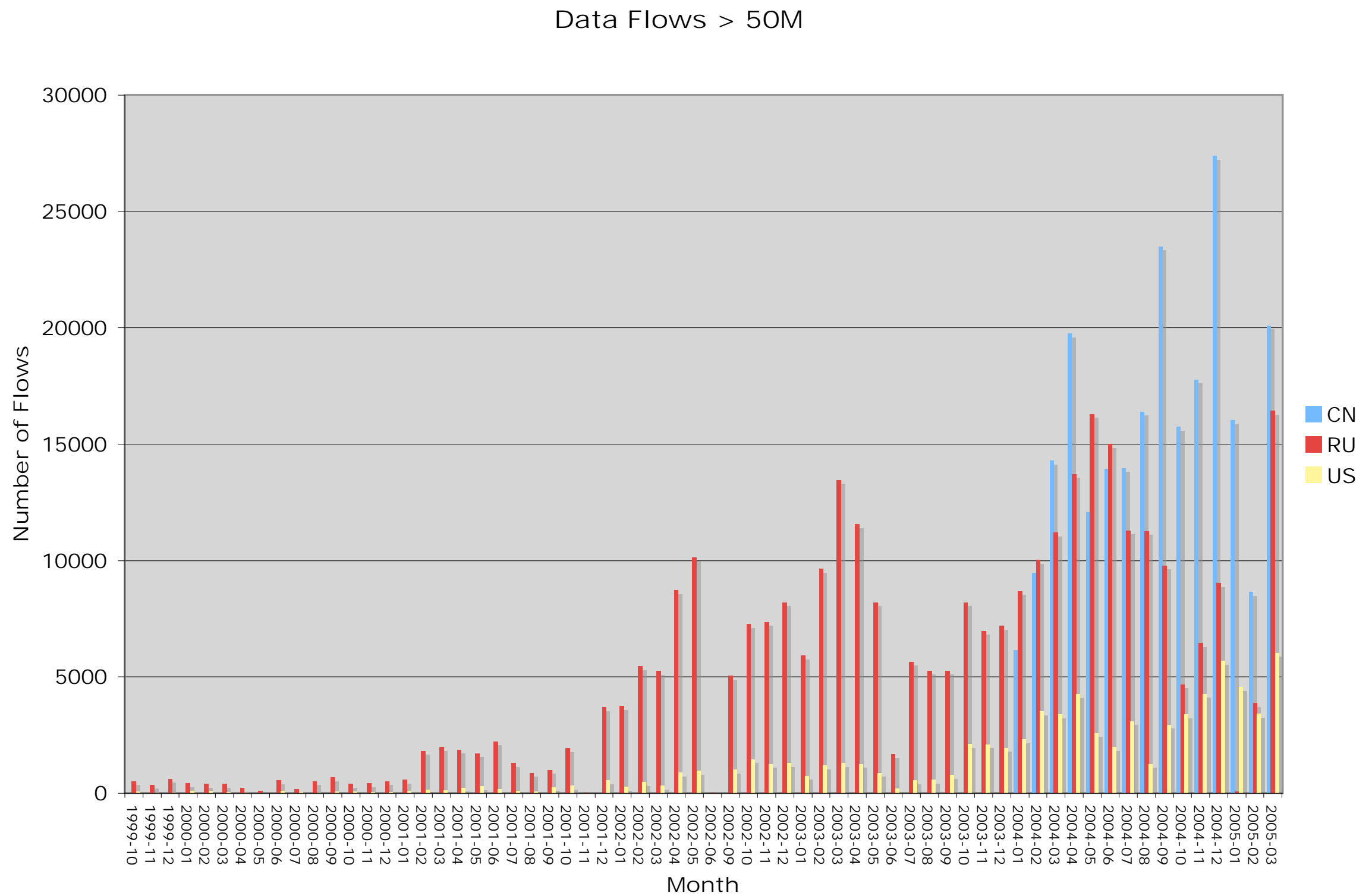
- Compress file
- UUencode it
- Split into 1000 uniform pieces
- FTP the 1000 files
- Uncompress the 1000 files
- Join into 1 file
- UUdecode it
- Uncompress it

Took all Weekend

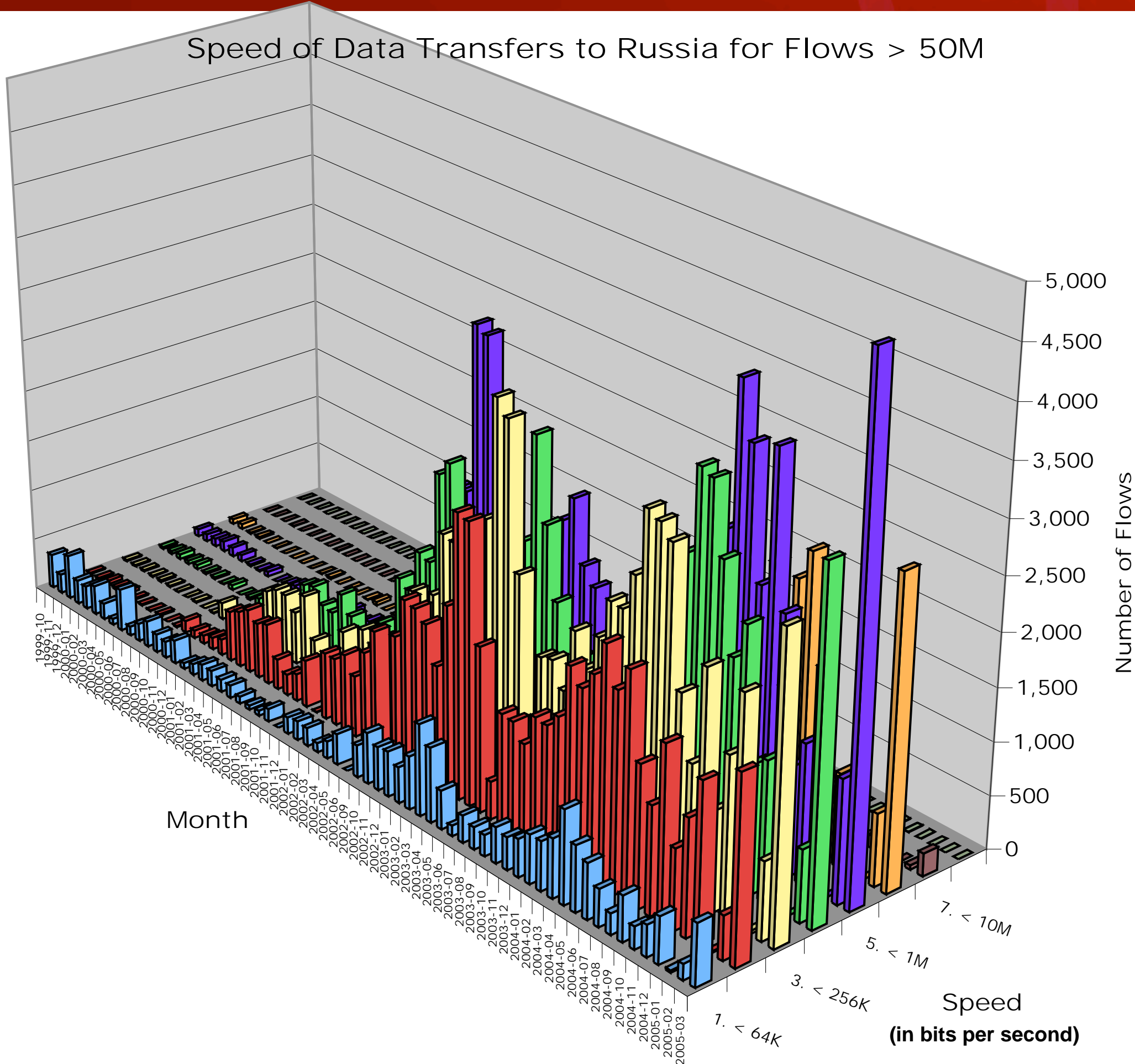
With GLORIAD, transfer is possible in a minute (actually, we see 4G transferred between partner sites in 1 hour)



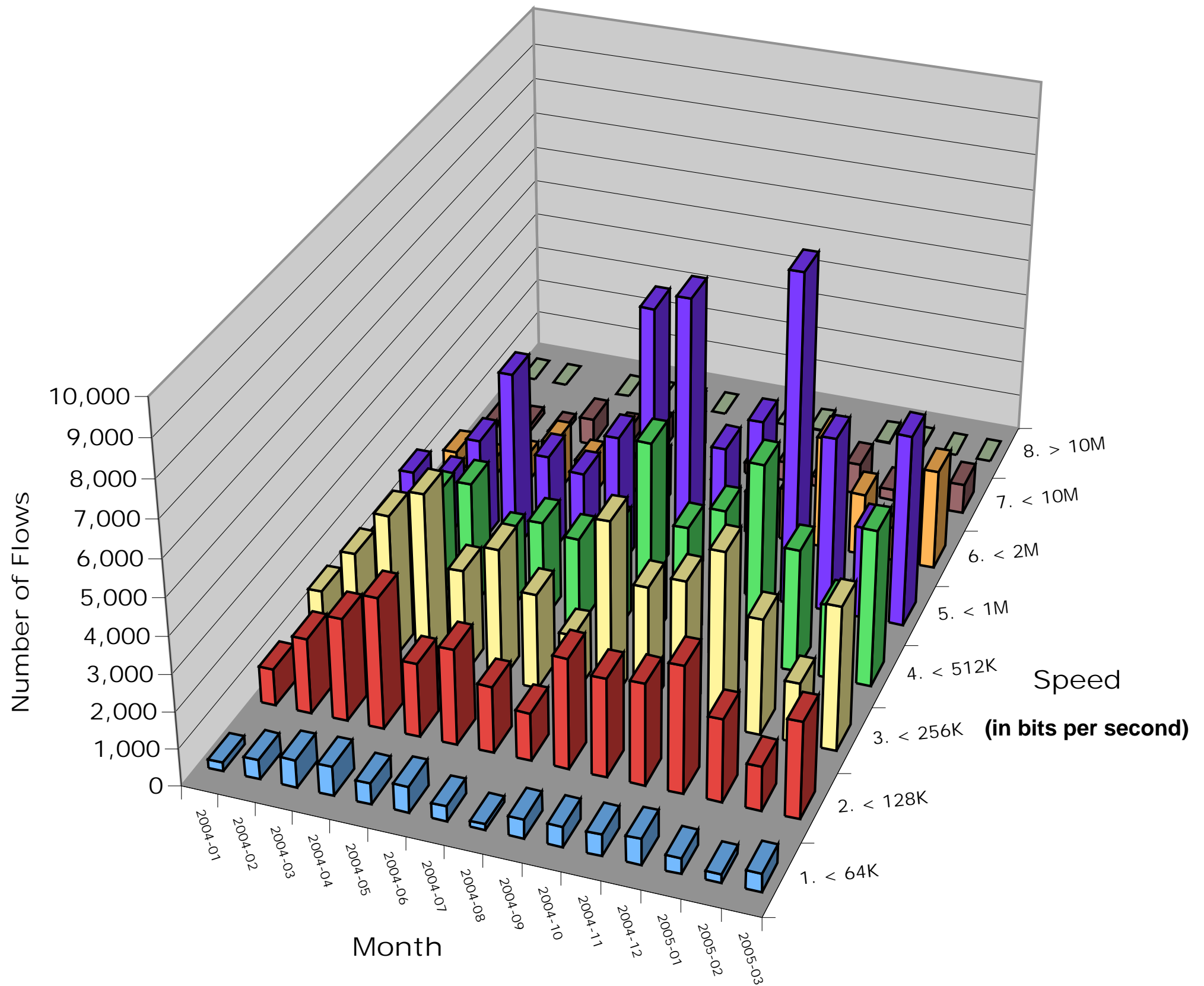
Growth in Data Flows > 50 Mbytes



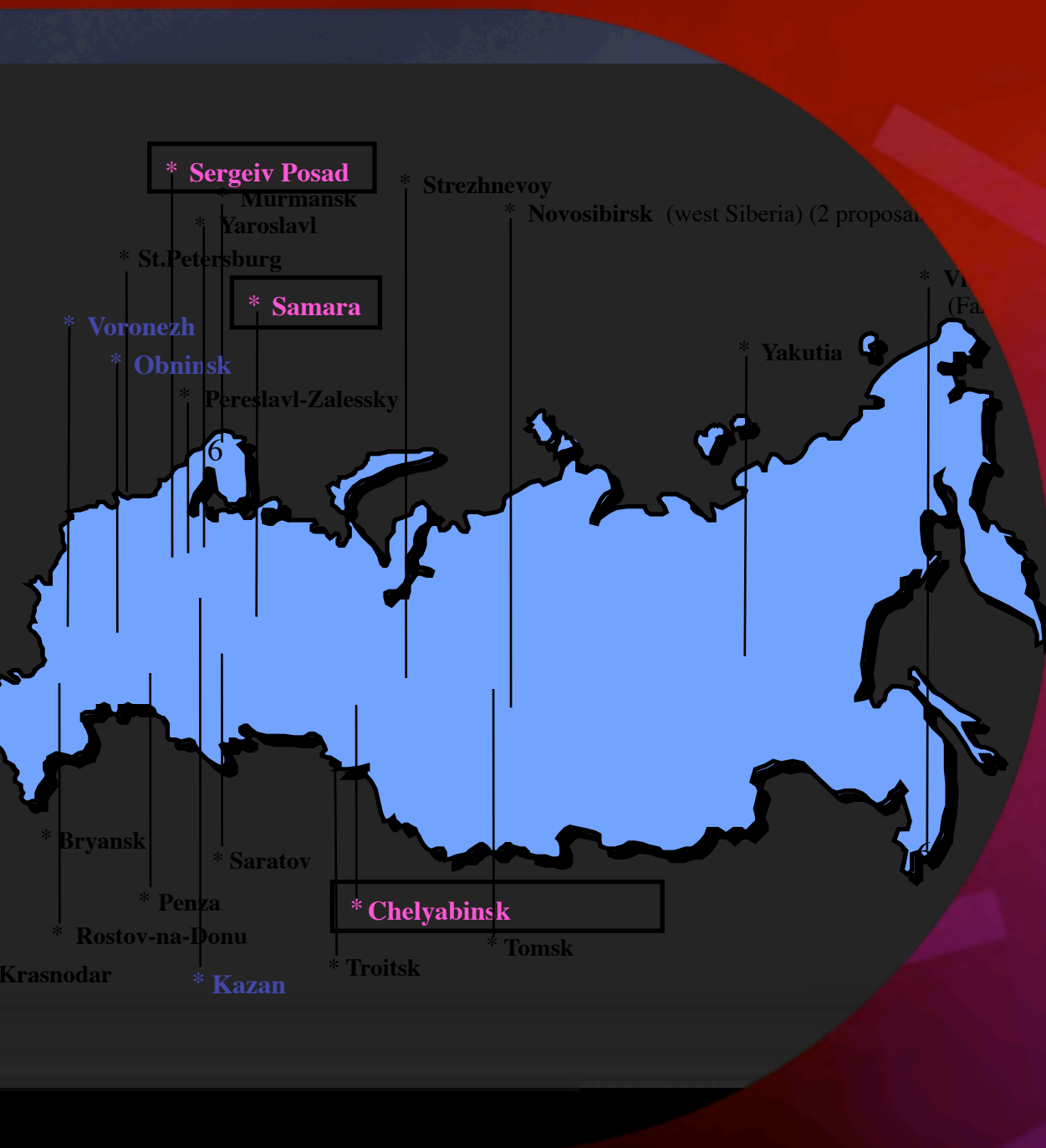
Speed of Data Transfers to Russia for Flows > 50M



Speed of Data Transfers to China for Flows > 50M



Civic Networking



- **Emphasis on local infrastructure and local community development**
- **Began 1994 in US, 1996 in Russia**
- **\$700K from Ford & Eurasia Foundations**
- **Six Operating CIVnets in Russia; KORRnet in East Tennessee**
- **Planning CIVGrid program**

Early Beginnings of GLORIAD

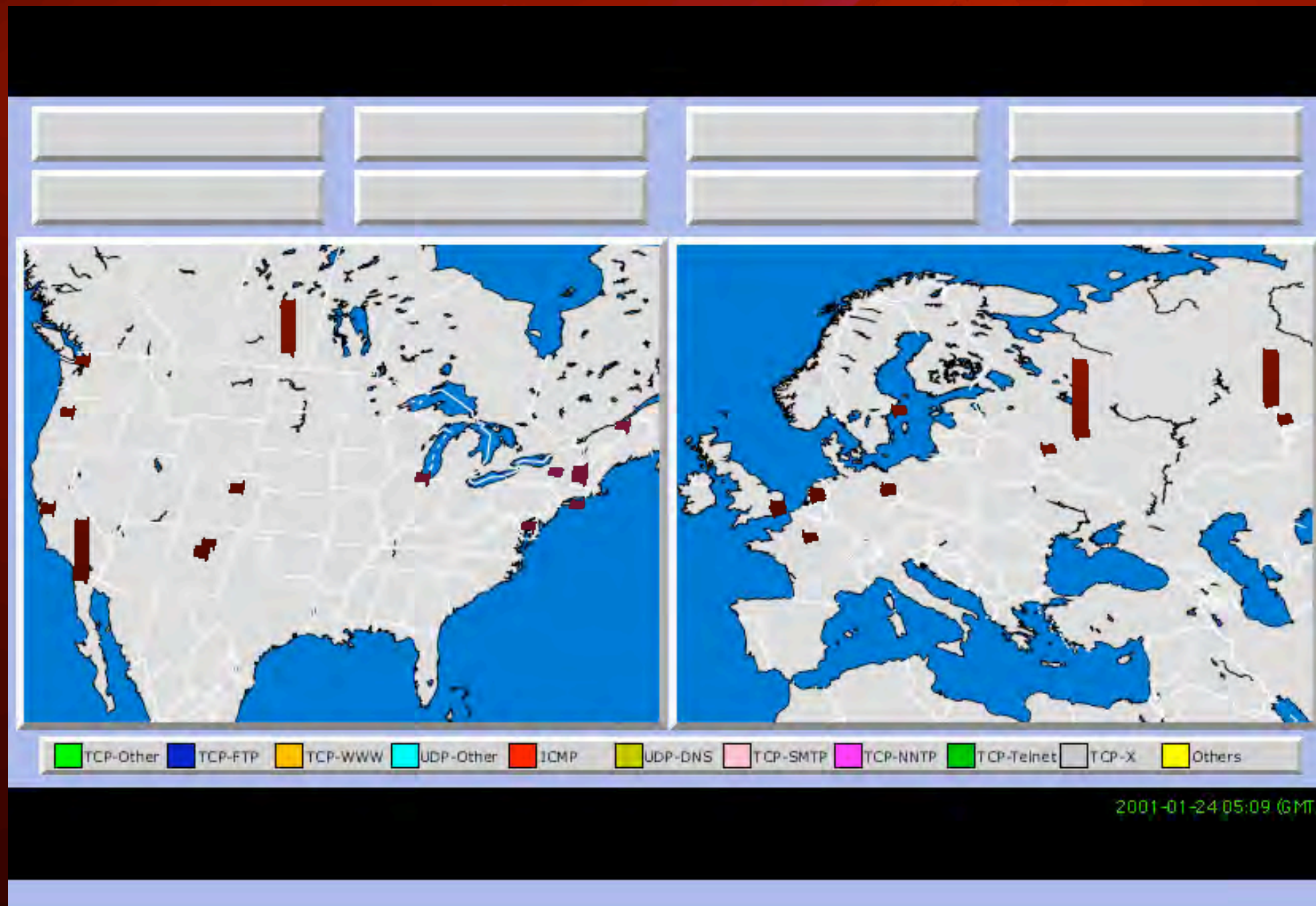
During time of F&P and CIVnet projects (mid-1997), we began working on high performance connectivity between US and Russia, applying for funding under the NSF High Performance International Internet Services (HPIIS) program.

HPIIS subsequently funded *MIRnet* as well as the larger Eurolink and TransPAC projects

Purpose of MIRnet was to broadly connect S&E network infrastructure between Russia and US

GLORIAD HISTORY

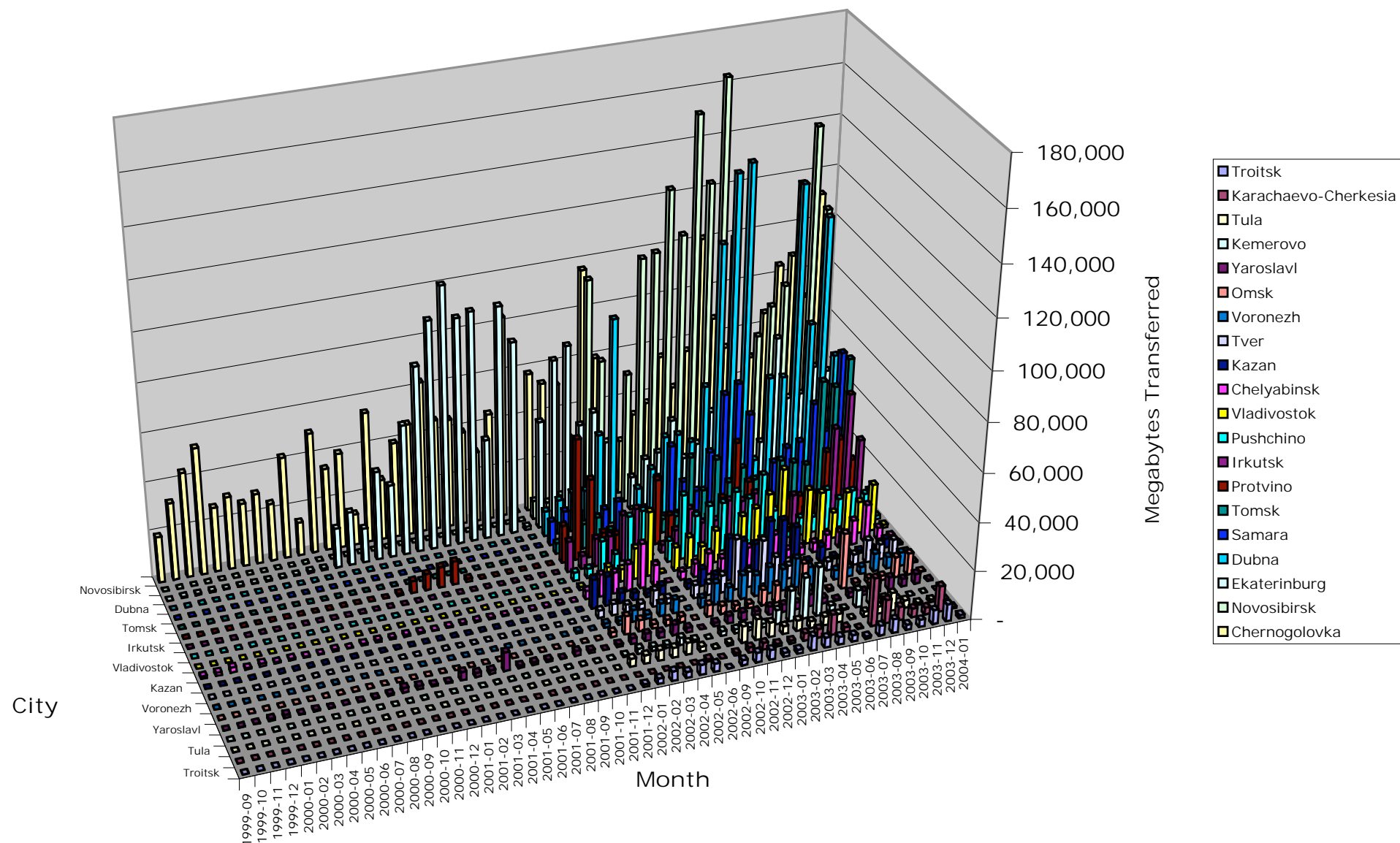
Began as the US-Russia 6 Mbps MIRnet Program in 1998, Limited Primarily to Moscow region



GLORIAD HISTORY

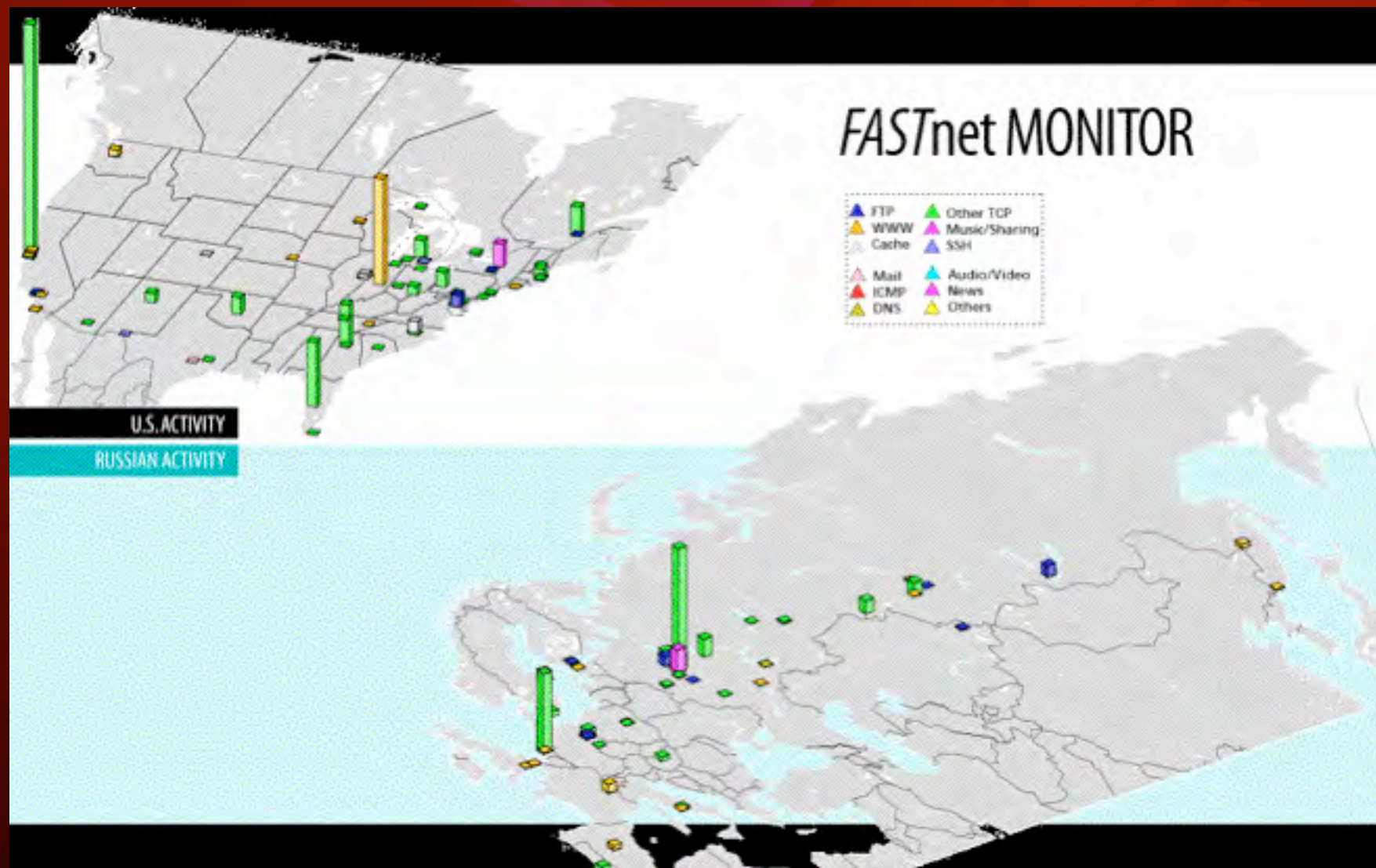
MIRnet served limited community in Russia;
in December 2001 (thanks to Acad. Velikhov),
Expanded across Russia

Russian Cities Using NaukaNet (top 20 minus Moscow)



GLORIAD HISTORY

Transitioned to the US-Russia 45 Mbps FastNet Program in Dec. 2001, and then the 155 Mbps NaukaNet in 2002



Transition Time

As the MIRnet/NaukaNet program began to draw to a close in 2002, we began thinking of how to continue/grow. We wanted to:

- **Keep going ...**
- **Dramatically expand connectivity/bandwidth across Russia**
- **Extend access from Russian Far East to US**
- **Bring Chinese science community in as partner**
- **Introduce the developing “GLIF” (initially LambdaGrid) networking paradigm/model to our partners in Russia and China**
- **Help address network needs of international ITER program**

In December 2002, we signed agreement with Russian (Acad. Evgeny Velikhov) and Chinese (Dr. Mianheng Jiang) partners to develop GLORIAD – first step: “Little GLORIAD”

Little GLORIAD



- ☉ Agreement signed by Velikhov, Jiang, Cole in December 2002
- ☉ Little GLORIAD became operational on January 9, 2004 (Tyco OC3 links Chicago-Moscow, Chicago-Beijing); launched in Beijing January 12, 2004
- ☉ Moscow-Beijing OC3 (across Russia-China border) became operational in July, 2004. Ring complete.
- ☉ Proposal submitted to NSF IRNC program June, 2004
- ☉ Meeting hosted by Netherlands partners in September, 2004 – US, Russian, Chinese, Korean, European partners attend
- ☉ News of NSF review in September, 2004
- ☉ Moved project from NCSA to UT/ORNL in summer/fall, 2004
- ☉ Meeting with Canadian partners in November, 2004
- ☉ HKLight launched by CAS/CNIC November 23, 2004
- ☉ NSF Grant funded December 2004, “Big GLORIAD” program begins in US on January 1, 2005

1996: Local Networking



1998: Int'l Networking



1994: Community Building



2004: GLORIAD Launch

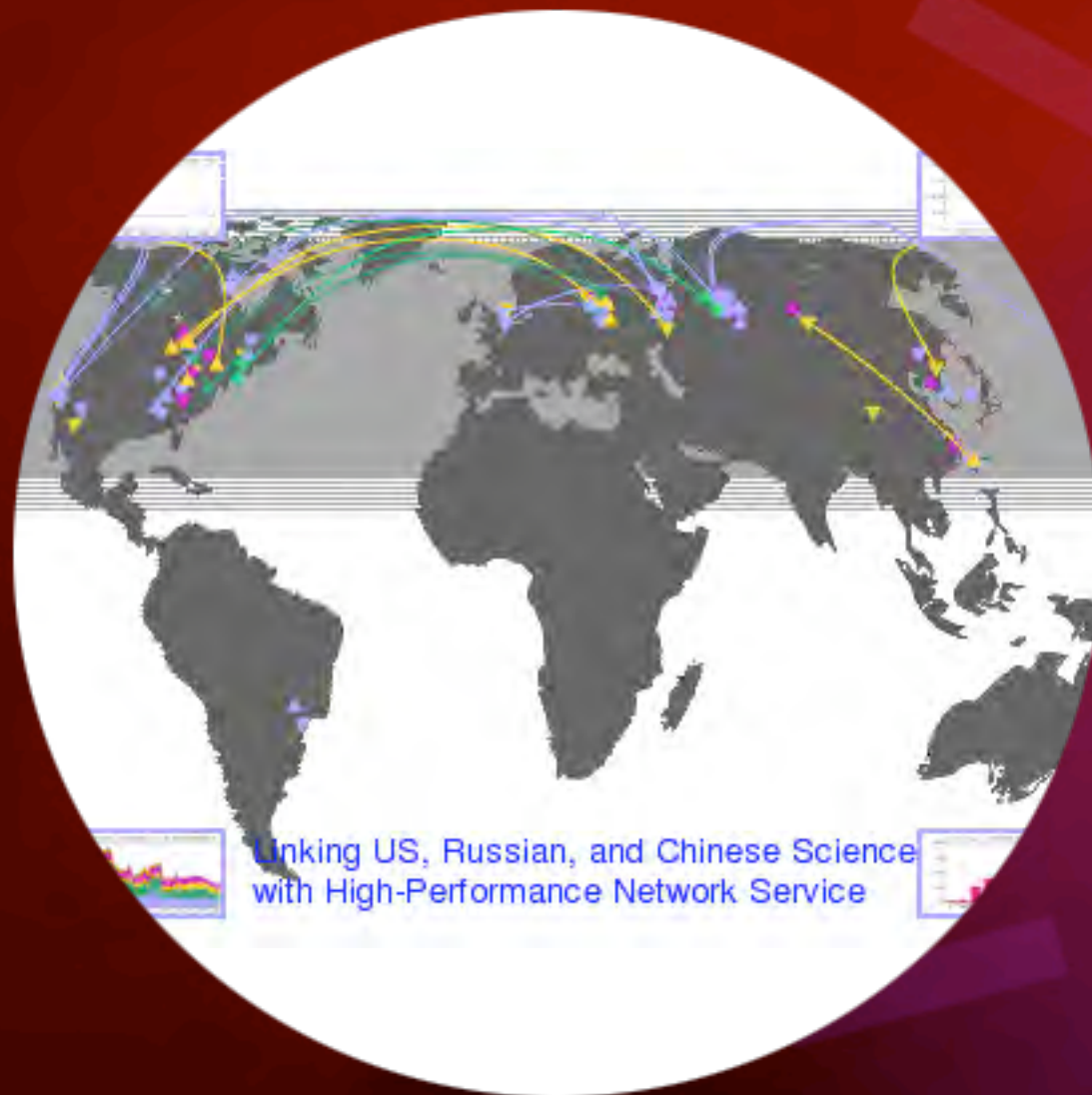
When/How?

- April 1993: that first email ...
- 1994: US-Russia Community-networking effort called "Friends & Partners" begins
- 1996: US-Russia "Civic Networking" begins (focus on local infrastructure)
- 1998: US-Russia "MIRnet/NaukaNet" begins (high performance international)
- 2002: Work begins on GLORIAD
- 2004: "Little GLORIAD" launched
- 2005: January 1 - GLORIAD begins

Presentation

- Background/History
- **GLORIAD Today, Tomorrow**
- Partners and Networks
- Measurement Program
- Application Areas
- Education/Outreach Activities
- Challenges, Issues

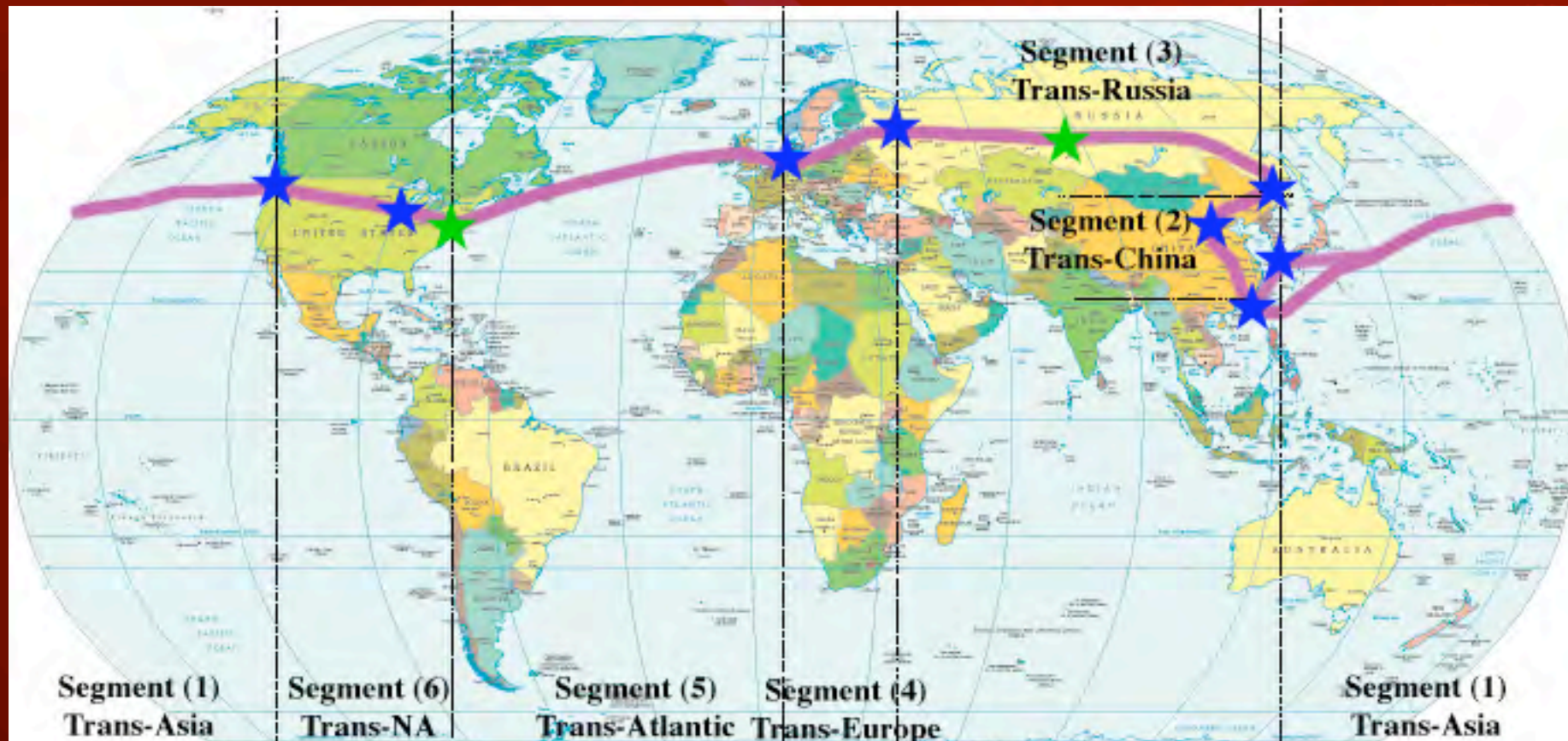
GLORIAD TODAY



- 155/622 Mbps Circuits Around Northern Hemisphere providing L3 service
- 622 Mbps Moscow-AMS-NYC
- 1 GbE NYC-Chicago (CANARIE)
- 155 Mbps Chicago-Hong Kong
- 2.5 Gbps Hong Kong-Beijing
- 155 Mbps Beijing-Khabarovsk-Moscow
- This year: 2.5 Gbps US-China link in September, **10 Gbps US-Korea-China link in August**, 10 Gbps US-AMS and US-China circuits in January, 2006

The GLORIAD Network Topology

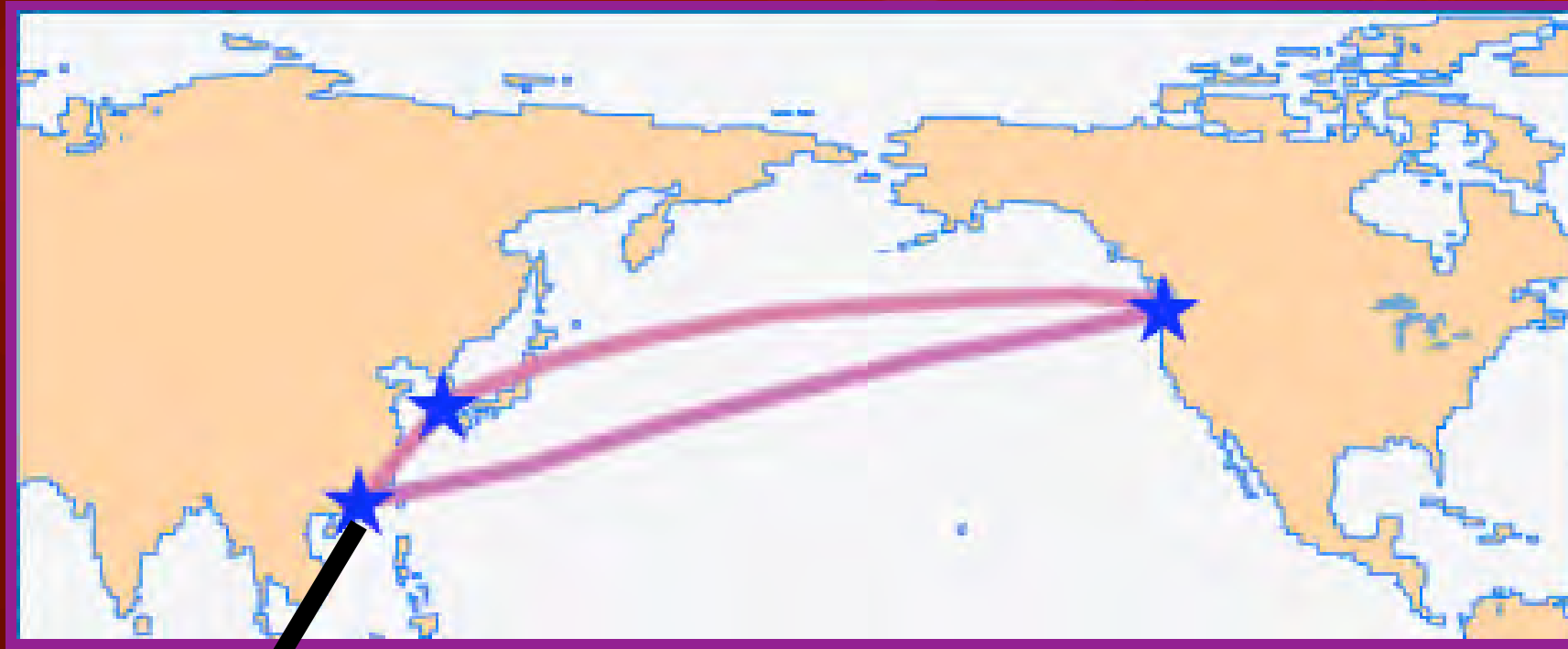
Current, Years 1-5



Segment	Current	Year 1	Year 2	Year 3	Year 4	Year 5
1 - Trans-Asia	155 Mbps	2.5 Gbps (US-China), 10 Gbps (US-Korea-China)	2 x 10 Gbps (US-China, US- Korea-China)	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
2 - Trans-China	2.5 Gbps (155 Mbps, Beijing- Khabarovsk)	2.5 Gbps	1 x 10 Gbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
3 - Trans-Russia	155 Mbps	155 Mbps	622 Mbps	1 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
4 - Trans-Europe	622 Mbps	622 Mbps	622 Mbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
5 - Trans-Atlantic	622 Mbps	1 Gbps	1 x 10 Gbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
6 - Trans-North America	155 Mbps (Asia- Chicago), GbE NYC-Chicago (via CANARIE)	10 Gbps, Seattle-Chicago- NYC	10 Gbps, Seattle-Chicago- NYC	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps

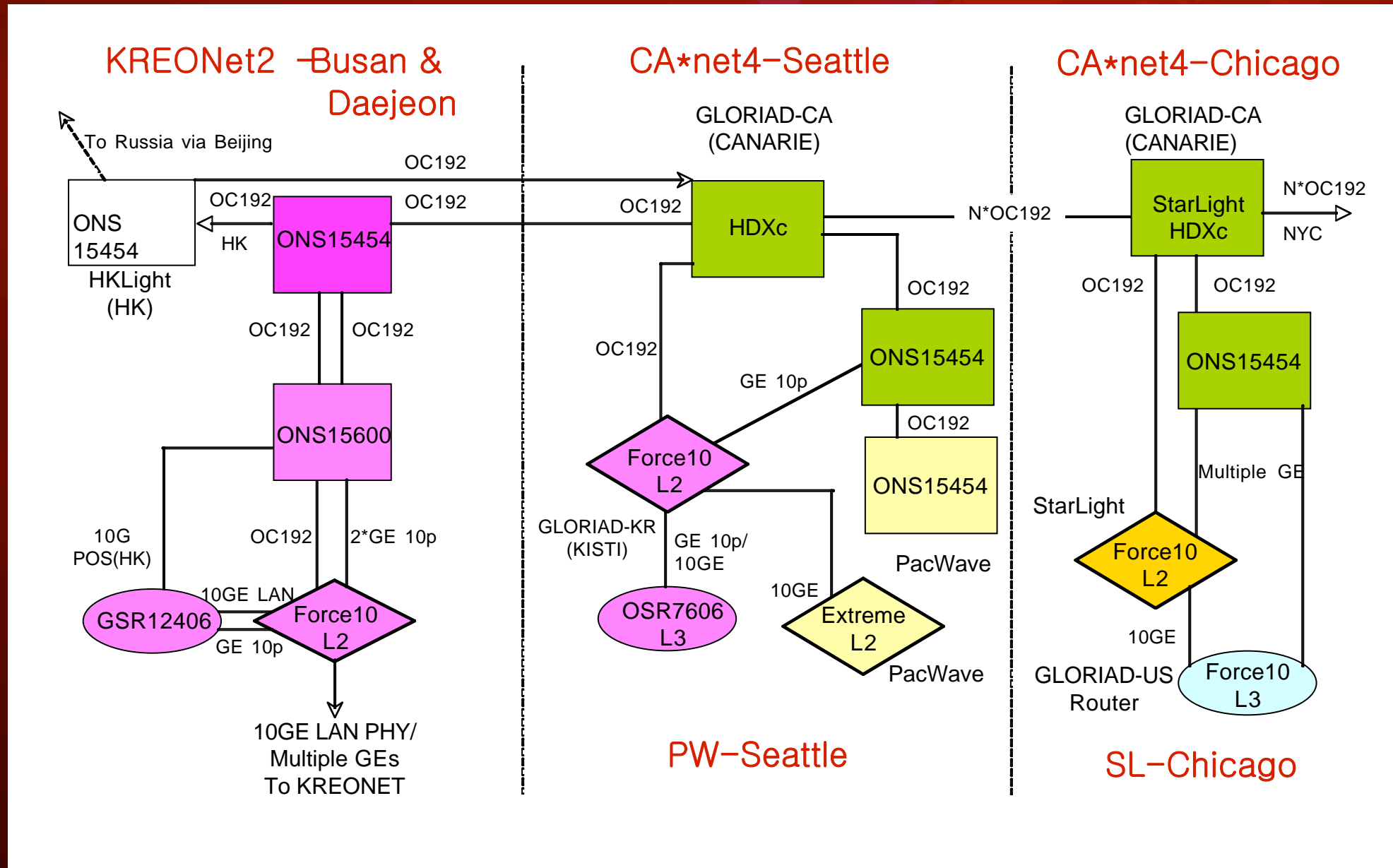
Trans-Pacific Portion (Segment 1)

(illustrating Hong-Kong–Seattle and Hong-Kong–Pusan–Seattle paths)

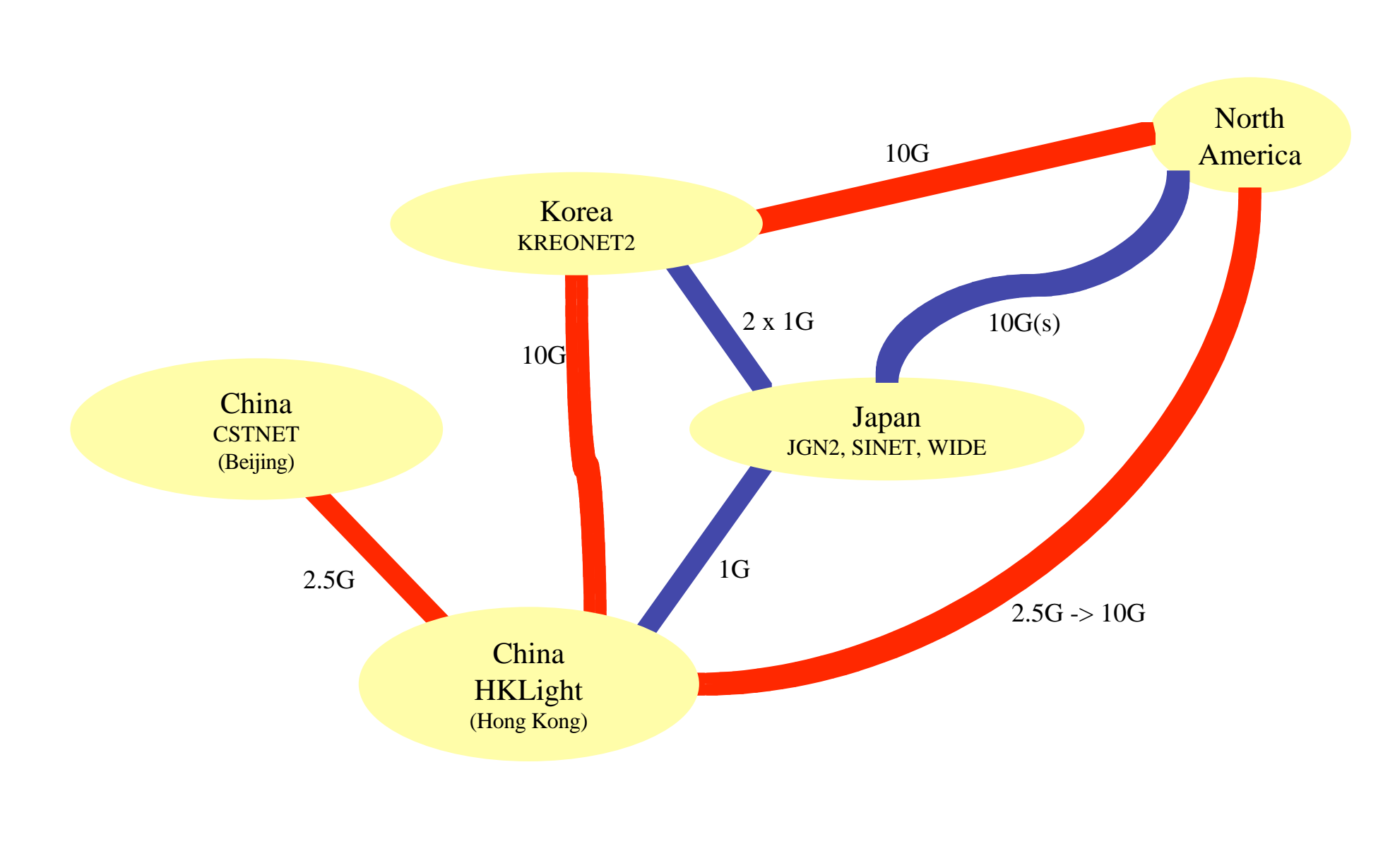


Hong Kong Light (HKLight) Open Exchange Point
Other exchange points include Starlight (Chicago),
Pacific Wave (Seattle), Netherlight (Amsterdam),
RussiaLight (Moscow)

10G Connectivity for GLORIAD



China-Korea Links for North Asia



GLORIAD Network

On 6/7/2005

Beijing-Khabarovsk (Russia)-
Novosibirsk, 155 Mbps

Chicago-Hong Kong, 155 Mbps
(Tyco Contract)

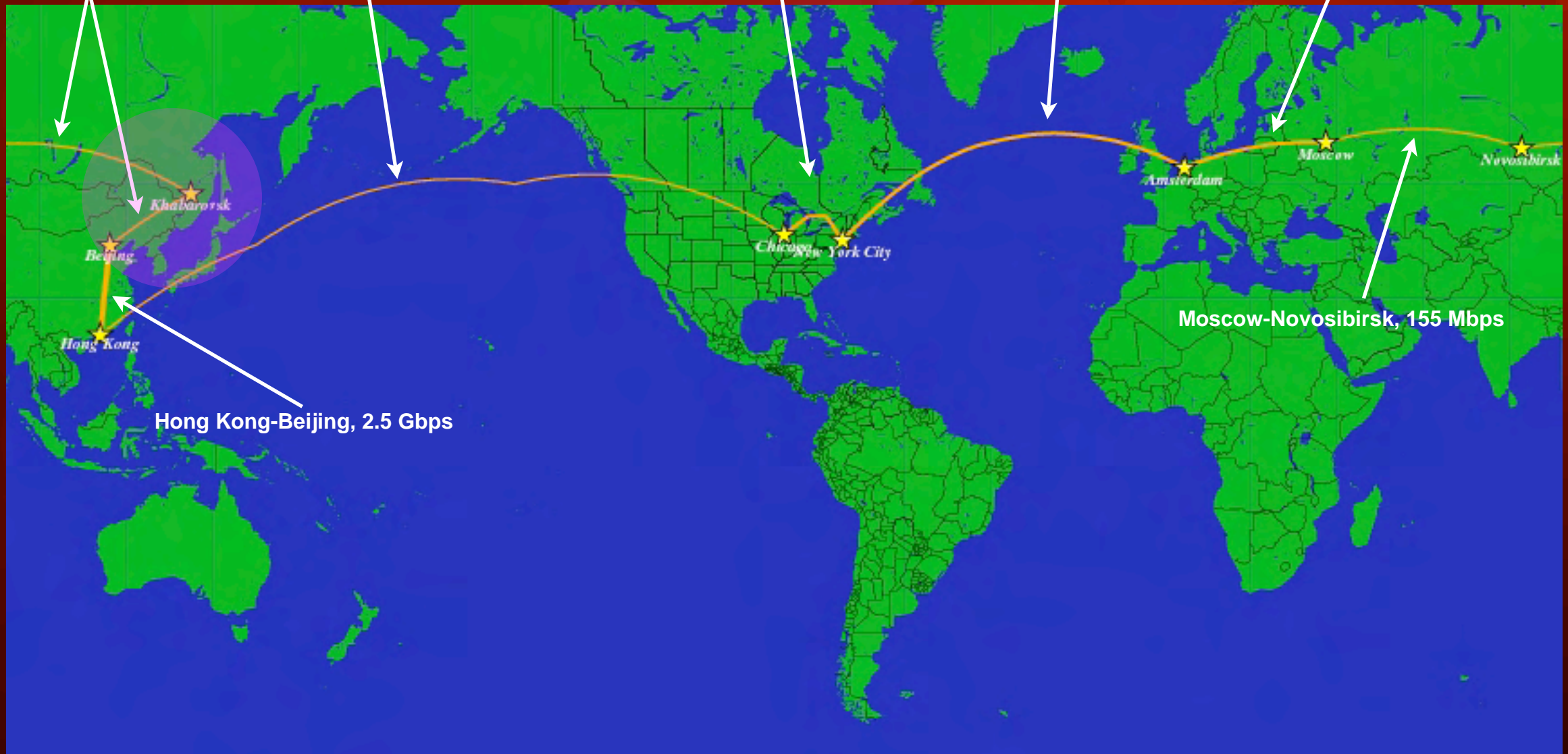
Chicago-NYC, 1 Gbps
(CANARIE Contribution)

NYC-Amsterdam, 622 Mbps
(Tyco Contribution)

Amsterdam-Moscow, 622 Mbps

Moscow-Novosibirsk, 155 Mbps

Hong Kong-Beijing, 2.5 Gbps



Crossing the Russia-China Border

Stanford
Linear
Accelerator
Center

New Route from SLAC to BINP/Novosibirsk

Les Cottrell. Page created: May 31, 2005

[Central Computer Access](#) | [Computer Networking](#) | [Network Group](#) | [More case studies](#)

Welcome

Highlighted

Detailed

Search

Phonebook

Problem

Since 2001 BINP, KEK and SLAC have been sharing the cost of a dedicated link from BINP to KEK. In April 2002 having identified congestion, this link was upgraded from 256kbps to 512kbps. This link has worked very satisfactorily providing reliable, consistent service. However, it is costly and low performance by today's standards. At the [International ICFA Workshop on HEP Networking, Grid and Digital Divide Issues for Global e-Science HEPDG Workshop](#) 2005, Daegu, Korea, May 23-27, 2005, Les Cottrell raised the question to Greg Cole of [GLORIAD](#) whether BINP could use GLORIAD instead of the dedicated link to communicate with SLAC, KEK and ESnet. Greg thought this would be possible and after communications with his Russian and Chinese partners confirmed the possibility. Following this exchange the experts in China, Russia, KEK and ESnet worked to change the routing.

Results

On May 31st 2005, Joe Burrencia of ESnet announced that he had changed the ESnet routing to prefer GLORIAD for 193.124.160.0/21. The routes from [SLAC to BINP](#) change between 00:45 and 00:55 5/31/2005 PDT, (see the [traceroute analysis](#)) then returned to its original route between 1:25 and 1:35am, and then back to the new route between 8:45 and 8:55am. The new route from SLAC now goes West to East instead of East to West (i.e. via Amsterdam rather than via KEK). It has more hops but appears to be slightly shorter in RTT (250-300ms vs 370ms)

<http://www.slac.stanford.edu/grp/scs/net/case/binp-may05/>

GLORIAD Network

Date: 8/16/2005

Beijing-Khabarovsk (Russia)-
Novosibirsk, 622 Mbps

Seattle-Hong Kong, 2.5 Gbps
(Tyco Contract)

Seattle-Chicago-NYC, 10 Gbps
(CANARIE Contribution)

NYC-Amsterdam, 10 Gbps
(Tyco Contract)

Amsterdam-Moscow, 2.5 Gbps



Seattle-Pusan-Hong Kong, 10 Gbps
(Tyco Contract)

Hong Kong-Beijing, 2.5 Gbps

Moscow-Novosibirsk, 622 Mbps

GLORIAD Network

Date: 3/1/2006

Beijing-Khabarovsk (Russia)-
Novosibirsk, 622 Mbps

Seattle-Hong Kong, 2.5 Gbps
(Tyco Contract)

Seattle-Chicago-NYC, 10 Gbps
(CANARIE Contribution)

NYC-Amsterdam, 10 Gbps
(Tyco Contract)

Amsterdam-Moscow, 2.5 Gbps



Seattle-Pusan-Hong Kong, 10 Gbps
(Tyco Contract)

Hong Kong-Beijing, 2.5 Gbps

Moscow-Novosibirsk, 622 Mbps

GLORIAD Network

Date: 3/1/2007



Architecture Motivation

- General S&E Applications – needs met by “best effort” routed infrastructure (but minimize congestion/packet loss)
- Specialized Applications requiring high capacity, low-latency and/or controlled jitter (i.e., dedicated end-to-end circuits)
- Network research/experimentation testbed
- Backup/protection services for partnering S&E networks

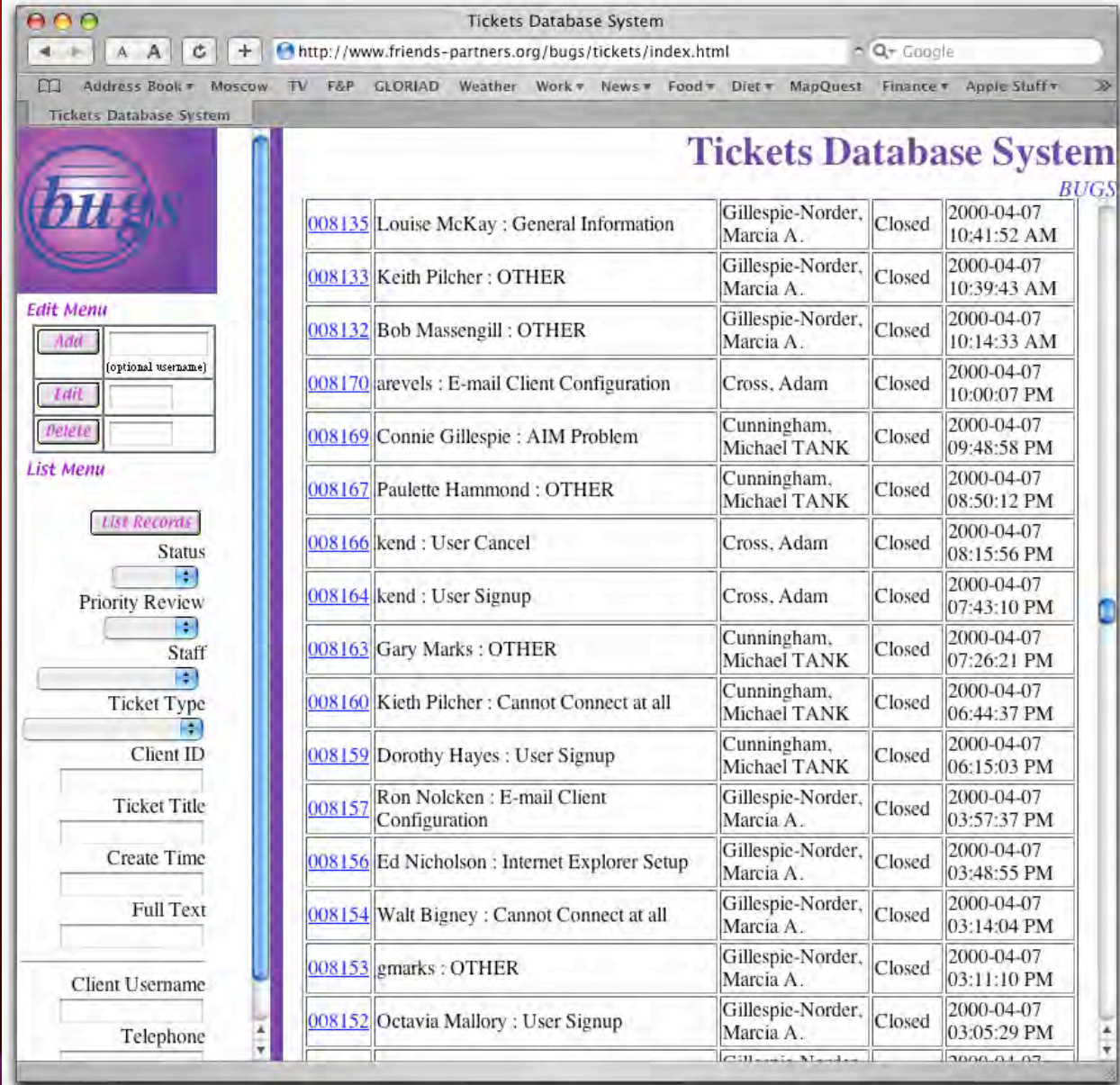
Network Design

- Using MSPP devices (i.e., Ciena CoreDirector, Cisco ONS 15454, etc.), provide L1 infrastructure
- Use UCLP to enable user community (and applications) to dynamically provision their own circuits across the core (and end-to-end where possible)
- Use N x GbE for layer-3 routed infrastructure (GLORIAD is in process of receiving its own AS number)
- Take advantage of ring topology for network reliability and for network experimentation
- Big emphasis on monitoring: (1) utilization, (2) performance, (3) security

Network Operations

Developing
“distributed NOC”

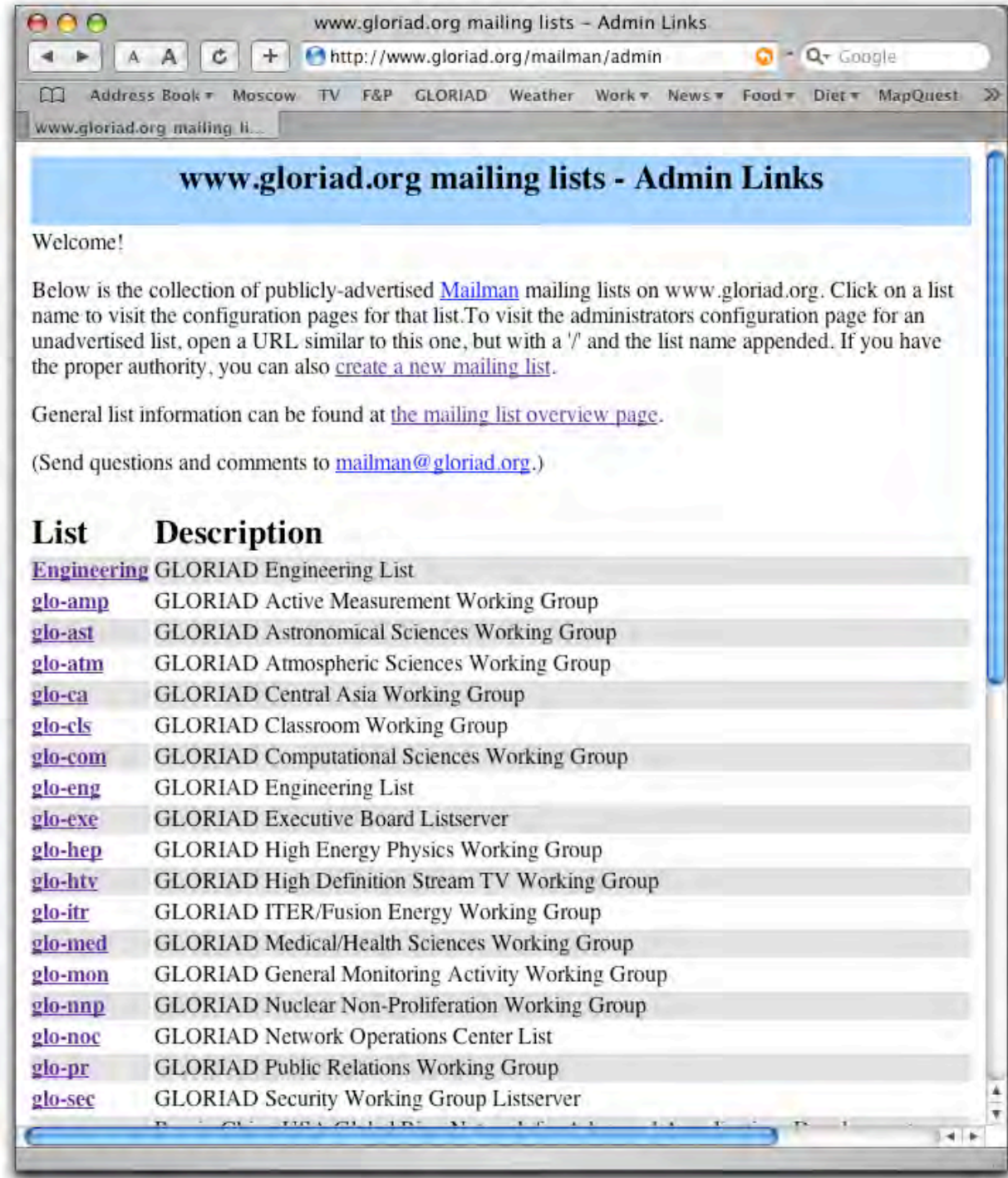
Deploying own
trouble ticketing
system (integrated
with monitoring
sub-systems)



ID	Client Information	Staff	Status	Date
008135	Louise McKay : General Information	Gillespie-Norder, Marcia A.	Closed	2000-04-07 10:41:52 AM
008133	Keith Pilcher : OTHER	Gillespie-Norder, Marcia A.	Closed	2000-04-07 10:39:43 AM
008132	Bob Massengill : OTHER	Gillespie-Norder, Marcia A.	Closed	2000-04-07 10:14:33 AM
008170	arevels : E-mail Client Configuration	Cross, Adam	Closed	2000-04-07 10:00:07 PM
008169	Connie Gillespie : AIM Problem	Cunningham, Michael TANK	Closed	2000-04-07 09:48:58 PM
008167	Paulette Hammond : OTHER	Cunningham, Michael TANK	Closed	2000-04-07 08:50:12 PM
008166	kend : User Cancel	Cross, Adam	Closed	2000-04-07 08:15:56 PM
008164	kend : User Signup	Cross, Adam	Closed	2000-04-07 07:43:10 PM
008163	Gary Marks : OTHER	Cunningham, Michael TANK	Closed	2000-04-07 07:26:21 PM
008160	Kieth Pilcher : Cannot Connect at all	Cunningham, Michael TANK	Closed	2000-04-07 06:44:37 PM
008159	Dorothy Hayes : User Signup	Cunningham, Michael TANK	Closed	2000-04-07 06:15:03 PM
008157	Ron Nolcken : E-mail Client Configuration	Gillespie-Norder, Marcia A.	Closed	2000-04-07 03:57:37 PM
008156	Ed Nicholson : Internet Explorer Setup	Gillespie-Norder, Marcia A.	Closed	2000-04-07 03:48:55 PM
008154	Walt Bigney : Cannot Connect at all	Gillespie-Norder, Marcia A.	Closed	2000-04-07 03:14:04 PM
008153	gmarks : OTHER	Gillespie-Norder, Marcia A.	Closed	2000-04-07 03:11:10 PM
008152	Octavia Mallory : User Signup	Gillespie-Norder, Marcia A.	Closed	2000-04-07 03:05:29 PM

Working Groups / Governance

- Executive Board
- 30+ Working Groups Dealing with:
 - Networking Issues
 - Monitoring/Security Issues
 - Research Disciplines
 - Project Management
 - Education/Outreach Programs



www.gloriad.org mailing lists - Admin Links

Welcome!

Below is the collection of publicly-advertised [Mailman](#) mailing lists on www.gloriad.org. Click on a list name to visit the configuration pages for that list. To visit the administrators configuration page for an unadvertised list, open a URL similar to this one, but with a '/' and the list name appended. If you have the proper authority, you can also [create a new mailing list](#).

General list information can be found at [the mailing list overview page](#).

(Send questions and comments to mailman@gloriad.org.)

List	Description
Engineering	GLORIAD Engineering List
glo-amp	GLORIAD Active Measurement Working Group
glo-ast	GLORIAD Astronomical Sciences Working Group
glo-atm	GLORIAD Atmospheric Sciences Working Group
glo-ca	GLORIAD Central Asia Working Group
glo-cls	GLORIAD Classroom Working Group
glo-com	GLORIAD Computational Sciences Working Group
glo-eng	GLORIAD Engineering List
glo-exe	GLORIAD Executive Board Listserver
glo-hep	GLORIAD High Energy Physics Working Group
glo-htv	GLORIAD High Definition Stream TV Working Group
glo-itr	GLORIAD ITER/Fusion Energy Working Group
glo-med	GLORIAD Medical/Health Sciences Working Group
glo-mon	GLORIAD General Monitoring Activity Working Group
glo-nnp	GLORIAD Nuclear Non-Proliferation Working Group
glo-noc	GLORIAD Network Operations Center List
glo-pr	GLORIAD Public Relations Working Group
glo-sec	GLORIAD Security Working Group Listserver

Presentation

- Background/History
- GLORIAD Today, Tomorrow
- **Partners and Networks**
- Measurement Program
- Application Areas
- Education/Outreach Activities
- Challenges, Issues

Who in Russia?



- Acad. Evgeny Velikhov, President, Kurchatov Institute, Academician-Secretary, Russian Academy of Sciences
- Ministry of Science & Education, Agency of Communications, Agency of Atomic Energy, Moscow State University, Joint Supercomputing Center
- Russian Backbone Network (RBNNet)



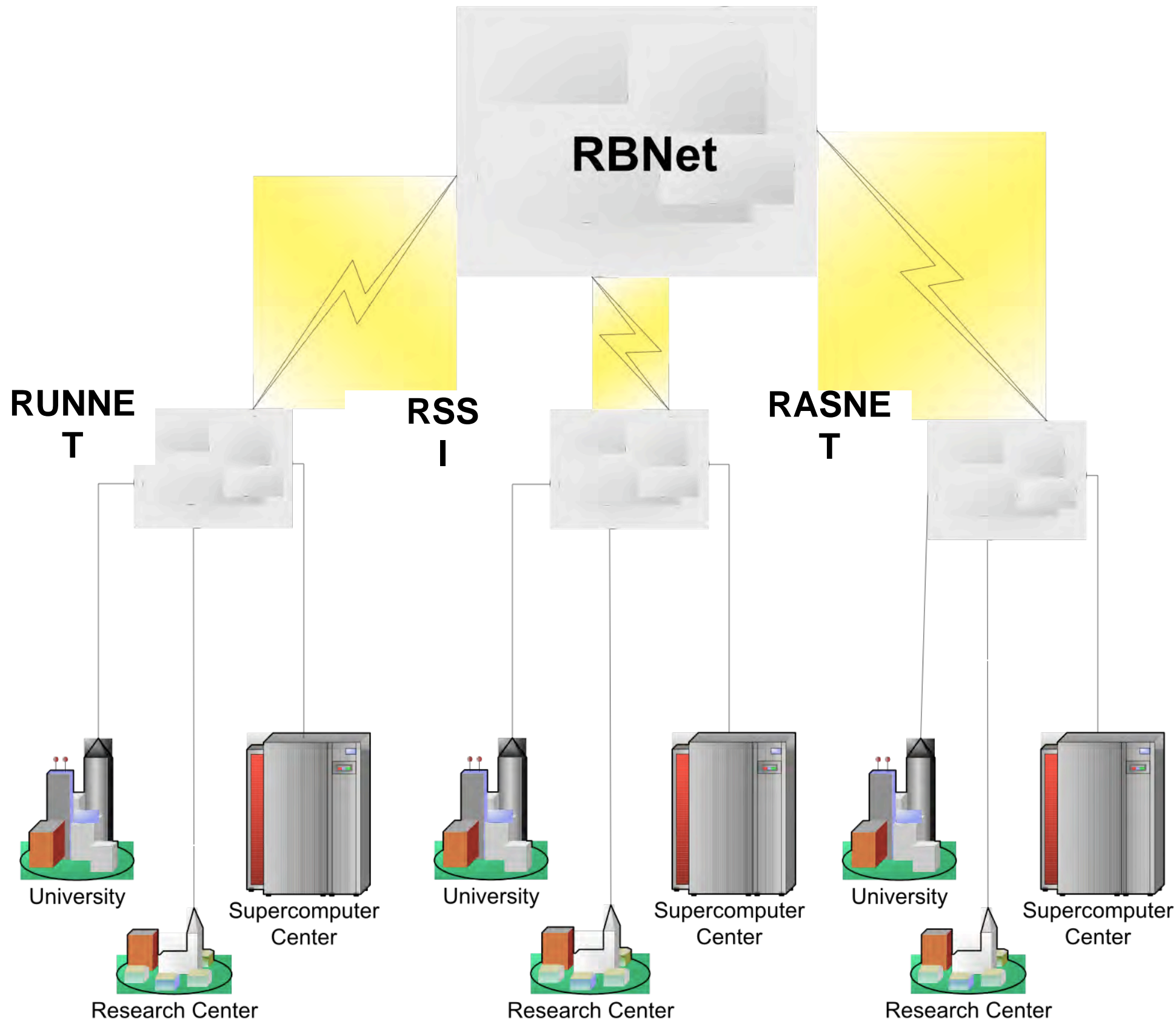


Russian Institute for Public Network

Russian Institute for Public Networks (RIPN) has been founded in 1992 by the Higher School Committee of Russia, Russian Research Centre "Kurchatov Institute" and Computer Centre of Kurchatov Institute. The aims declared were the following:

- to develop computer communications in the interests of Research & Education (R&E);
- to coordinate IP networking in Russia;
- to promote research studies in the field of computer communications;
- to support R&E organizations in getting access to the Internet information resources via public networks.

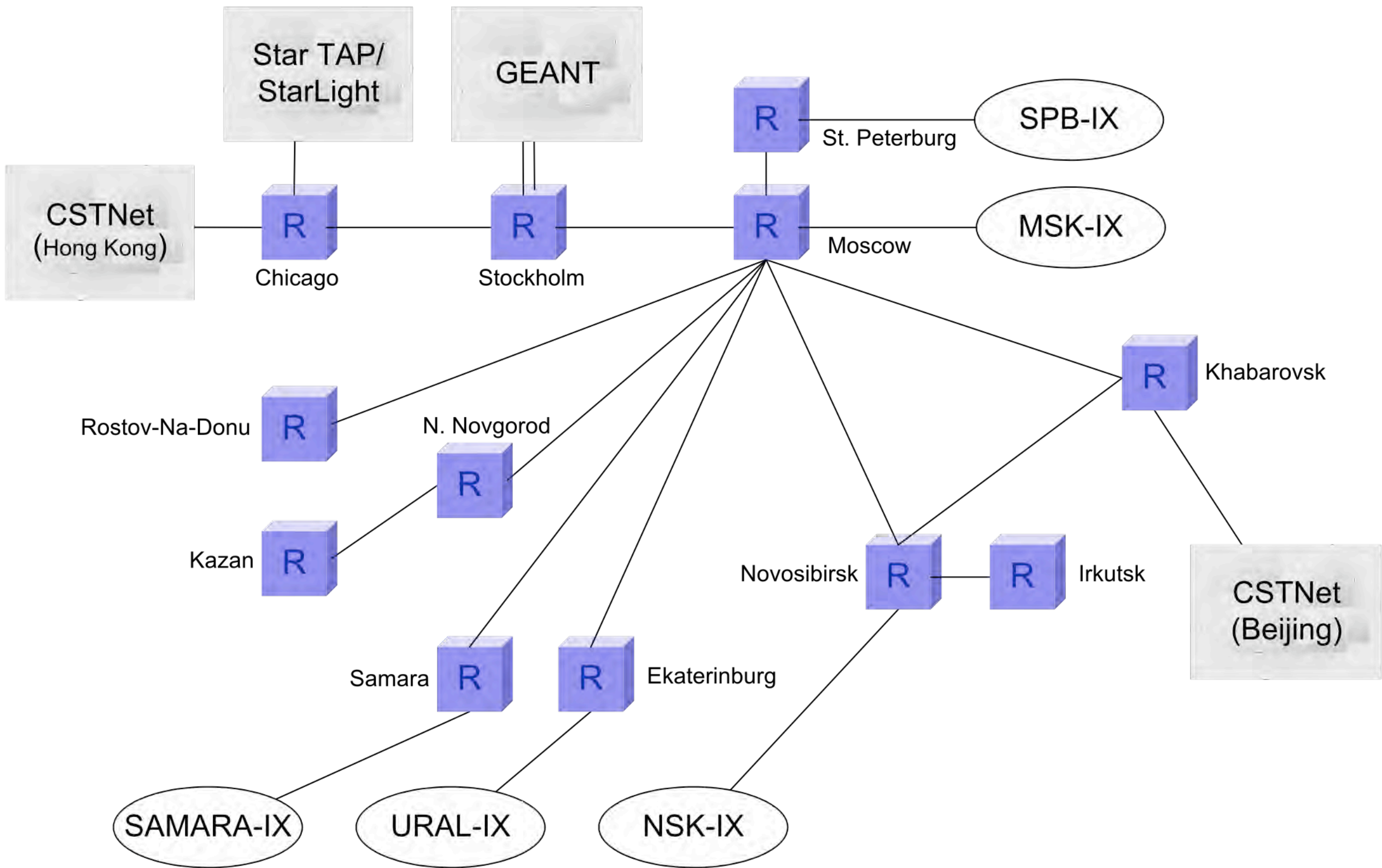
RBNet 2-level structure



R&D Networks:
-Regional
-Corporate
-Specialized
...

End Users:
-Universities
-Research Centers
-Supercomputer Centers
...

RBNet POPs



RBNet access system (Moscow)

- **RBNet Network Operation Center is placed at Kurchatov Institute.**
- **Datacenter "KIAEhouse" is designed professionally as telecommunication equipment housing location:**
 - ☞ **Rack space in a 19" rack for router and auxiliary equipment;**
 - ☞ **Backup power system;**
 - ☞ **Air-conditioning;**
 - ☞ **Fire protection;**
 - ☞ **Closed circuit television system;**
 - ☞ **Out-of-band management;**
 - ☞ **24*7 security on site ;**
 - ☞ **Intelligent hands 24*7.**



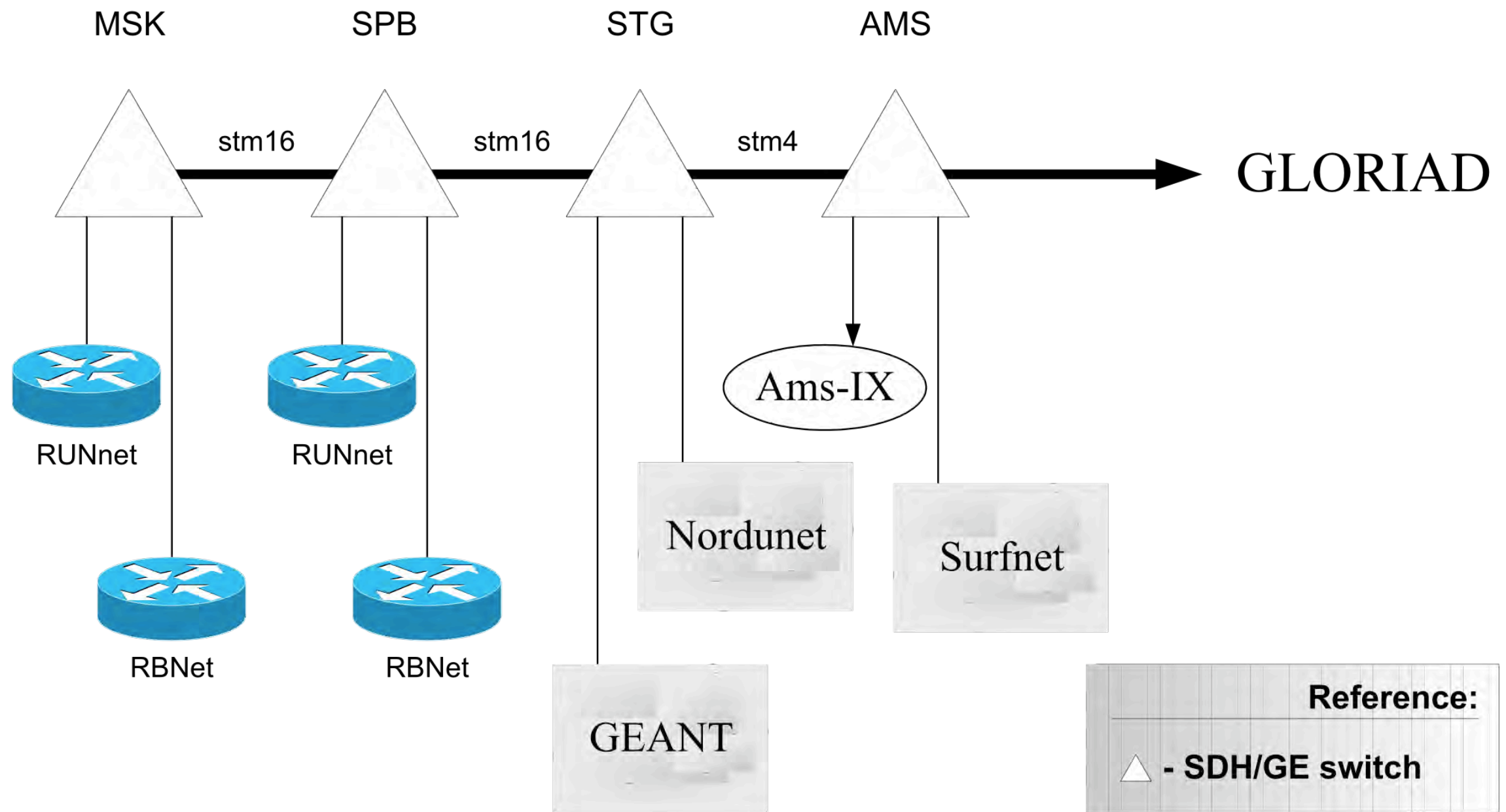
RBNet access system (Moscow)



RBNet access system (Khabarovsk)

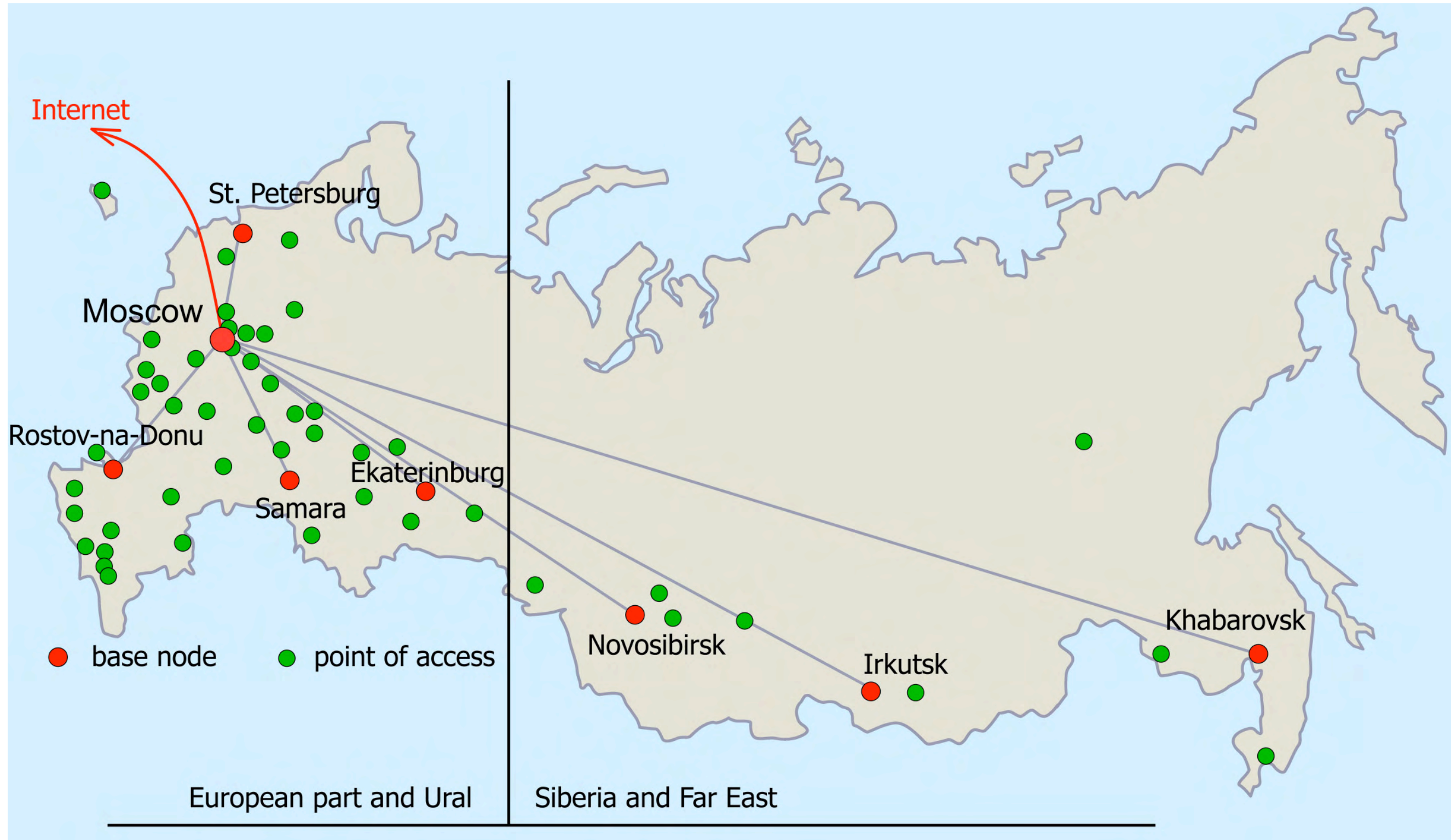


RBNet/RUNnet integrated International link

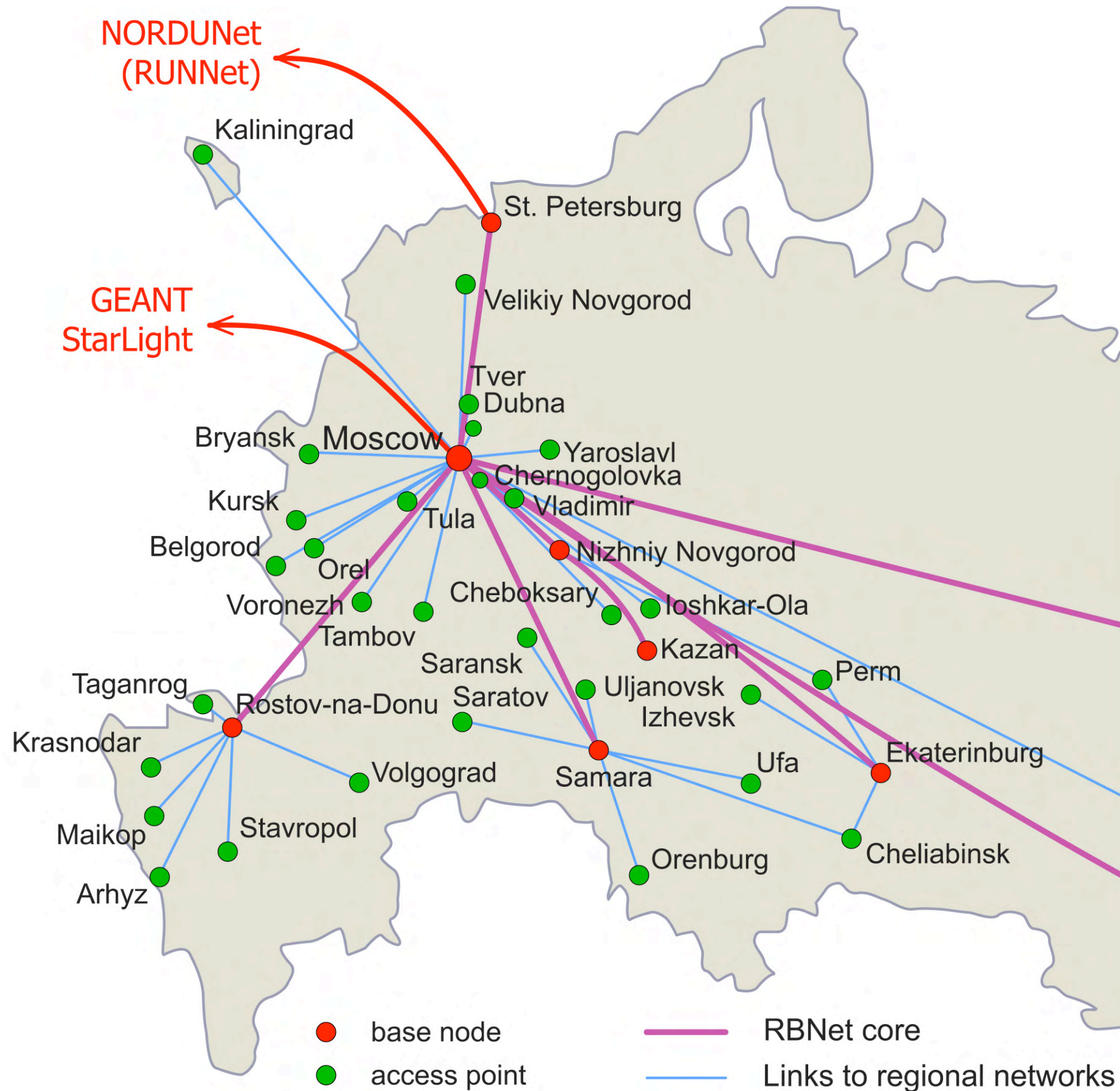


RBNet links

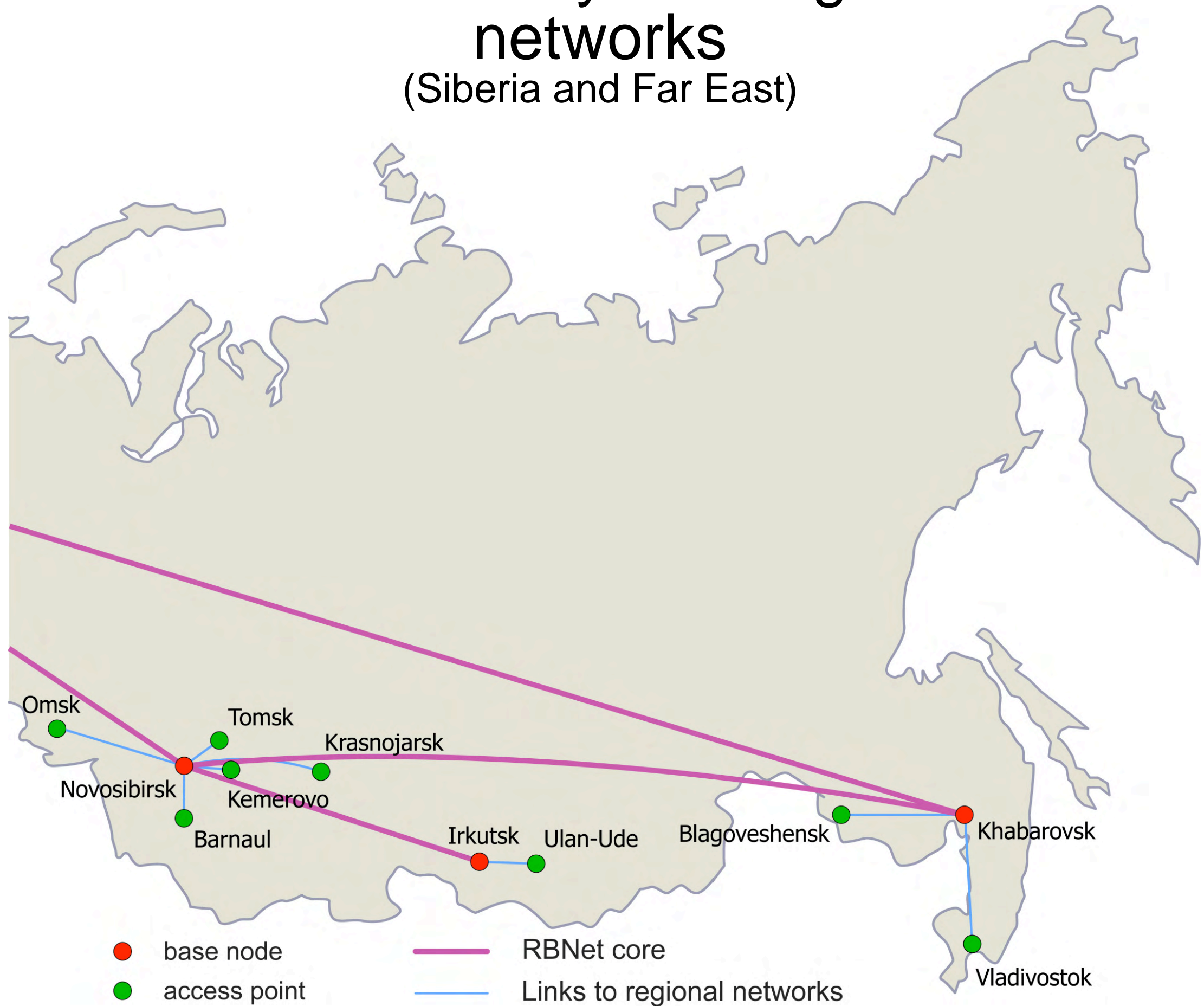
(General scheme)



RBNet connectivity with regional R&E networks (European part and Ural)



RBNet connectivity with regional R&E networks (Siberia and Far East)



Who in China?



- ☉ Dr. Mianheng Jiang, Vice President, Chinese Academy of Sciences, Telecomm/IT Developer (signatory of first GLORIAD agreement)
- ☉ Dr. Baoping Yan, Director, Computer Network Information Center (CNIC), Chinese Academy of Sciences. Directs all GLORIAD activities in China
- ☉ Dr. Jun Li, Deputy Director, CNIC, Director, China Science & Technology Network (CSTnet)



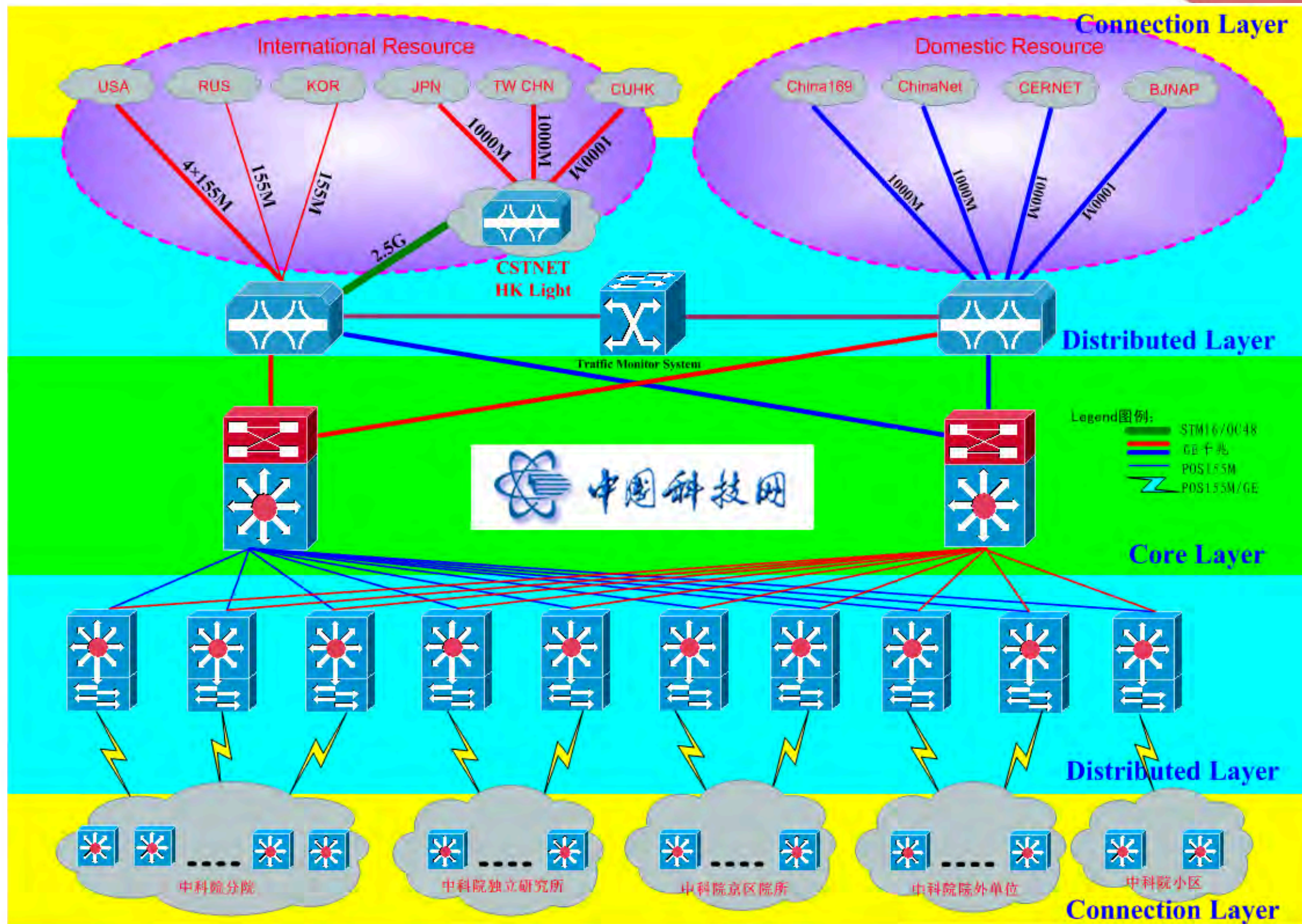
CSTNET Today

Dr. Jun Li

jlee@cstnet.cn

*China Science & Technology Network
Computer Network Information Center
Chinese Academy of Sciences*

CSTNET Core Infrastructure





Introduction of CSTNET

- Base on the NCFC and the network of CAS
- Opened the first Internet link of China 1994
- One of the top large scale networks in China
- .cn top domain service
- Cover more than 20 provinces, 100 institutes, and 1,000,000 end users
- Large scale upgrade in 2001-2005
- Bandwidths
 - Backbone 2.5G
 - MAN link 1G
 - WAN link 155M
- CNGI
 - 7 nodes (cooperating with China Netcom)

CSTNET Peering Deployment



CSTNET Domestic/International Peering Deployment



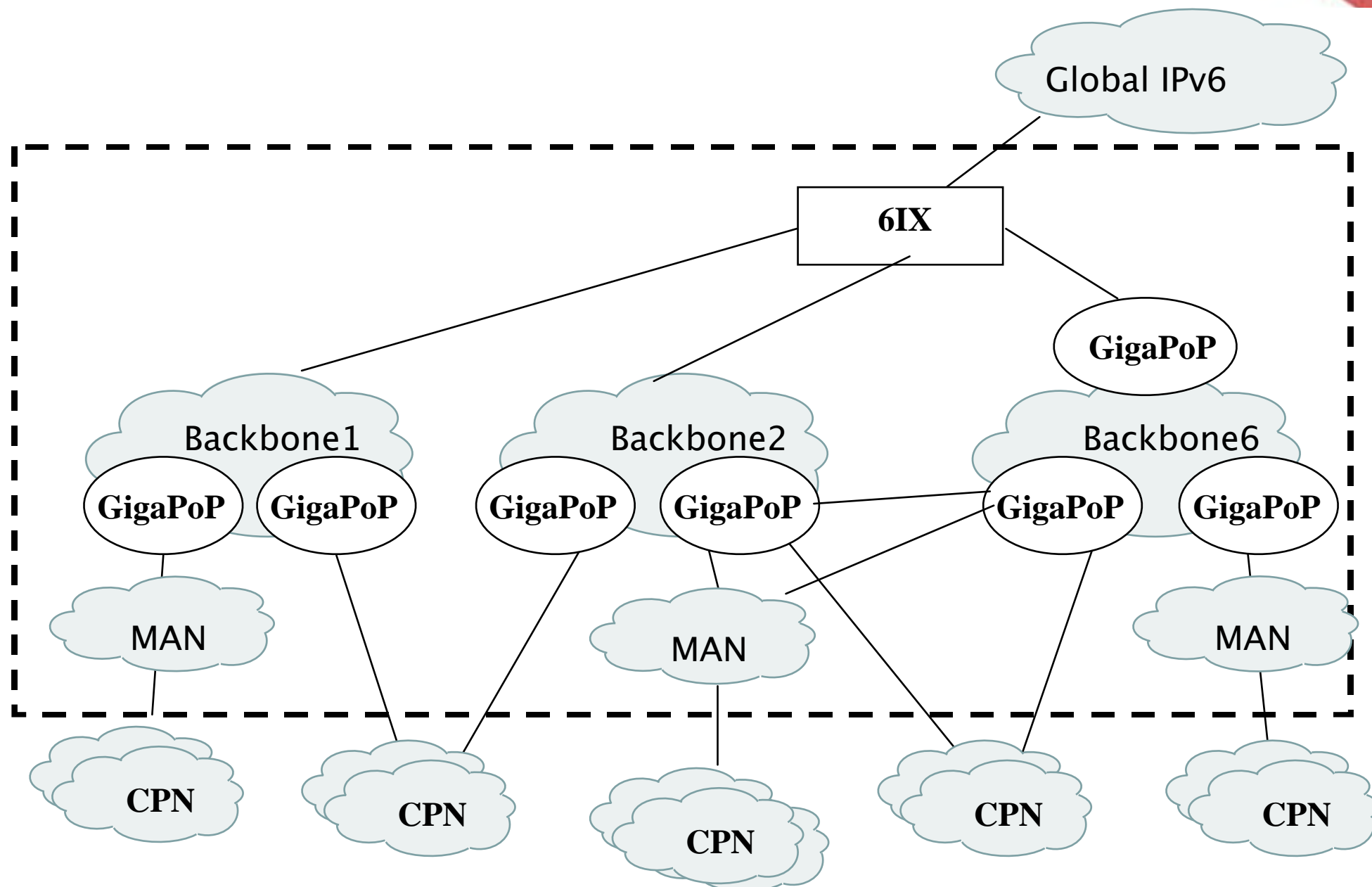


Key Issues of CNGI

- Standard study
- Large scale routing (BGP implementation...)
- Large Scale multicast
- QoS
- Mobility
- Management (BOSS)
- Migration from IPv4 to IPv6
- Accounting and business model
-

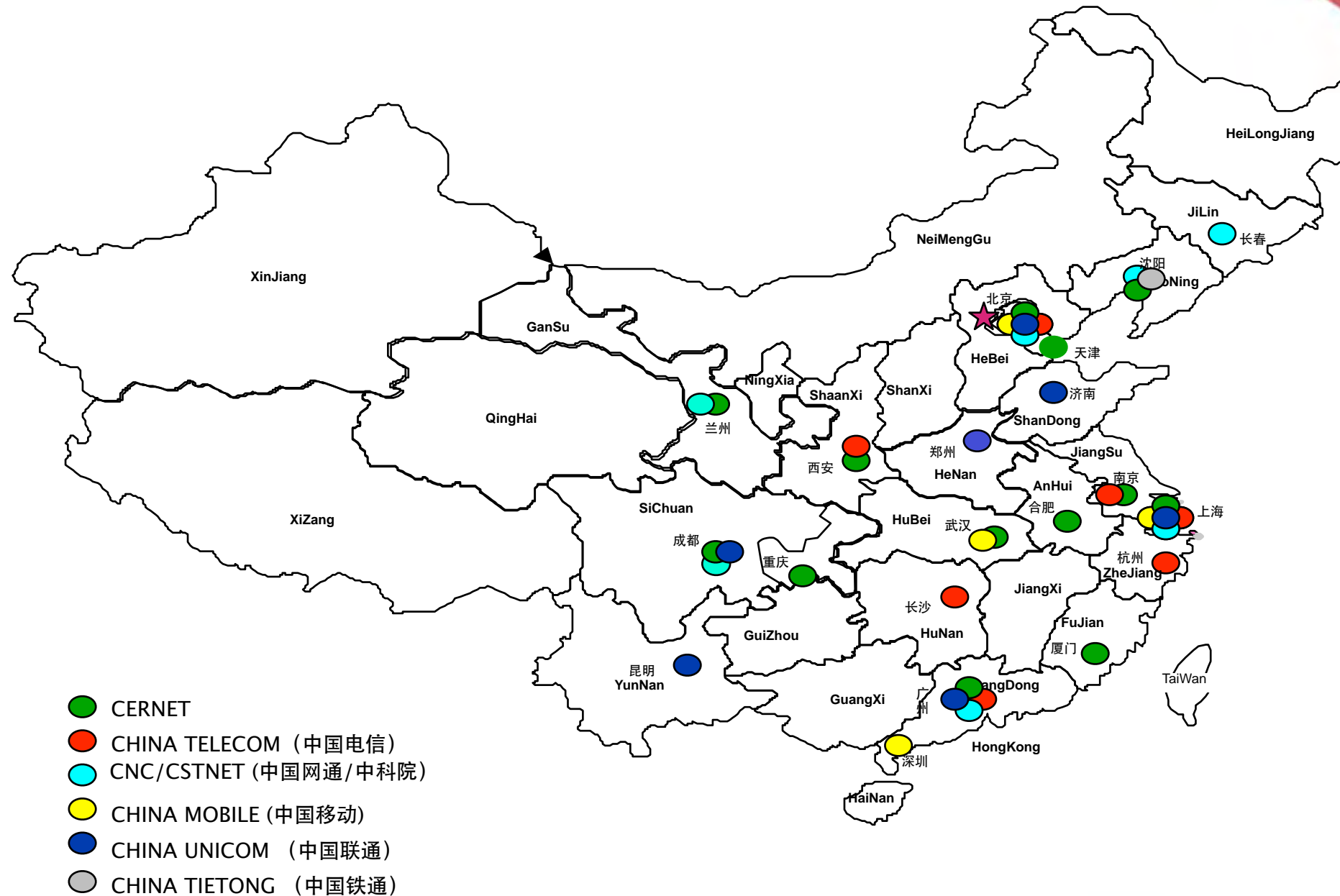


CNGI Backbone





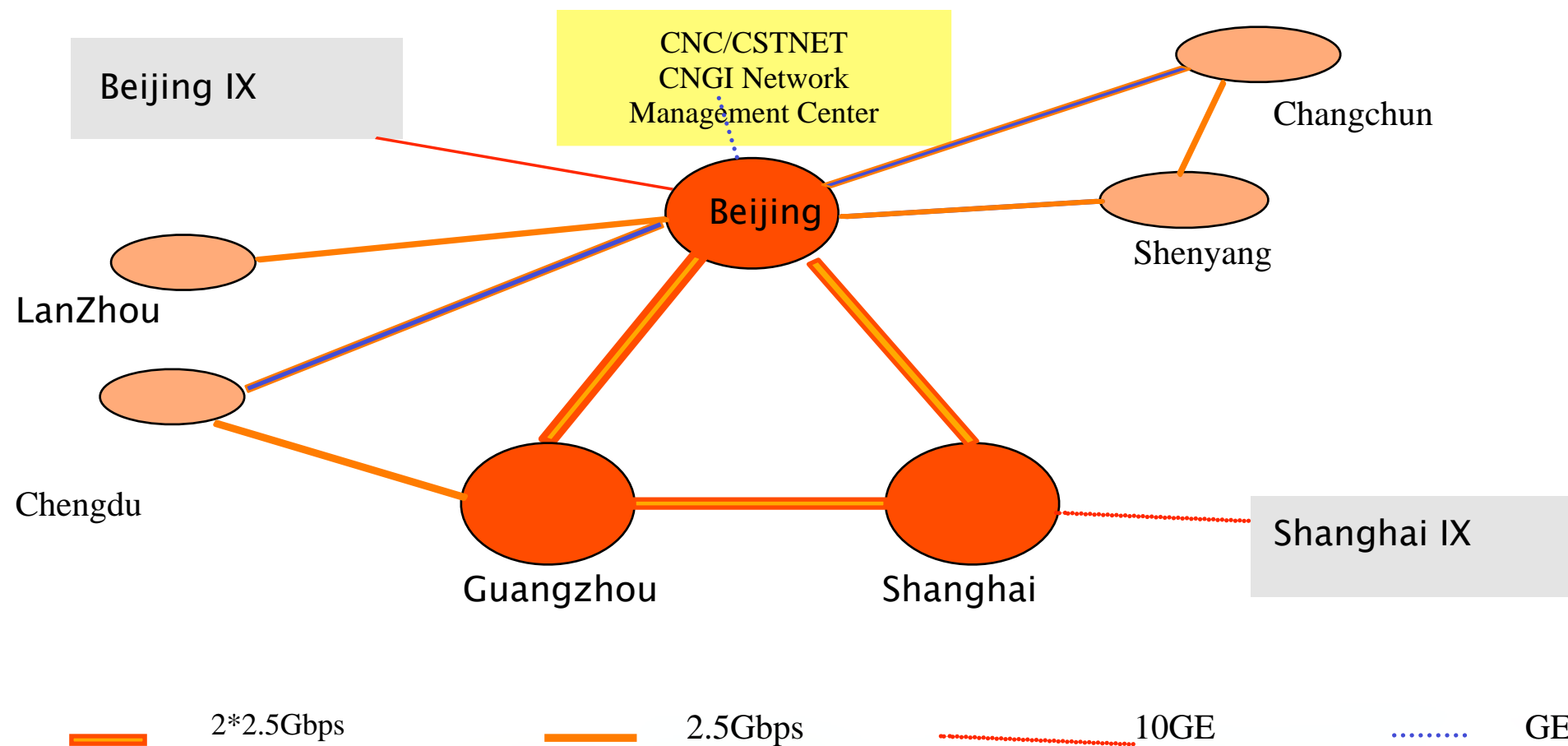
CNGI GigaPoPs





Our Achievement In CNGI

- China Netcom/CSTNet establishes 7 GigaPoPs in Beijing, Shanghai, Guangzhou, Shenyang, Changchun, Chengdu, Lianzhou and the network management center.





Hong Kong Internet Open Exchange Point

- Nov 23, 2004, the Beijing-Hong Kong section of the "China-US-Russia Global Ring Network for Advanced Applications Development (GLORIAD)" has been upgraded to 2.5G
- On the same day, the Chinese Academy of Sciences formally announced a plan to establish the next generation light wave "Hong Kong Internet Open Exchange Point-HK Light"
- HK Light is the first Open Exchange Point in Asia
- HK Light will serve as a venue with high-speed(proposed to be 10G) networks coming from Japan, South Korea and China Taiwan etc. Other States as Singapore, India and Australia are also very much interested in it.



HK Light Press Conference



HKLight Kit



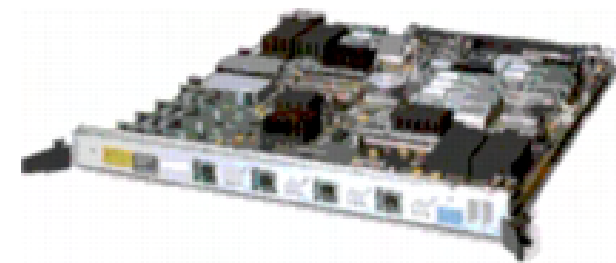
- At present...



**Cisco12008
(EoL/EoS)**



**1 Port Packet Over SONET
OC-48c/STM-16**



4 Port ISE Gigabit Ethernet

**(EoL/
EoS)**

1 Port Gigabit Ethernet



4 Port Packet Over SONET OC-3c/STM-1

HKLight Kit

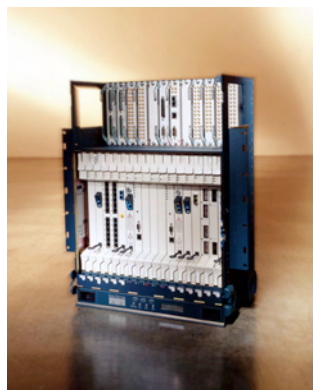


Cisco GSR 12410



Cisco 1-port OC192 POS

- Upcoming...

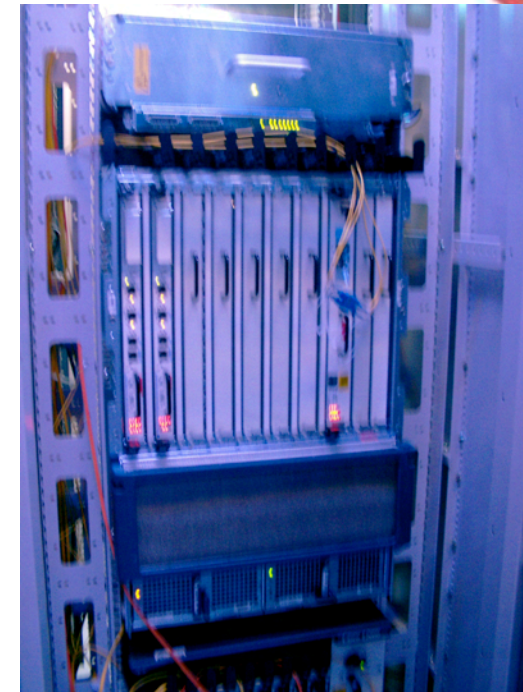


Cisco ONS 15454

HKLight Cross-Connections



- At Present...
 - OC-48c/STM-16
 - To CSTNET HQ, BJ
 - OC-3c/STM-1
 - GLORIAD, Chicago, USA
 - Gigabit Ethernet
 - To ASNET Taiwan, China
 - To NICT JP
 - To HARNET
 - To CUHK
 - **OC-192/STM-48**
 - **To: KISTI, Busan KR**





HK Internet Open Exchange Point

HK IOEP Exposition View



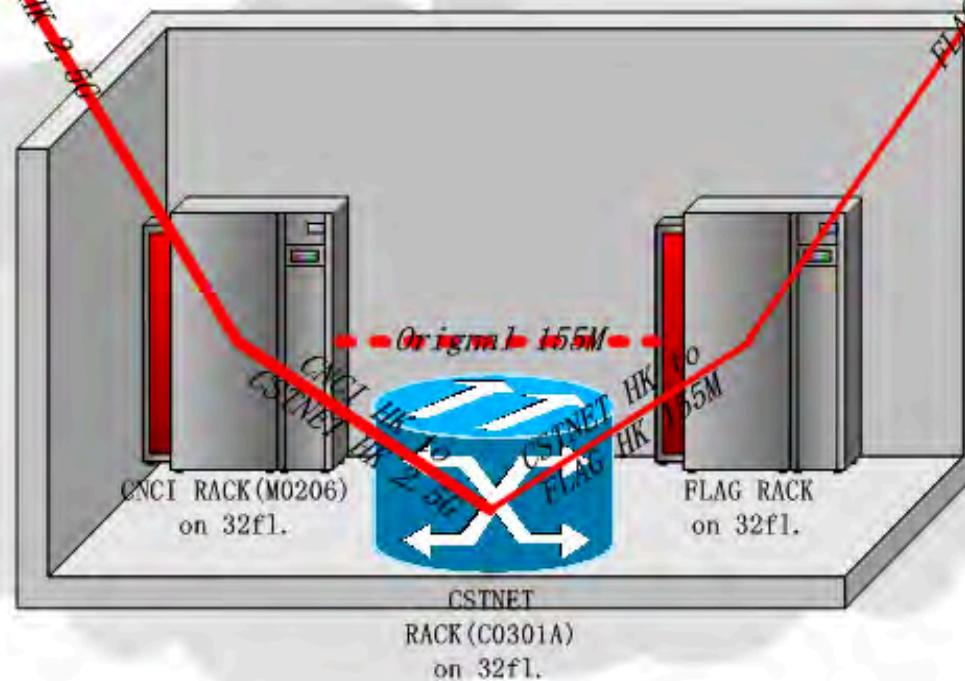
CSTNET
Beijing



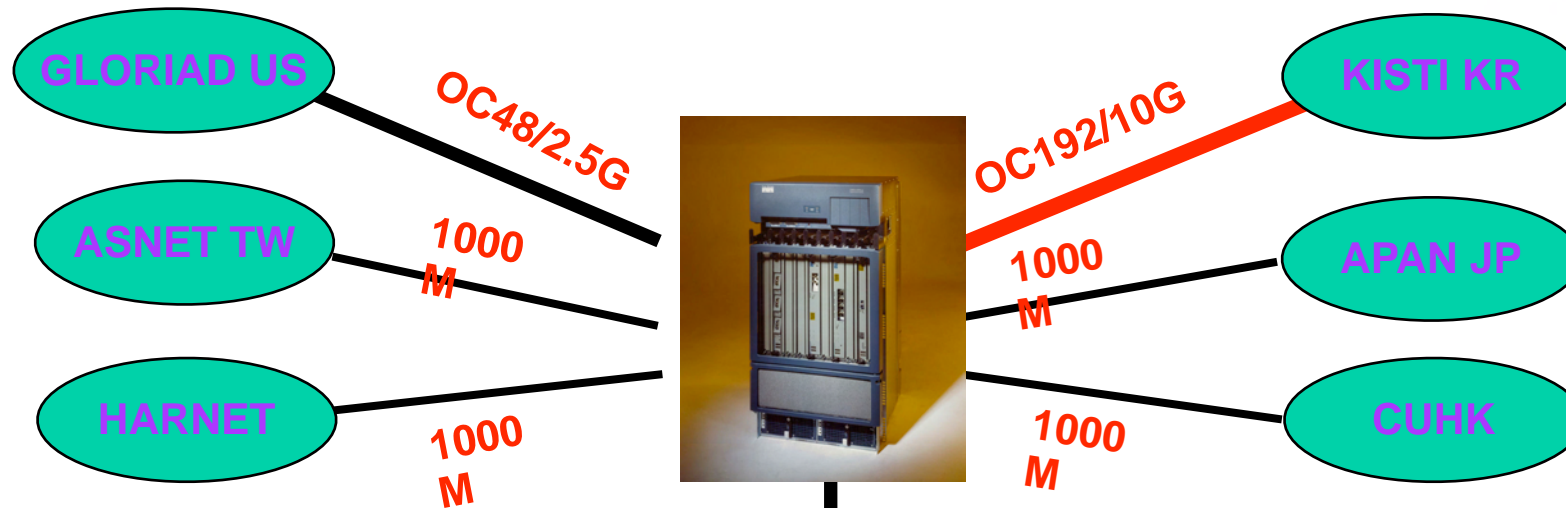
Chicago
USA

CSTNET Beijing to CSCI HK 155M

FLAG HK to Chicago USA 155M

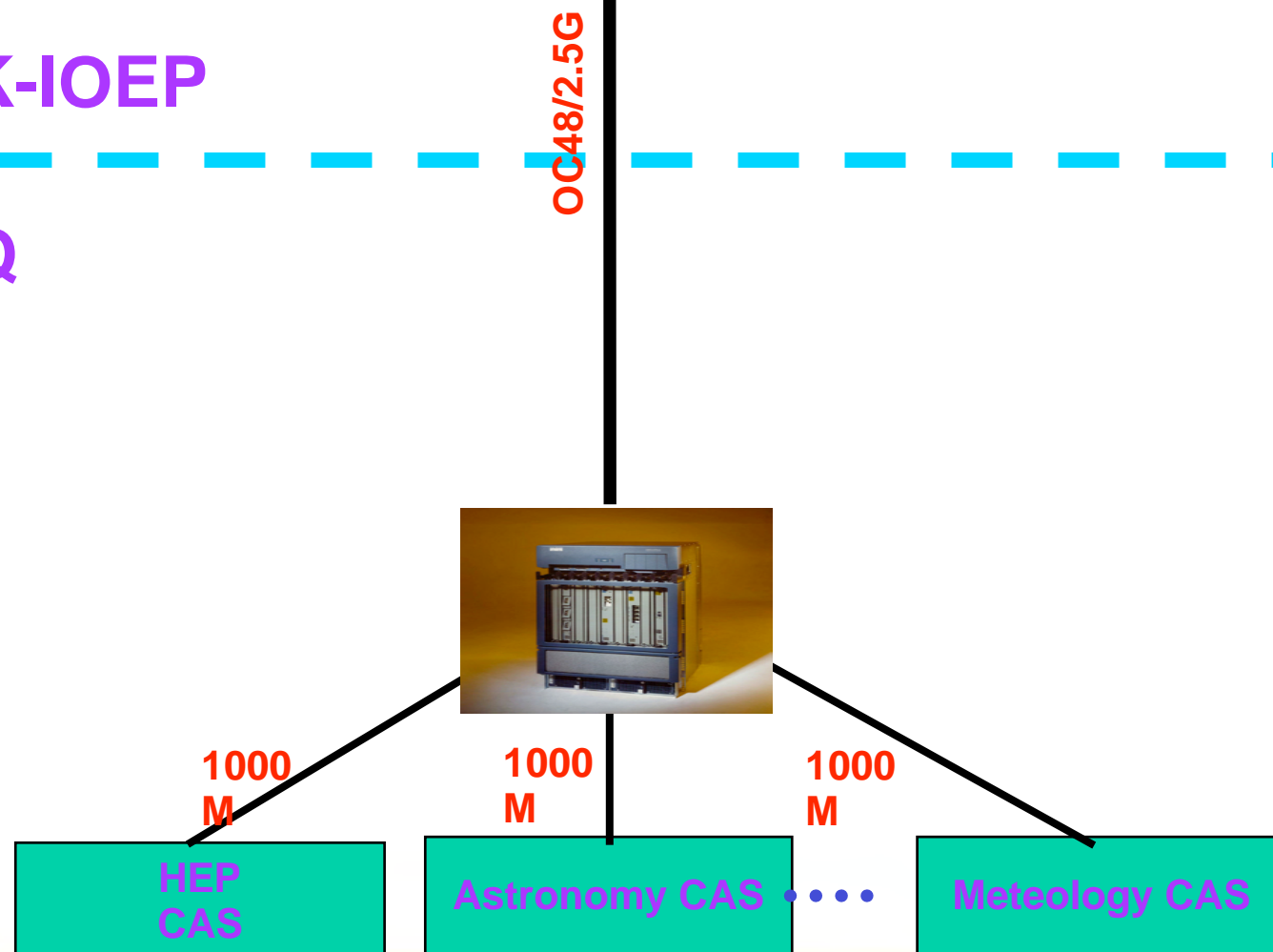


HKLight Network (right now)

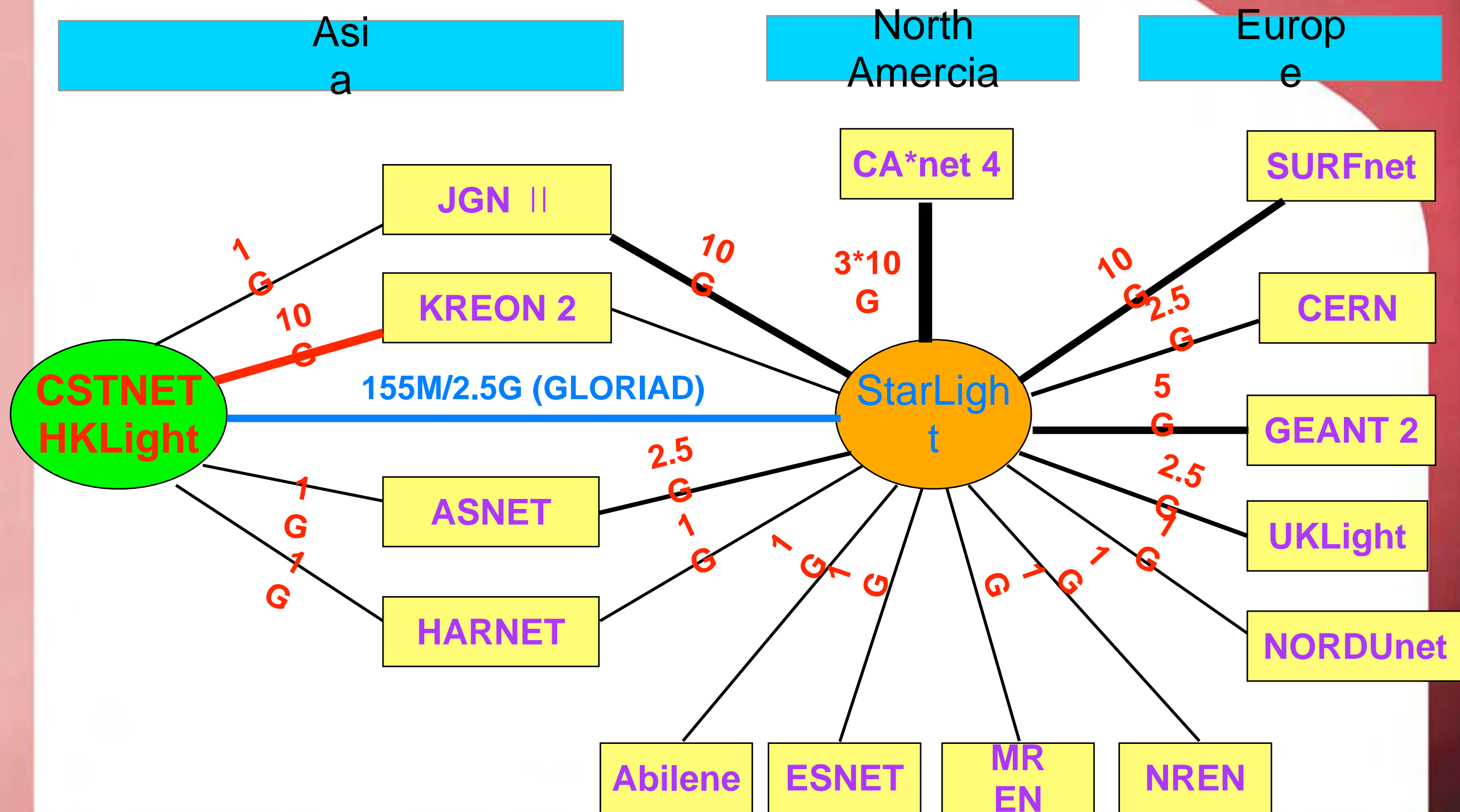


HK-Light/HK-IOEP

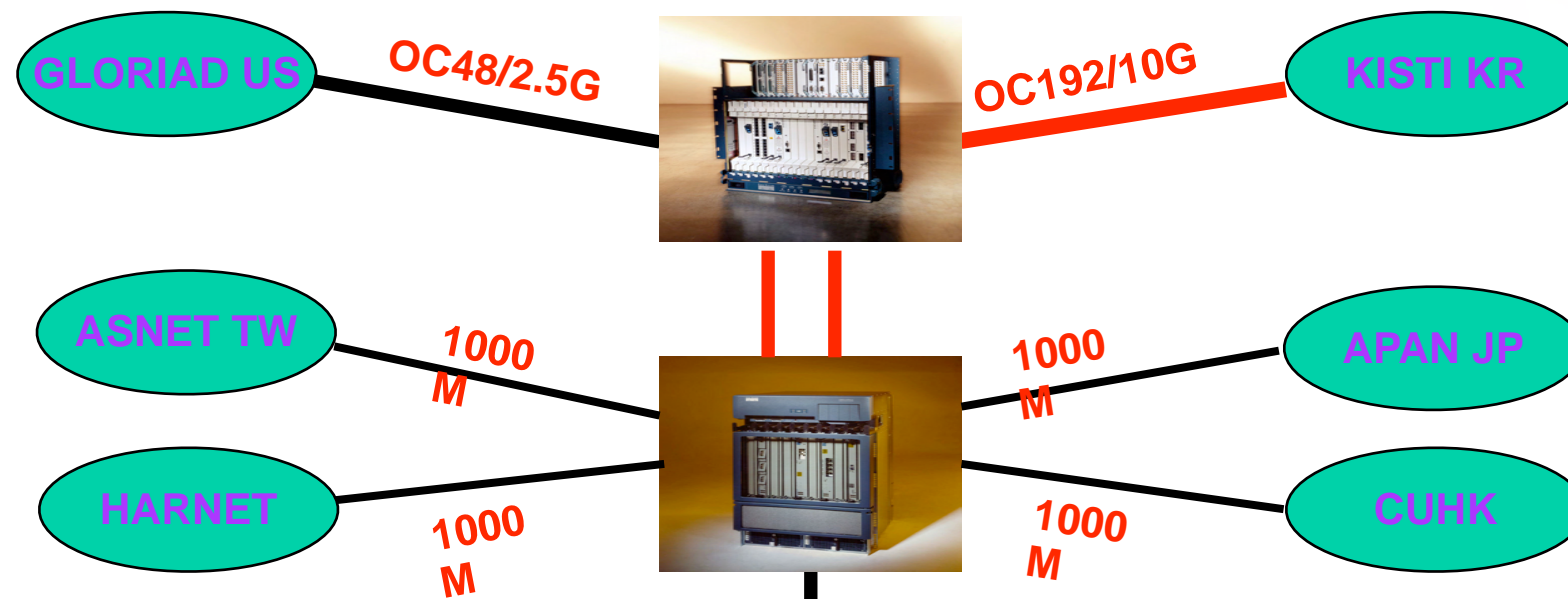
CSTNET HQ
BJ



HKLight vs. StarLight

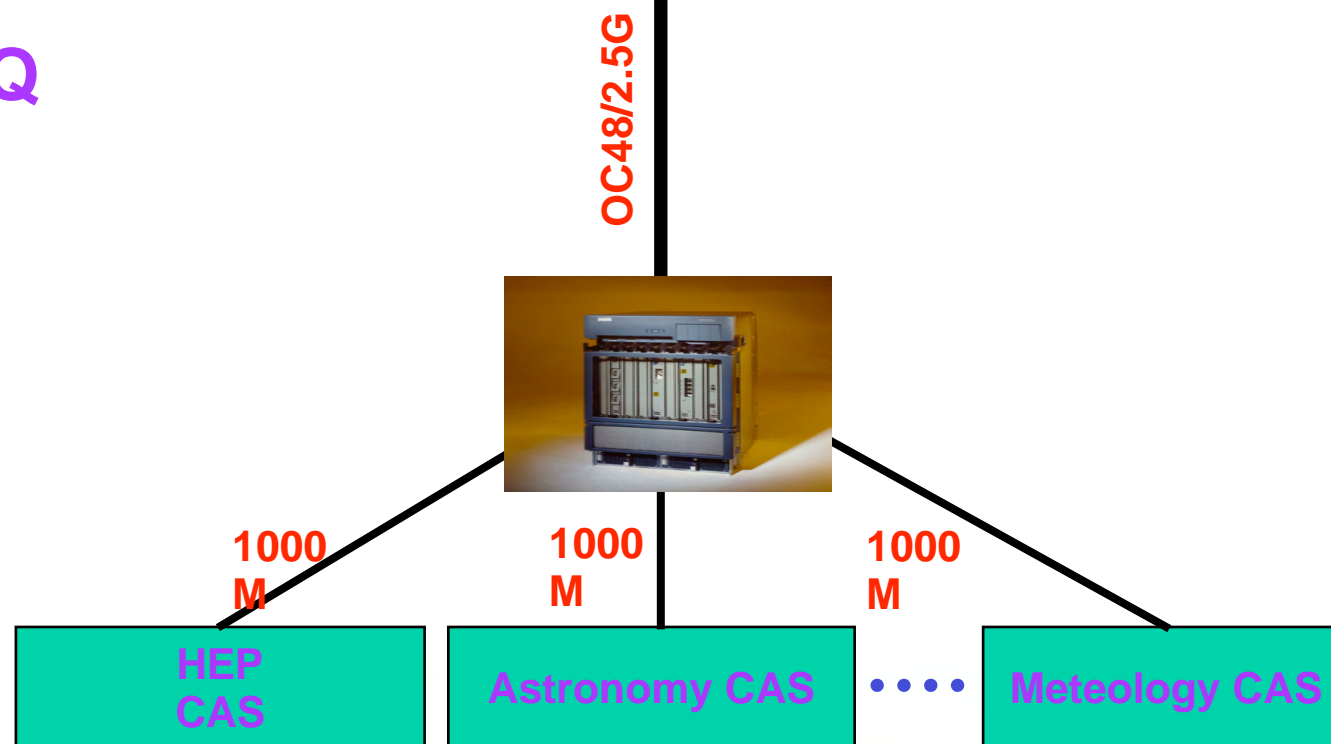


HKLight Hybrid Network (Upcoming)

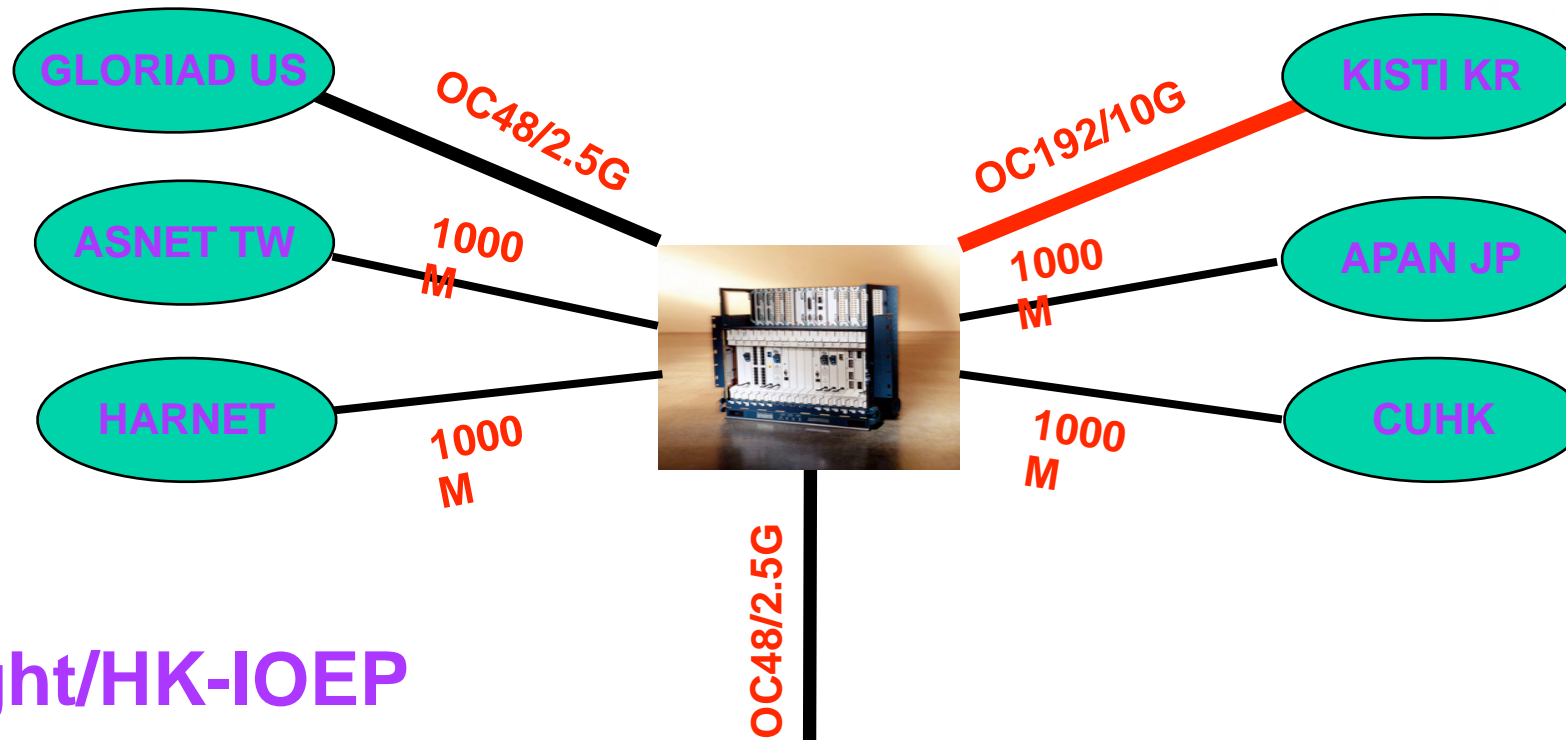


HK-Light/HK-IOEP

CSTNET HQ
BJ

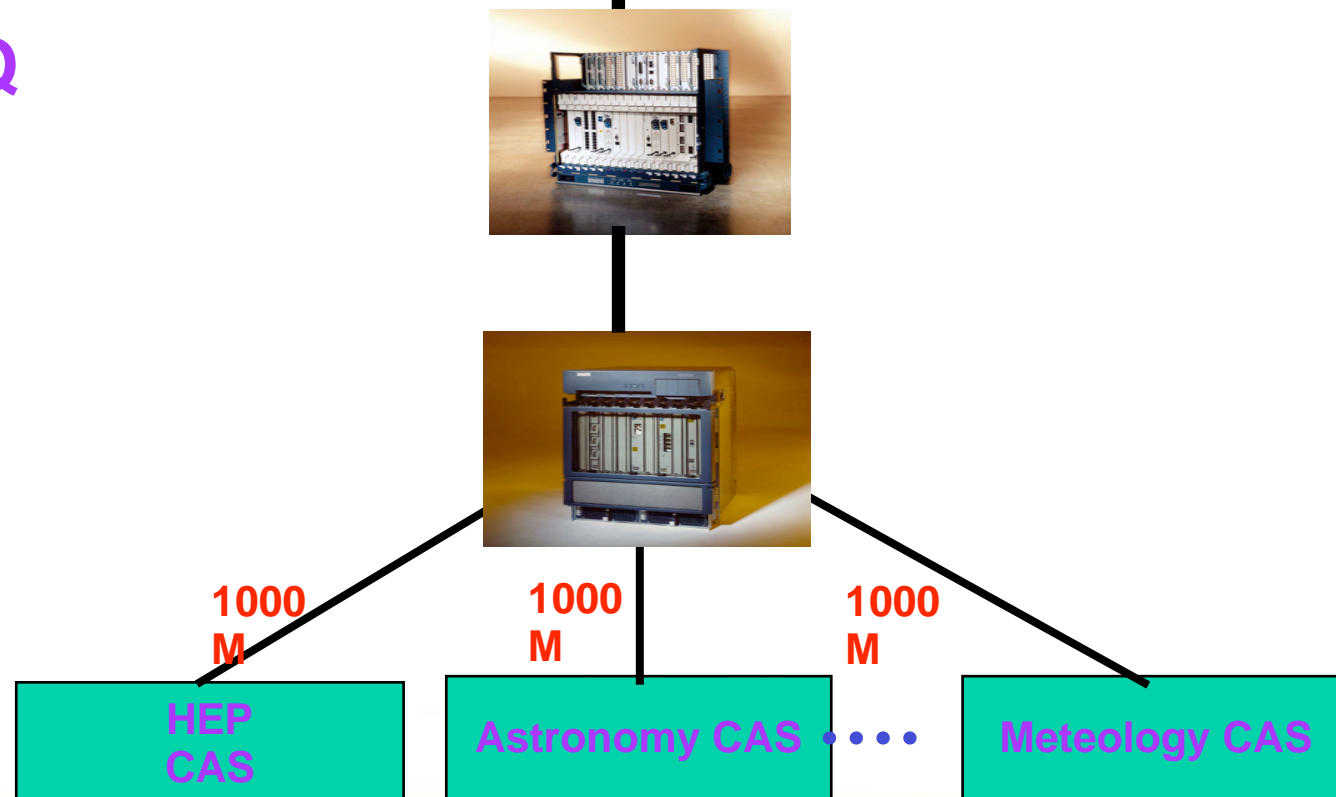


HKLight Hybrid Network (Upcoming)



HK-Light/HK-IOEP

CSTNET HQ
BJ





CSTNET and GLORIAD

GLORIAD Growth-Up on CSTNET



- November 2004
 - To CSTNET HK IOEP(HK-LIGHT): **2.5G**
- December 2004
 - To NICT Japan: **1G**
- January 2005
 - To ASNET Taiwan region: **1G**
- March 2005
 - To CUHK HongKong: **1G**
 - To HK-IX: **1G**
- **July 30, 2005**
 - To **KISTI Busan KR: 10G**

GLORIAD Growth-Up on CSTNET (Cont.)



GLORIAD SCHEMIA



GLORIAD Growth-Up on CSTNET (Cont.)

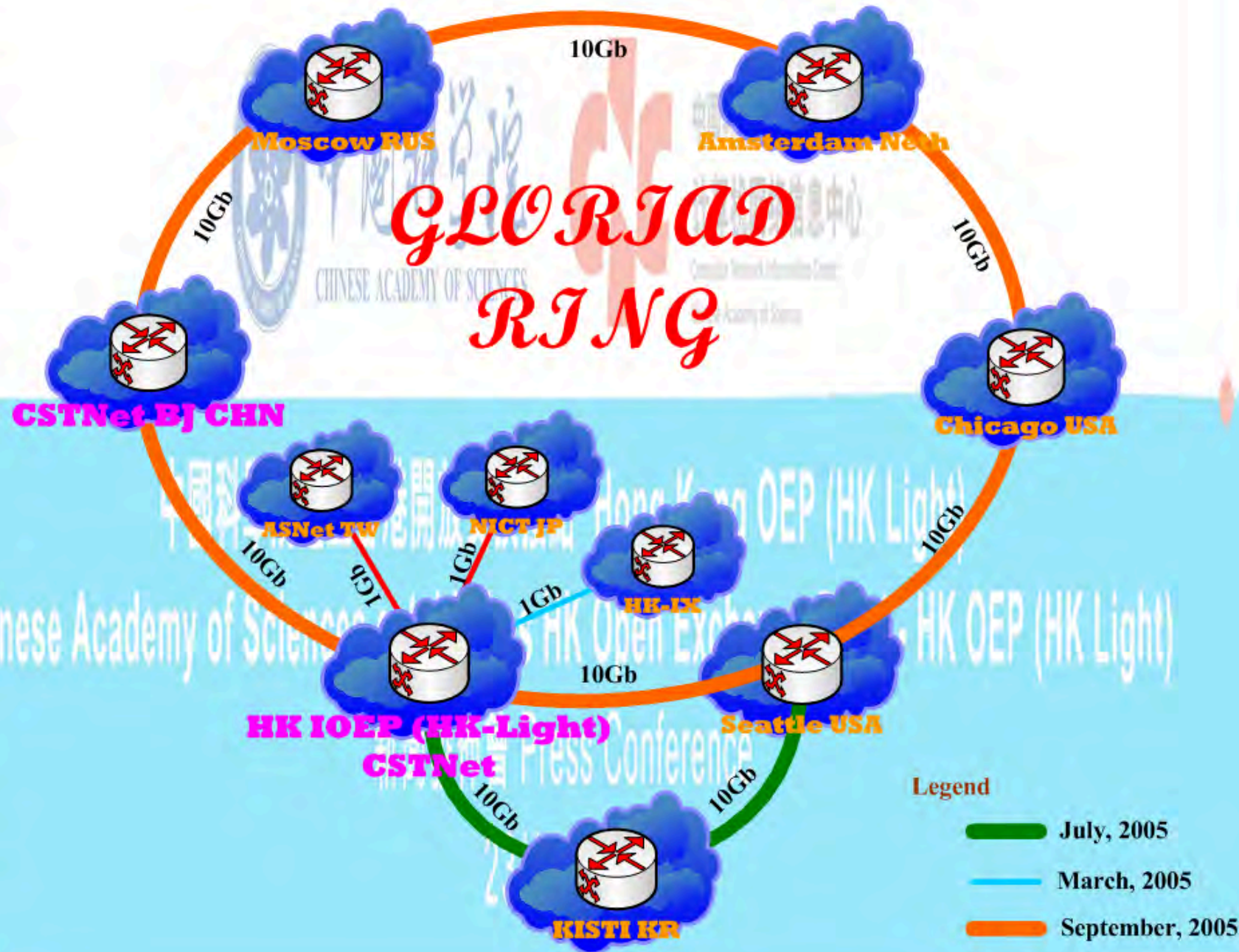


- Looking forward
 - To Chicago US: **2.5G**
 - Great GLORIAD rocket-up to **10G**

GLORIAD Growth-Up on CSTNET (Cont.)



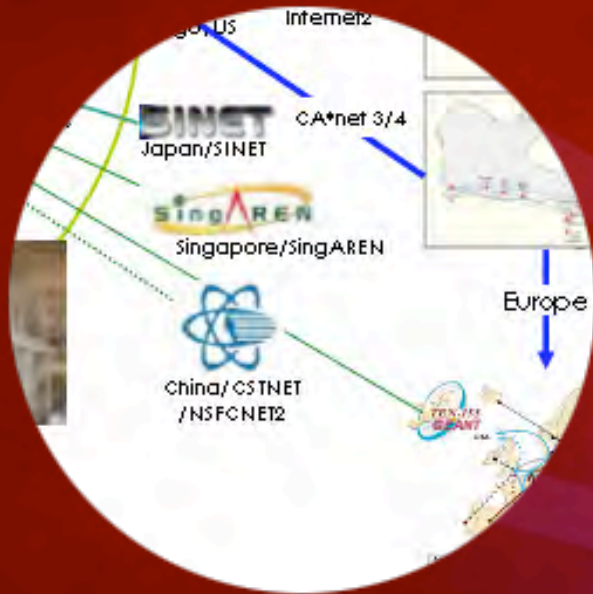
GLORIAD SCHEMATA





THANK YOU

Who in Korea?



- Dr. Young-Hwa Cho, Director, Korea Institute of Science and Technology Information (KISTI)
- Dr. Jysoo Lee, Director, Supercomputing Center, KISTI
- Dr. Ok-Hwan Byeon, Dongkyun Kim, Minsun Lee, KREONet2, KISTI
- Korea Research Education Network (KREONet)

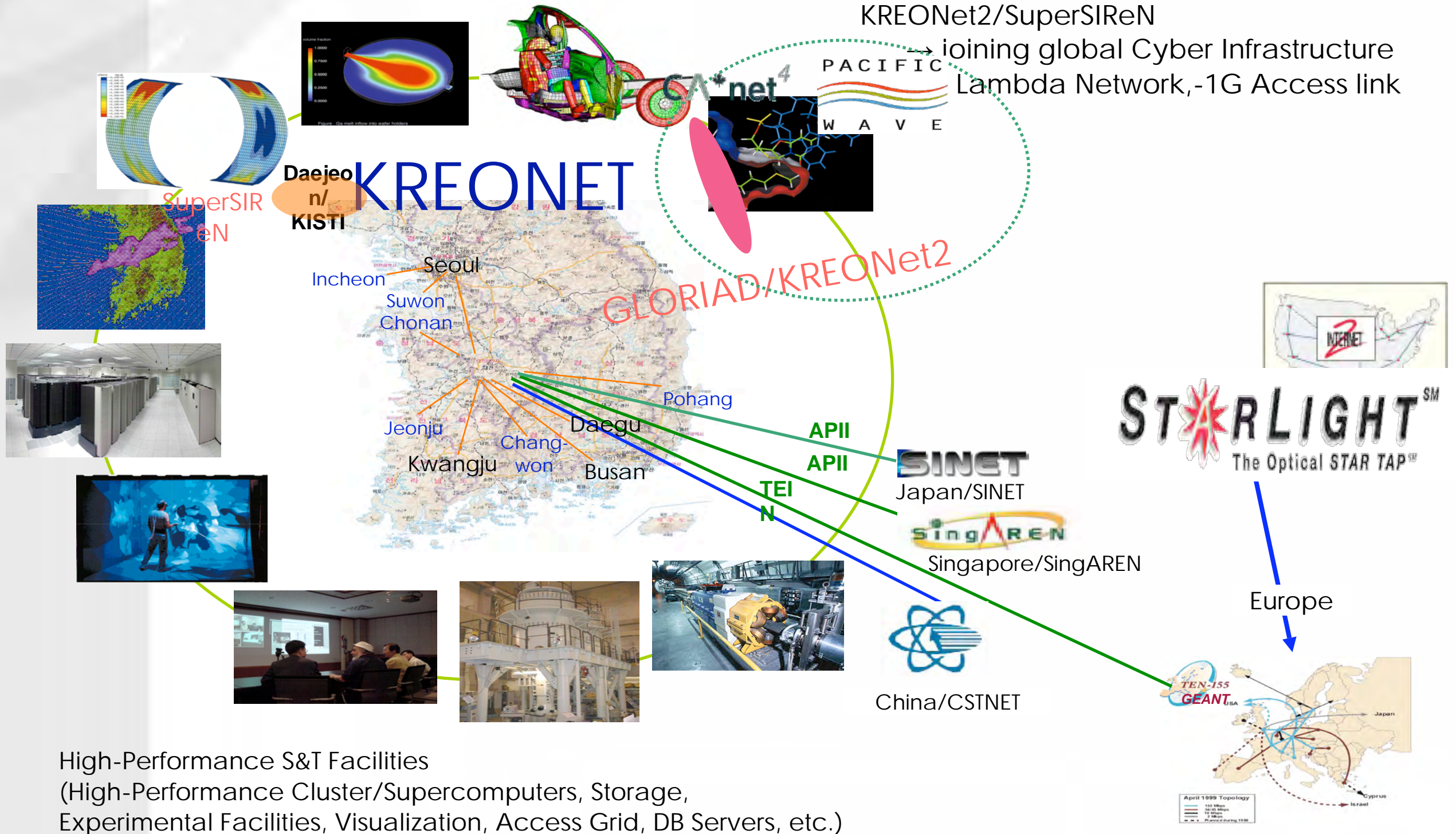
KREONET

- **Korea Research Environment Open NETWORK**
 - **National high-performance science & research network in Korea**
 - About 200 members : Universities, National Research Labs, government organizations, etc.
 - High-capacity access network(1Gbps~10Gbps) : 30 members
 - **Nation-wide optical gigabit backbone network**
 - 12 GigaPoPs in 11 regions (~ 10Gbps)
 - **GLORIAD/KREONet2**
 - **International R&E network based on KREONET**
 - Korea-US : 10Gbps
 - Korea-China (CSTNet/CNIC) : 10Gbps
 - KR-JP, KR-SG, KR-EU (via APII, TEIN) : ~2Gbps
 - **Advanced network engineering**
 - IPv6, QoS, Multicast, Traffic Measurement, Security, etc.
 - Nation-wide 6KREONET and Mbone
 - **Supporting advanced applications : e-Science and Grid**

GLORIAD/KREONet2

Grid/e-Science based KREONET/
KREONet2/SuperSIRen

Joining global Cyber Infrastructure
Lambda Network, -1G Access link



High-Performance S&T Facilities
(High-Performance Cluster/Supercomputers, Storage,
Experimental Facilities, Visualization, Access Grid, DB Servers, etc.)

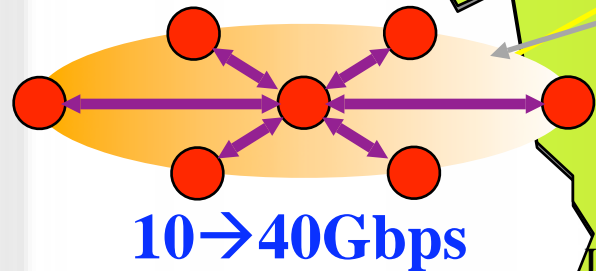
Backbone Networks

Supercomputing Facilities

- IBM (4,236 Gflops) Service
- NEC (240 Gflops) Service
- HP SMP (115Gflops) Service
- TeraCluster (221.6Gflops) service
- SeeMore (CAVE)
- Access Grid

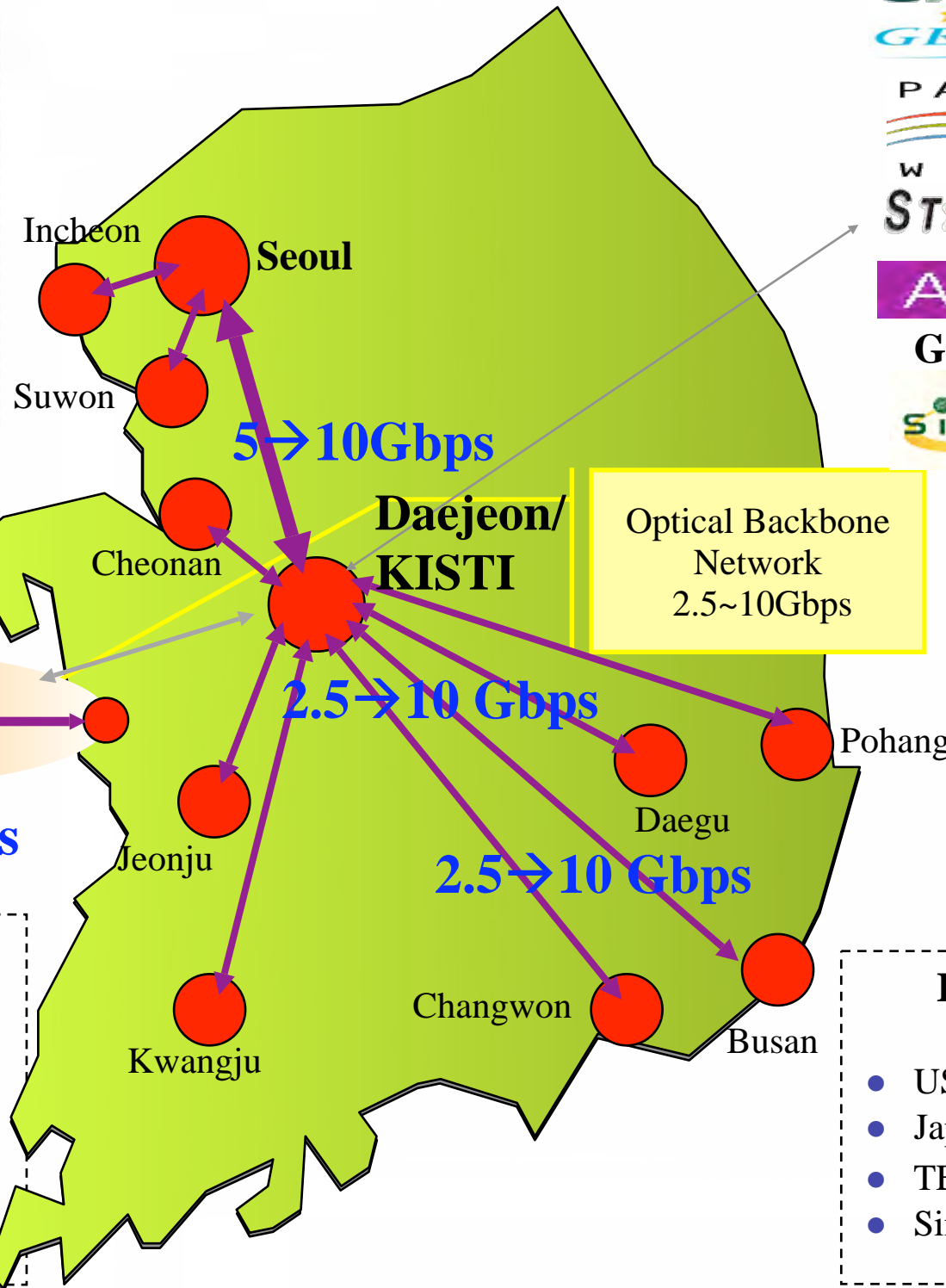


SuperSIREn



SuperSIREn

- Optical 10Gbps Backbone
- High Speed Wireless 1.25Gbps
- Next Generation Application Support
- Collaboration Environment Support
- 7 Academic Research Institutes



Optical Backbone Network
2.5~10Gbps

KREONET

- 11 regions, 12 GigaPoPs
- 24 x 7 Operation Services
- Optical 2.5~10Gbps Backbone Network
- SONET/SDH, GigE, ATM

International Link(with GLORIAD-KREONet2/APII/TEIN)

- US(STAR TAP) : 1.2Gbps -> 10Gbps
- Japan (Hyunhai/Genkai) : 1Gbps
- TEIN (Geant) : 155Mbps
- Singapore (SingAREN) : 17Mbps

Who in Netherlands?



- ☉ Kees Neggers, Executive Director, SURFnet, Amsterdam, The Netherlands
- ☉ Erik-Jan Bos, Chief Network Engineer, SURFnet, Amsterdam, The Netherlands
- ☉ SURFnet, Netherlight Network

Who in Canada?

☉ Bill St. Arnaud, Senior Director,
Advanced Networks, CANARIE

☉ Rene' Hatem, Thomas Tam, Chief
network engineers, CANARIE

☉ CANARIE



Who in USA



**Oak Ridge
National
Laboratory**

- Greg Cole and Natasha Bulashova, Research Director/Research Scientist, UT-ORNL Joint Institute for Computational Sciences, PI/Co-PI, NSF GLORIAD Agreement
- Anita Colliate Howard (Research Assoc.), John Lankford (Network Architect/Engineer), Lyn Prowse-Bishop (Exec. Asst), 2 REU students (coming), Ana Preston, Predrag
- Sponsor: National Science Foundation (~\$9.5M since 1998), Other sponsors of US-Russia work: NATO, Sun Microsystems, US State Department, Ford Foundation, Eurasia Foundation, US AID
- Many other partners: Harvey Newman (Chief Science Advisor) (~ 40 other scientists/educators/others on advisory groups), Starlight, Pacific Wave, others
- Networks: National Lambda Rail, ESnet, NASA R&E Networks, Internet2/Abilene (peering), Federal Networks, etc.
- Also, important contributor/participant in GLIF

Who Ties it Together?

○ VSNL (formerly Tyco Global Networks):
Trans-Atlantic and Trans-Pacific
Provider (with FLAG); is important
service provider and research partner
since the beginning of GLORIAD

○ Russia: RosTelecomm

○ China: China Netcom

○ North America: CANARIE



Presentation

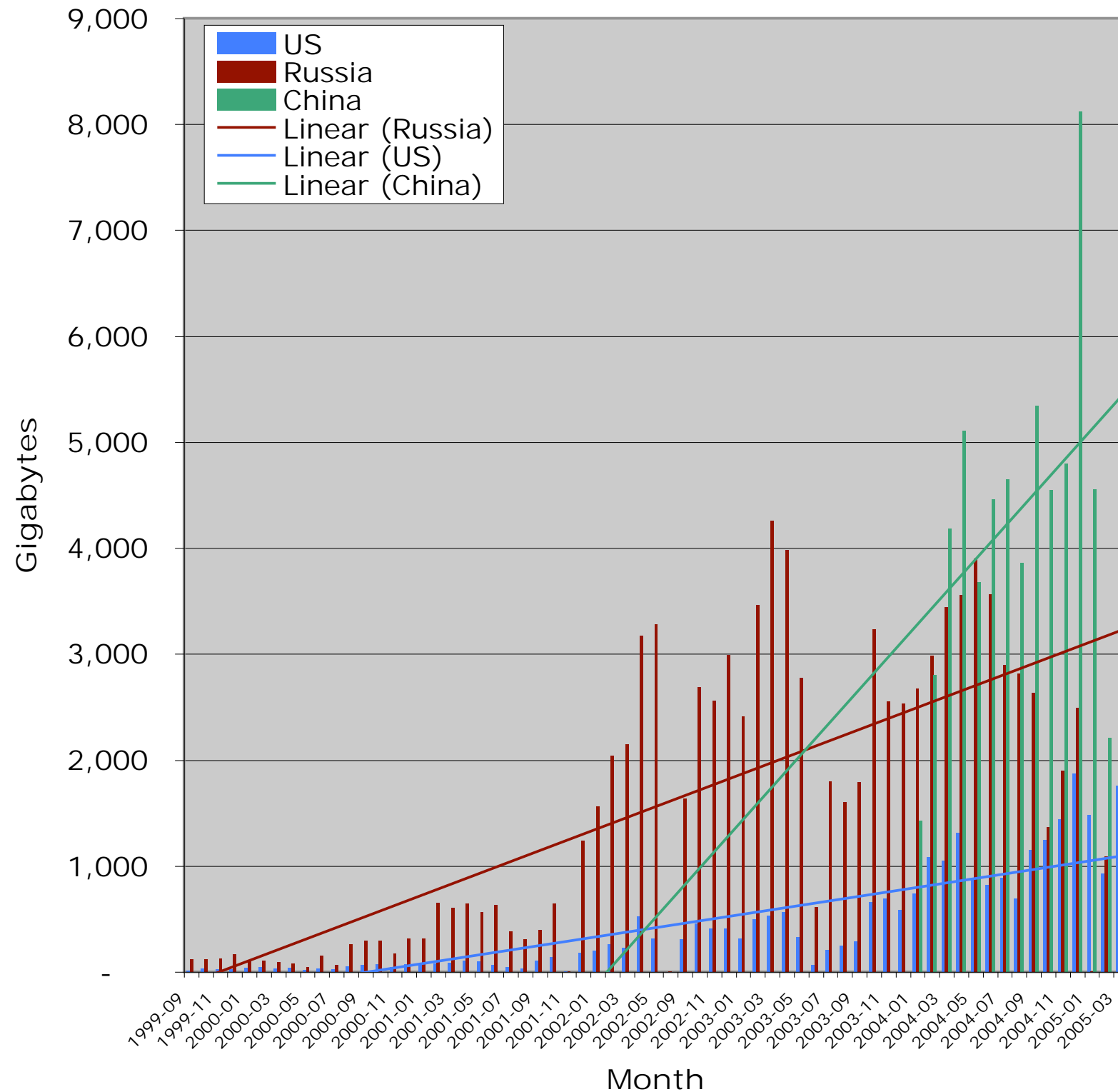
- Background/History
- GLORIAD Today, Tomorrow
- Partners and Networks
- **Measurement Program**
- Application Areas
- Education/Outreach Activities
- Challenges, Issues

Monitoring Program

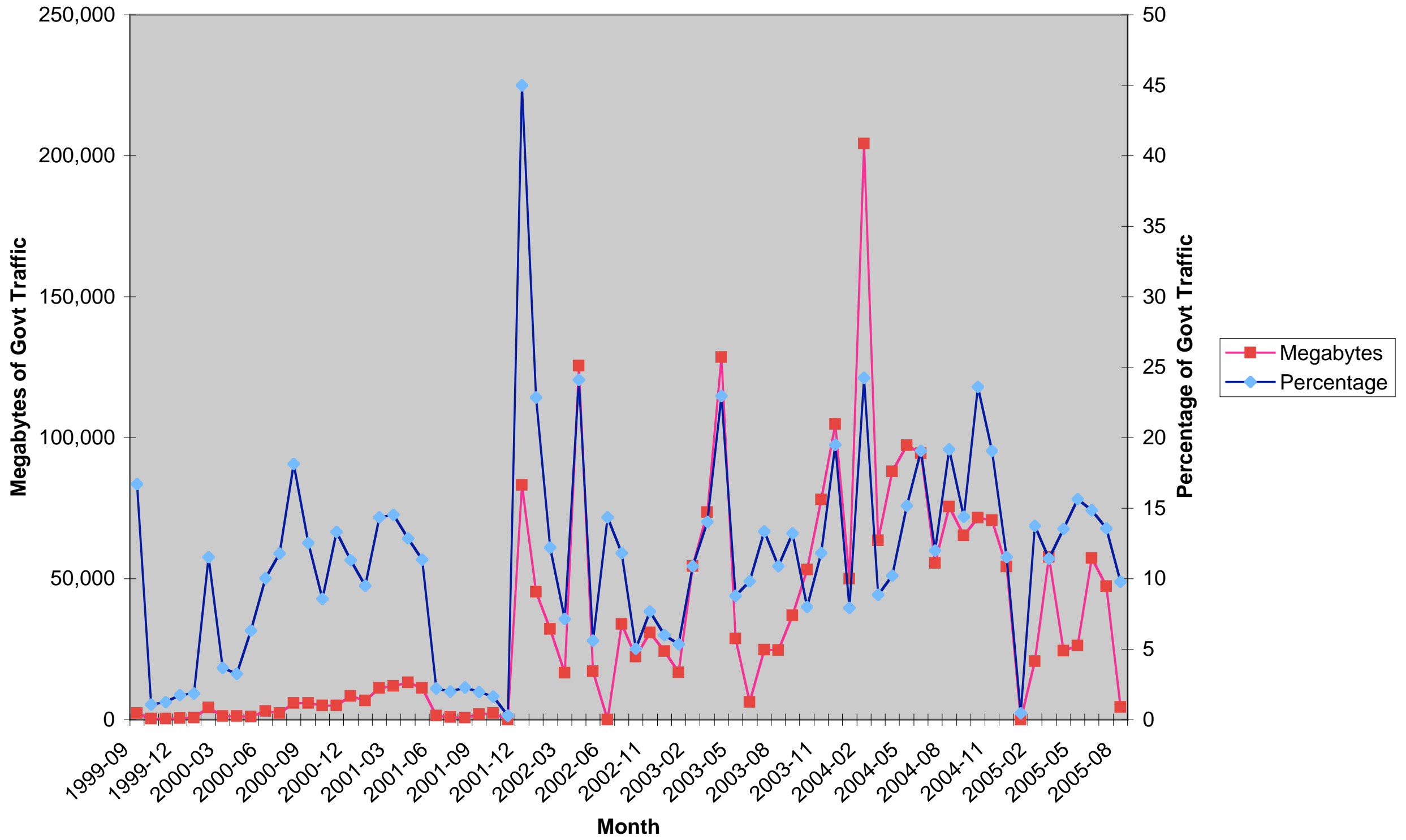
- Utilization Monitoring (netflow-based, circuit up-time, utilization, institutional and application reporting, MonALISA)
- Performance Monitoring (Intl AMP Mesh w/NLANR)
- Security Monitoring (BRO box in Chicago for research)

Overall Traffic Growth

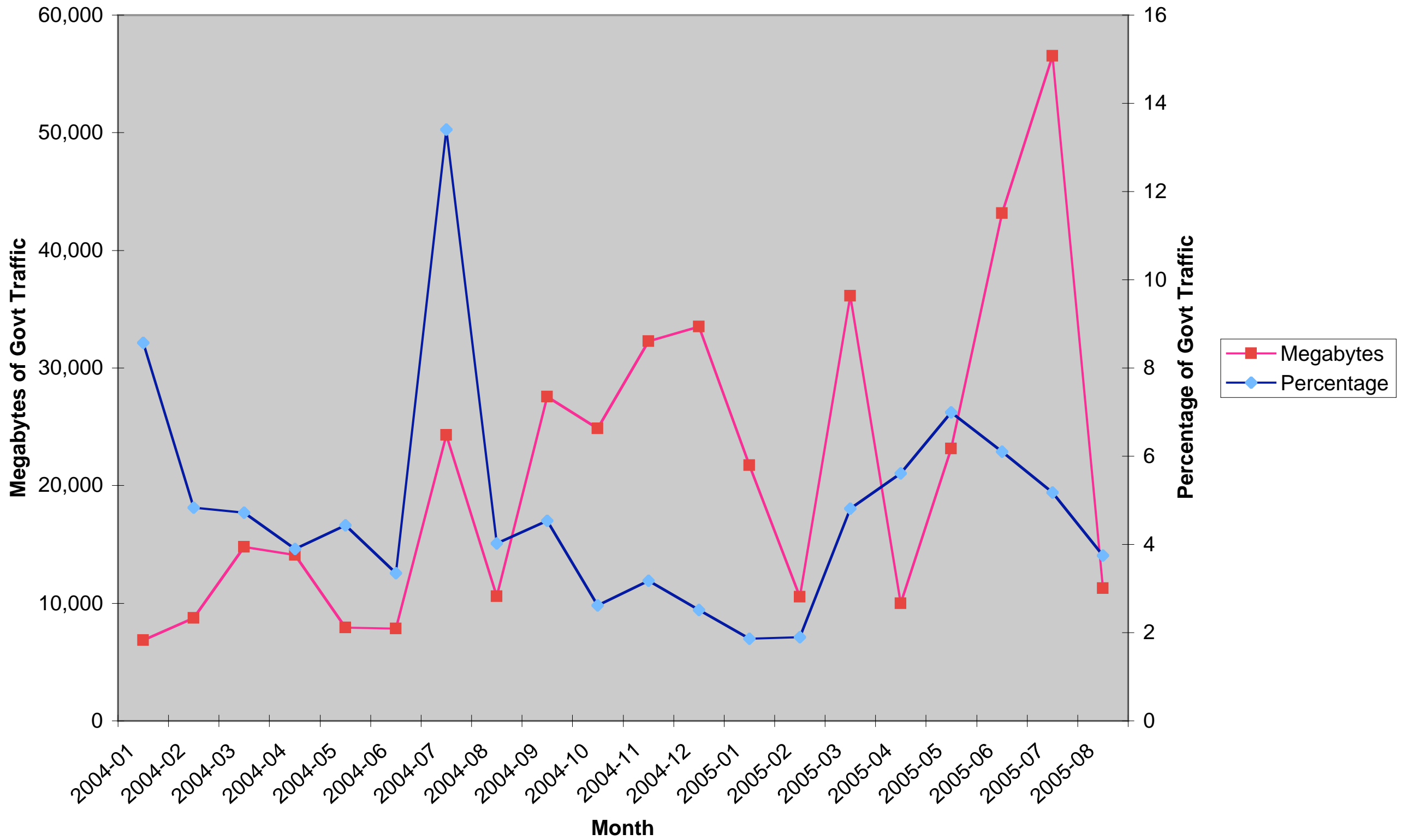
GLORIAD Data Flows



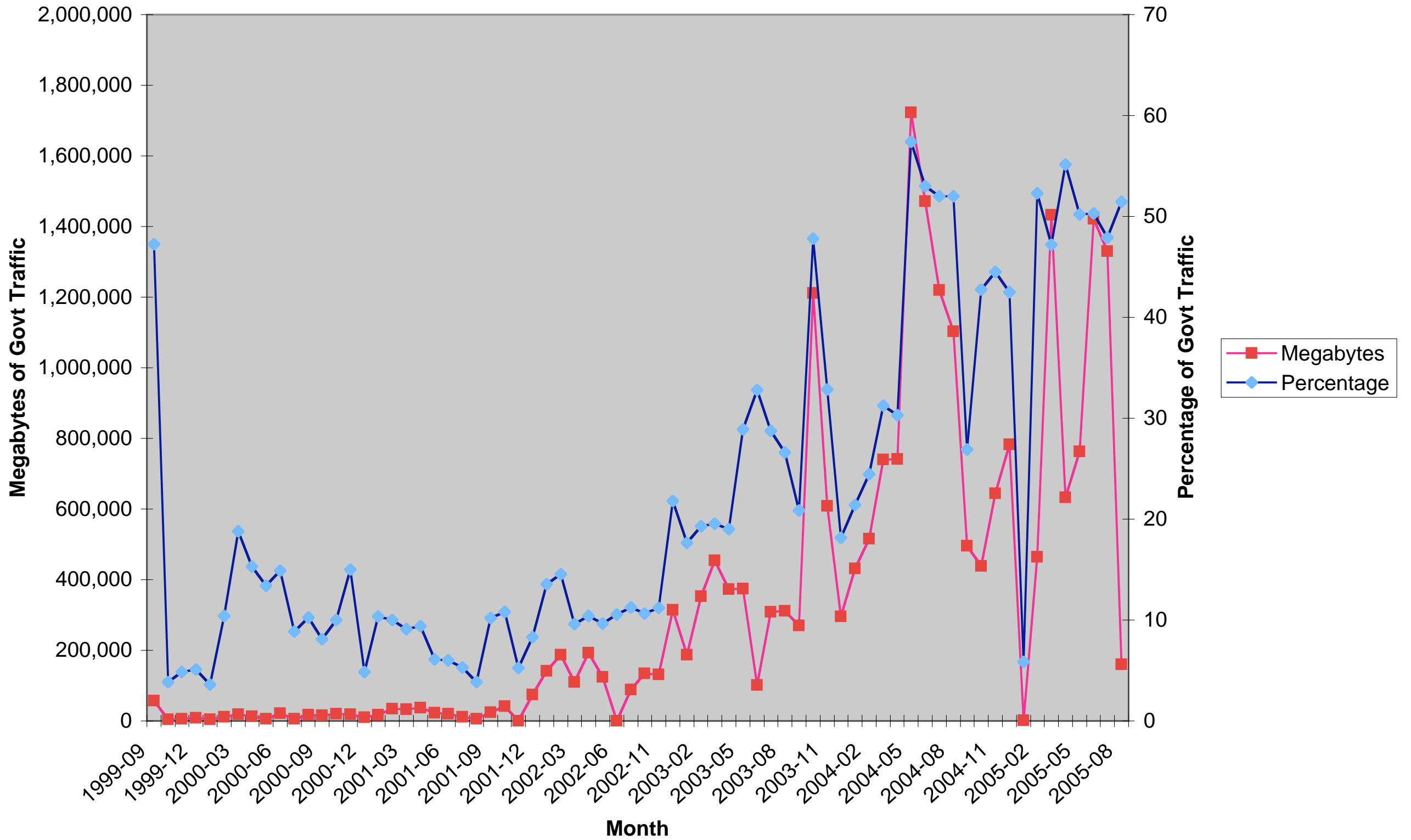
Russia to US Traffic



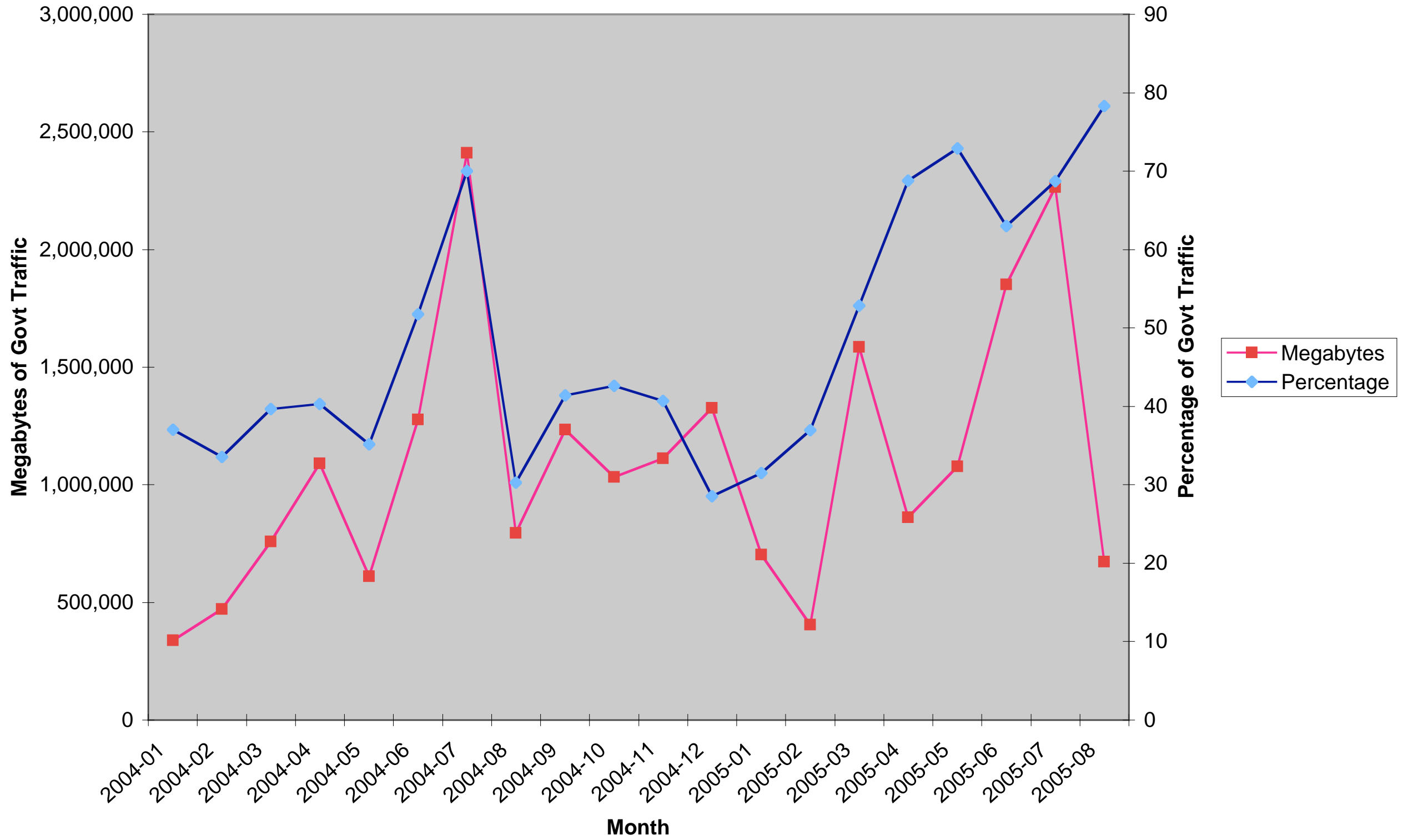
China to US Traffic



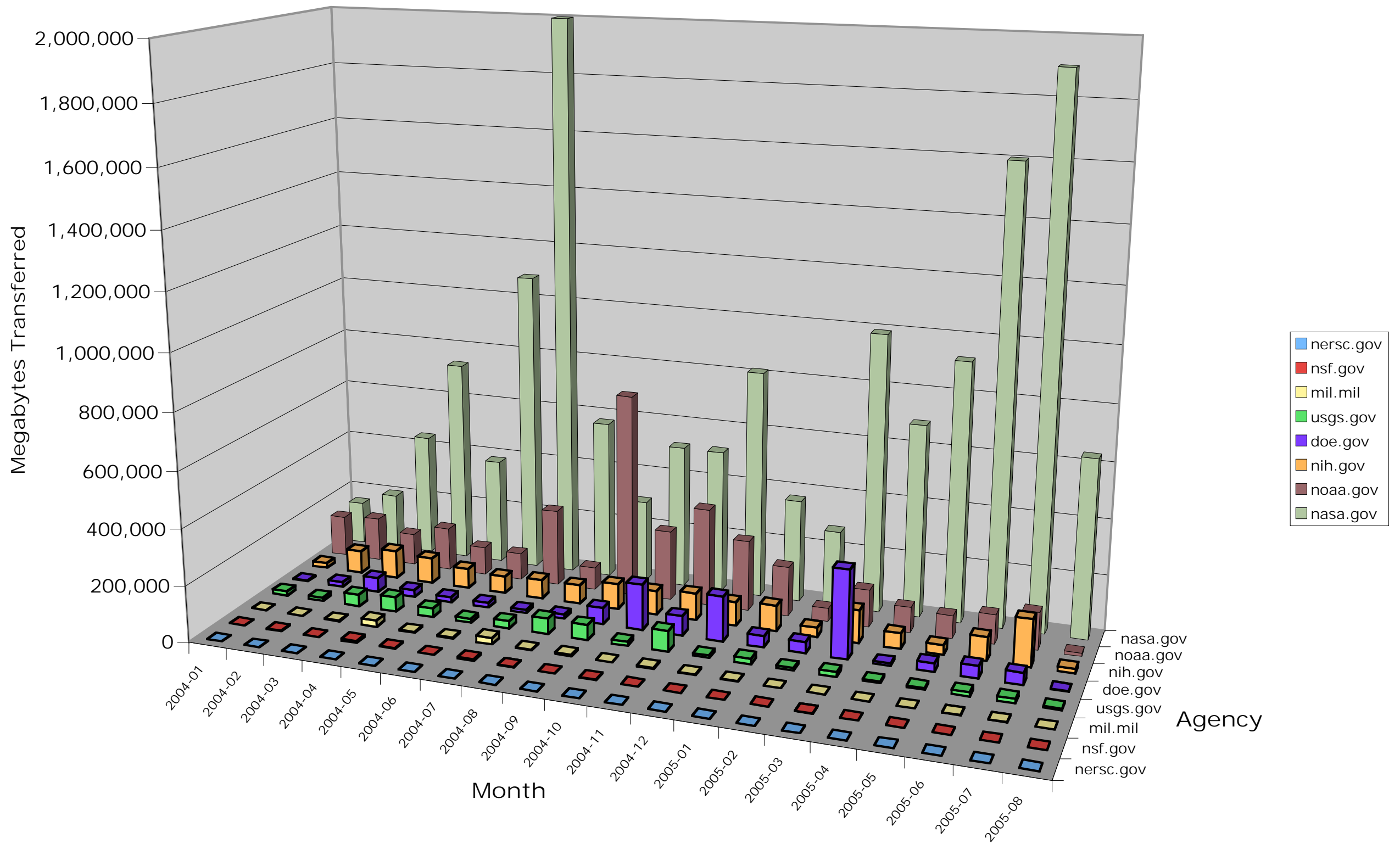
US to Russia Traffic



US to China Traffic



Top US Government Agencies Sending Data to China



GLORIAD Traffic from China

January, 2004

to Russia

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
Moscow State University	Moscow	6,407	8.13
FREEnet Web	Moscow	6,050	7.68
Joint Institute for Nuclear Research (Dubna)	Dubna	4,861	6.17
Bauman Moscow State Tech Univ	Moscow	3,412	4.33
FREEnet		2,575	3.27
Institute for Information Transmission Problems	Moscow	2,491	3.16
Tomsk Education Network	Tomsk	2,337	2.96
Joint Institute for Nuclear Research (Dubna)	Dubna	2,193	2.78
nsc.ru (Novosibirsk)	Novosibirsk	2,007	2.55
Institute for High Energy Physics (Protvino)	Protvino	1,946	2.47
troitsk.ru	Troitsk	1,432	1.82
Kurchatov Inst	Moscow	1,336	1.69
nsk.ru (Novosibirsk)	Novosibirsk	1,274	1.62
Russian Academy of Sciences	Moscow	1,024	1.30
Russian Space Science Internet	Moscow	814	1.03
Institute of Theoretical and Experimental Physics	Moscow	754	0.96
Kurchatov Inst	Moscow	744	0.94
RELARN	Moscow	730	0.93
Ural State University	Ekaterinburg	680	0.86
Krasnoyarsk Science Center	Krasnoyarsk	675	0.86
Moscow Technical Univ of Communications & Informatic	Moscow	670	0.85
Other		34,400	43.64
Total		78,811	100.00

to US

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
U of Illinois Urbana-Champaign	Urbana	8,072	12.69
Columbia University	New York	7,660	12.05
Princeton University	Princeton	4,087	6.43
U of Michigan	Ann Arbor	3,112	4.89
U of Chicago	Chicago	2,044	3.21
U of Tennessee, Knoxville	Knoxville	1,913	3.01
National Oceanic and Atmosphere Administration	Suitland	1,844	2.90
U of Colorado Boulder	Boulder	1,800	2.83
Rochester Inst of Tech	Rochester	1,450	2.28
U of Maryland	College Park	1,406	2.21
Univ of Georgia-Athens	Athens	1,367	2.15
Georgia Inst. Of Technology	Atlanta	1,359	2.14
University of Hawaii	Honolulu	1,167	1.84
Fermi National Laboratory	Batavia	1,158	1.82
Univ of Delaware	Newark	1,130	1.78
Colorado State University	Fort Collins	1,044	1.64
U of Illinois Chicago	Chicago	960	1.51
U of Oklahoma	Norman	948	1.49
Natl Inst of Standards and Tech	Boulder	828	1.30
Boston University	Boston	755	1.19
Oak Ridge Natl Lab	Oak Ridge	672	1.06
Other		18,831	29.58
Total		63,608	100.00

GLORIAD Traffic from Russia

January, 2004

to China

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
China (unidentified)		9,075	65.78
Chinese Academy of Sciences (general)	Beijing	1,392	10.09
China Education and Research Network		324	2.35
Academy of Math and Systems Science, CAS	Beijing	303	2.19
Institute of Software, CAS	Beijing	77	0.56
Lanzhou, China, CAS	Lanzhou	12	0.09
Library of Chinese Academy of Sciences	Beijing	10	0.07
China Academy of Sciences		9	0.06
Institute of Zoology, CAS	Beijing	7	0.05
Institute of Automation, CAS	Beijing	5	0.04
Institute of Mechanics, CAS	Beijing	4	0.03
China Internet Network Information Ctr, CAS	Beijing	4	0.03
Beijing Institute of System Engineering, CAS	Beijing	4	0.03
Institute of Physics & Chemistry, CAS	Beijing	4	0.03
Guangzhou Institute of Chemistry, CAS	Guangzhou	3	0.02
Institute of Hydrobiology, CAS	Beijing	2	0.02
Institute of Atmospheric Physics, CAS	Beijing	2	0.02
Institute of Computing Technology, CAS	Beijing	2	0.01
Institute of Microbiology, CAS	Beijing	1	0.01
Institute of Chemistry, CAS	Beijing	1	0.01
Institute of Biophysics, CAS	Beijing	1	0.01
Other		2,555	18.50
Total		13,797	100.00

to US

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
Fermi National Laboratory	Batavia	13,256	2.90
U of Michigan	Ann Arbor	12,467	2.73
Purdue University - W Lafayette	West Lafayette	12,333	2.70
Stanford University	Los Angeles	11,680	2.56
U of California San Diego	La Jolla	11,478	2.51
Mass. Inst. of Technology	Cambridge	9,338	2.04
Georgia Inst. Of Technology	Atlanta	9,232	2.02
Princeton University	Princeton	8,862	1.94
Brookhaven National Laboratory	Long Island	7,911	1.73
Jefferson Lab	Newport New	7,238	1.58
Boston University	Boston	6,912	1.51
U of Pennsylvania	Philadelphia	6,557	1.44
U of California Los Angeles	Los Angeles	6,171	1.35
New York University	New York	5,667	1.24
Univ of California Davis	Davis	5,566	1.22
State U of NY at Buffalo	Buffalo	5,450	1.19
Iowa State University	Ames	5,287	1.16
Michigan State University	East Lansing	5,239	1.15
Rochester Inst of Tech	Rochester	5,216	1.14
U of S California	Los Angeles	5,110	1.12
Carnegie Mellon University	Pittsburgh	5,006	1.10
Other		291,133	63.67
Total		457,111	100.00

GLORIAD Traffic from US

January, 2004

to Russia

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
Moscow State University	Moscow	172,059	12.05
Chernogolovka Science Center	Chernogolovk	168,853	11.83
Russian Space Science Internet	Moscow	94,352	6.61
Russian Academy of Sciences	Moscow	82,351	5.77
nsc.ru (Novosibirsk)	Novosibirsk	72,436	5.07
Radio Moscow State University Network	Moscow	71,069	4.98
smr.ru (Samara)	Samara	64,951	4.55
Joint Institute for Nuclear Research (Dubna)	Dubna	45,694	3.20
Bauman Moscow State Tech Univ	Moscow	30,960	2.17
RELARN	Moscow	25,500	1.79
FREEnet Web	Moscow	24,028	1.68
Institute for High Energy Physics (Protvino)	Protvino	23,603	1.65
irk.ru (Irkutsk)	Irkutsk	20,222	1.42
Russian IR Cache	Moscow	18,548	1.30
Tomsk Education Network	Tomsk	17,226	1.21
nsk.ru (Novosibirsk)	Novosibirsk	16,862	1.18
Tomsk State University	Tomsk	15,375	1.08
Institute for Information Transmission Problems	Moscow	15,100	1.06
Saratov State University	Saratov	15,024	1.05
Ural Branch of the Russian Academy of Science	Ekaterinburg	11,852	0.83
Kurchatov Inst	Moscow	11,758	0.82
Other		410,050	28.70
Total		1,427,873	100.00

to China

<i>Institution</i>	<i>City</i>	<i>Megabytes</i>	<i>% Total</i>
Chinese Academy of Sciences (general)	Beijing	317,151	41.38
Institute of Atmospheric Physics, CAS	Beijing	139,011	18.14
Natl Astronomical Observatory, CAS	Beijing	100,627	13.13
China (unidentified)		65,672	8.57
Institute of Hydrobiology, CAS	Beijing	61,506	8.02
Institute of Computing Technology, CAS	Beijing	11,036	1.44
Library of Chinese Academy of Sciences	Beijing	7,660	1.00
Guangzhou Institute of Chemistry, CAS	Guangzhou	7,448	0.97
Academy of Mathematics and Systems Science, CAS	Beijing	6,820	0.89
Institute of Software, CAS	Beijing	6,678	0.87
Academy of Preventive Medicine, CAS	Beijing	5,049	0.66
Institute of Computational Math and S/E Computing, CA	Beijing	4,551	0.59
Institute of Zoology, CAS	Beijing	4,399	0.57
Institute of Biophysics, CAS	Beijing	4,169	0.54
Lanzhou, China, CAS	Lanzhou	3,829	0.50
Institute of Automation, CAS	Beijing	3,706	0.48
Institute of Theoretical Physics, CAS	Beijing	2,437	0.32
Institute of Microbiology, CAS	Beijing	2,128	0.28
Institute of Mechanics, CAS	Beijing	1,929	0.25
China Academy of Sciences (other)		1,840	0.24
China Internet Network Information Ctr, CAS	Beijing	1,192	0.16
Other		7,596	1.00
Total		766,435	100.00

GLORIAD Traffic to/from Europe-China

24 Hour Period: June 6-7, 2005

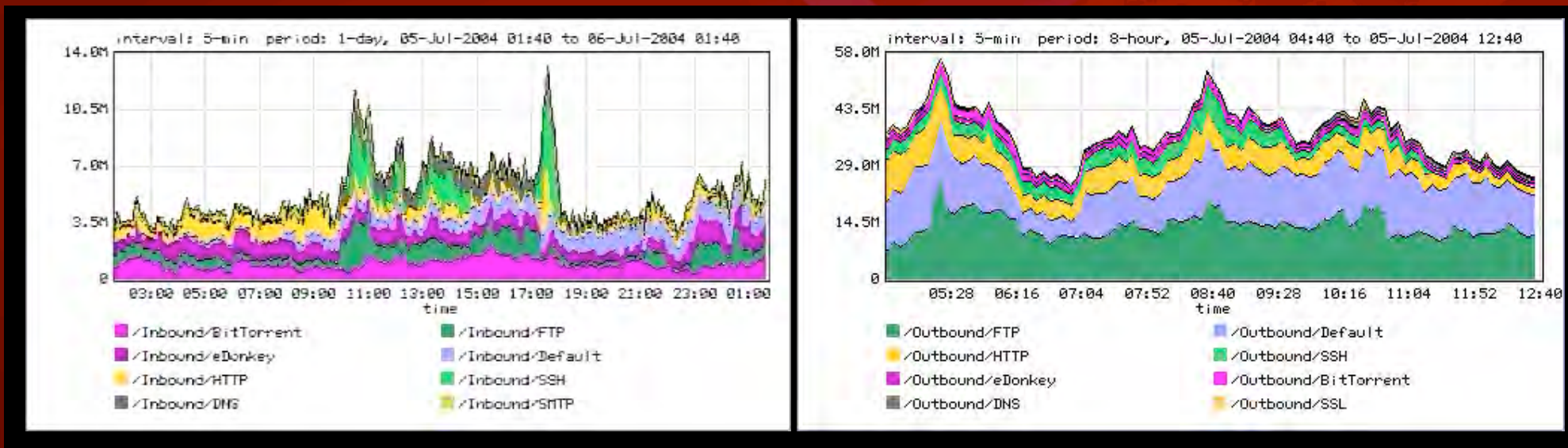
from China to Europe

<i>Country</i>	<i>Megabytes</i>	<i>% Total</i>
Germany	6,060	19%
Great Britain (UK)	5,907	19%
Poland	4,024	13%
Italy	3,478	11%
Netherlands	2,125	7%
Sweden	1,219	4%
France	1,131	4%
Greece	1,100	4%
Austria	1,045	3%
Slovenia	1,012	3%
Norway	624	2%
Switzerland	575	2%
Finland	556	2%
Spain	368	1%
Portugal	339	1%
Romania	336	1%
Yugoslavia	274	1%
Hungary	267	1%
Slovakia	217	1%
Czech Republic	211	1%
Belgium	148	0%
Croatia (Hrvatska)	100	0%
Ukraine	57	0%
Denmark	56	0%
Ireland	35	0%
Bulgaria	23	0%
Belarus	20	0%
Estonia	19	0%
Luxembourg	12	0%
Lithuania	12	0%
Total	31,349	100%

from Europe to China

<i>Country</i>	<i>Megabytes</i>	<i>% Total</i>
Sweden	20,390	36%
France	7,183	13%
Switzerland	6,857	12%
Great Britain (UK)	6,156	11%
Germany	5,169	9%
Norway	1,841	3%
Poland	1,406	3%
Italy	1,209	2%
Ireland	980	2%
Denmark	811	1%
Spain	695	1%
Hungary	647	1%
Austria	521	1%
Slovenia	451	1%
Greece	446	1%
Belgium	300	1%
Czech Republic	279	0%
Finland	236	0%
Croatia (Hrvatska)	152	0%
Romania	147	0%
Portugal	117	0%
Slovakia	84	0%
Yugoslavia	45	0%
Bulgaria	22	0%
Lithuania	21	0%
Iceland	11	0%
Luxembourg	10	0%
Ukraine	3	0%
Latvia	1	0%
Estonia	1	0%
Total	56,192	100%

GLORIAD Application Utilization Monitoring System (using Packeteer Boxes)



Monitoring

Institutional Use

Applications Use

Basic Performance metrics

Network “anomalies”

AMP (One-way) Measurements to Russia



MEASUREMENT & NETWORK ANALYSIS

"amp-naukanetnwu russia results"

[\[NLANR\]](#) [\[AMP\]](#) [\[Monitors\]](#) [\[route summary\]](#) [\[summary graph\]](#) [\[site info\]](#)

Site Name - Graph	Min (ms)	Mean (ms)	Max (ms)	Stddev (ms)	Loss (%)	Stats from
hmstu	147.00	149.59	173.00	1.51	0.42	2005/3/9
ccas	145.00	151.20	322.00	14.61	1.39	2005/3/9
chg	146.00	148.62	209.00	2.61	1.32	2005/3/9
chph-ras	0.00	0.00	0.00	0.00	100.00	2005/3/9
core-gw-3-se-0-3-1-mtts-ksu	0.00	0.00	0.00	0.00	100.00	2005/3/9
dvo	262.00	276.96	513.00	16.78	6.18	2005/3/9
earth-crust-irk	0.00	0.00	0.00	0.00	100.00	2005/3/9
freeNet	145.00	145.86	179.00	1.19	1.25	2005/3/9
friends-partners	147.00	149.68	229.00	4.77	7.15	2005/3/9
gpi	145.00	158.24	477.00	34.47	2.01	2005/3/9
gpntb	147.00	149.11	450.00	8.25	3.06	2005/3/9
ihep.su	147.00	150.16	168.00	2.02	0.35	2005/3/9
iitp	0.00	0.00	0.00	0.00	100.00	2005/3/9
ikia-ircache	144.00	145.05	168.00	1.12	0.62	2005/3/9
ioc-ac	145.00	146.66	202.00	2.17	4.31	2005/3/9
ipmce	0.00	0.00	0.00	0.00	100.00	2005/3/9
ippe-obninsk	155.00	242.33	3227.00	165.72	10.69	2005/3/9
iskran-iip	145.00	148.11	192.00	1.72	0.49	2005/3/9
itep	144.00	146.60	237.00	7.13	0.97	2005/3/9
ivep-khv	731.00	944.14	1753.00	188.55	1.67	2005/3/9
jinr	148.00	155.30	273.00	14.49	0.49	2005/3/9
keldysh	146.00	148.36	187.00	3.16	3.82	2005/3/9

kiae	146.00	152.56	274.00	10.02	1.74	2005/3/9
krasn	192.00	547.68	1079.00	280.42	2.22	2005/3/9
kubsu	168.00	172.78	213.00	3.78	0.90	2005/3/9
lebedev	147.00	149.70	161.00	1.81	0.49	2005/3/9
mipt	145.00	149.76	375.00	8.27	1.32	2005/3/9
mpei-ac	146.00	149.21	291.00	7.08	3.89	2005/3/9
nsc	0.00	0.00	0.00	0.00	100.00	2005/3/9
pfu	146.00	169.07	386.00	37.40	7.71	2005/3/9
pmc	146.00	152.02	224.00	7.04	0.49	2005/3/9
psn	155.00	176.03	439.00	34.03	2.57	2005/3/9
radio-msu	145.00	148.05	167.00	2.39	0.56	2005/3/9
relarn	0.00	0.00	0.00	0.00	100.00	2005/3/9
rssi	144.00	145.64	267.00	4.88	1.18	2005/3/9
rsuh	145.00	148.03	179.00	2.51	2.57	2005/3/9
sgu	163.00	240.47	909.00	109.12	10.00	2005/3/9
sinp-msu	145.00	146.81	176.00	1.53	1.63	2005/3/9
siobc-ras	147.00	157.51	336.00	21.22	1.11	2005/3/9
smr	161.00	163.64	185.00	2.48	1.39	2005/3/9
stankin	0.00	0.00	0.00	0.00	100.00	2005/3/9
tversu	0.00	0.00	0.00	0.00	100.00	2005/3/9
unn	150.00	163.63	316.00	19.51	1.11	2005/3/9
urc-ac	181.00	828.43	2362.00	535.89	7.22	2005/3/9
usu	0.00	0.00	0.00	0.00	100.00	2005/3/9
vigg	150.00	222.85	741.00	43.09	20.56	2005/3/9
vspsu	182.00	463.21	1771.00	255.60	9.65	2005/3/9
ysu	157.00	173.38	286.00	14.48	1.04	2005/3/9
x-atom	150.00	161.36	517.00	25.24	8.33	2005/3/9

Generated at Thu Mar 10 01:08:16 2005.

[Top](#) last modified: 10 Mar 2005 Tony McGregor Comments, questions are welcome: [Feedback](#)

AMP Measurements to Moscow BMSTU



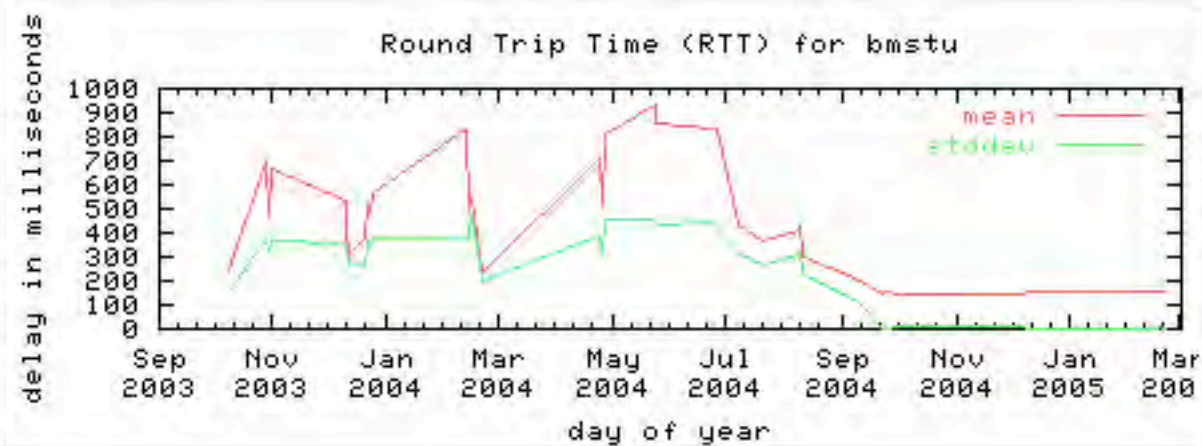
RTT And Loss Measurements

amp-ru-bmstu from amp-naukanetnwu

[\[NLANR\]](#) [\[AMP\]](#) [\[monitors\]](#) [\[amp-naukanetnwu\]](#) [\[reverse\]](#) [\[src info\]](#)

[Fill in all graphs](#)

Long Term average per day



Presentation

- Background/History
- GLORIAD Today, Tomorrow
- Partners and Networks
- Measurement Program
- **Application Areas**
- Education/Outreach Activities
- Challenges, Issues

GLORIAD: more than a network



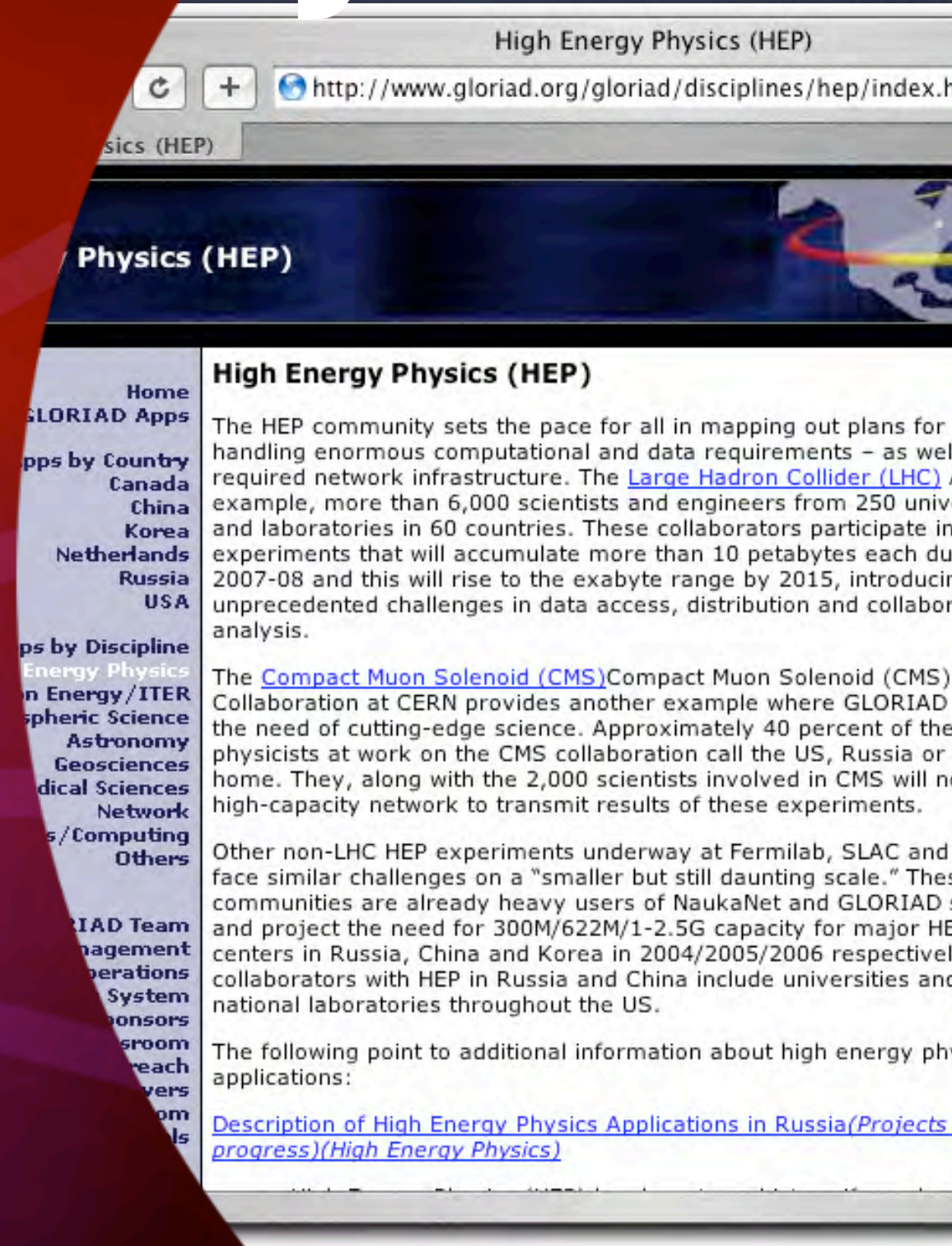
- ☉ Serving ITER, High Energy Physics, Astronomy, Atmos. Sciences, Earth Sciences, Bio Sciences, Telemedicine, Materials Sciences and many others
- ☉ Serving humanities and social sciences
- ☉ Serving Nuclear Non-Proliferation, Materials Protection, Anti-Terrorism, International Security
- ☉ Serving Educators: Edu-Cultural Digital TV Channel, Intl Science Fairs, Junior Achievement, "Simple Words", Virtual Museums
- ☉ Serving Advanced Networking: Wavelength Disk Drive, IPv6, Collaboration Infrastructure

Driving Disciplines

- High Energy Physics
- Fusion Energy Physics/ITER
- Astronomy
- Earth Sciences
- Atmospheric Sciences/THORPEX
- GRIDS/Computational Resources
- Network Research

High Energy Physics

- Most immediate driver for international high performance S&E networking
- Large Hadron Collider (LHC) experiments will begin generating petabytes of data in 2007-2008, exabytes by 2015
- Community has developed international infrastructure for sharing data for shared analysis
- Heaviest single community user of GLORIAD today (40% of traffic some days)
- Propose need for GbEs immediately



The screenshot shows a web browser window with the URL <http://www.gloriad.org/gloriad/disciplines/hep/index.h>. The page title is "High Energy Physics (HEP)". The main content area is titled "High Energy Physics (HEP)" and contains several paragraphs of text. The text discusses the HEP community's role in mapping out plans for handling enormous computational and data requirements, mentioning the Large Hadron Collider (LHC) and the Compact Muon Solenoid (CMS). It also mentions the need for cutting-edge science and the challenges of high-capacity networks. A sidebar on the left lists various disciplines and links. At the bottom, there is a link to "Description of High Energy Physics Applications in Russia(Projects progress)(High Energy Physics)".

High Energy Physics (HEP)

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spheric Science
Astronomy
Geosciences
Medical Sciences
Network
s/Computing
Others
GLORIAD Team
Management
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Sponsors
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Reach
Layers
om
als

High Energy Physics (HEP)

The HEP community sets the pace for all in mapping out plans for handling enormous computational and data requirements – as well as required network infrastructure. The [Large Hadron Collider \(LHC\)](#) is an example, more than 6,000 scientists and engineers from 250 universities and laboratories in 60 countries. These collaborators participate in experiments that will accumulate more than 10 petabytes each during 2007-08 and this will rise to the exabyte range by 2015, introducing unprecedented challenges in data access, distribution and collaborative analysis.

The [Compact Muon Solenoid \(CMS\)](#) Compact Muon Solenoid (CMS) Collaboration at CERN provides another example where GLORIAD addresses the need of cutting-edge science. Approximately 40 percent of the physicists at work on the CMS collaboration call the US, Russia or home. They, along with the 2,000 scientists involved in CMS will need a high-capacity network to transmit results of these experiments.

Other non-LHC HEP experiments underway at Fermilab, SLAC and elsewhere face similar challenges on a "smaller but still daunting scale." These communities are already heavy users of NaukaNet and GLORIAD and project the need for 300M/622M/1-2.5G capacity for major HEP centers in Russia, China and Korea in 2004/2005/2006 respectively. Collaborators with HEP in Russia and China include universities and national laboratories throughout the US.

The following point to additional information about high energy physics applications:

[Description of High Energy Physics Applications in Russia\(Projects progress\)\(High Energy Physics\)](#)

Fusion Energy

International Thermonuclear Experimental Reactor

- ☉ GLORIAD motivated, in part, to help serve ITER community (US, Russia, China, Korea, Europe, Japan)
- ☉ \$Multi-billion construction to begin when site decision is made; #1 science/facility priority for US Department of Energy
- ☉ Will require GbE around GLORIAD ring initially; 10G circuit by 2008
- ☉ Heavy user of computational resources, need to cooperatively control experiments remotely, massive data storage and transmission requirements



GLORIAD/ITER-Grid Meeting,
December 21, 2003

Astronomy

- International Virtual Observatory Project (involving US, Russia, China, Korea, Europe, others) proposes generation of 10 petabytes of data annually
- International Very Long Baseline Interferometry (VLBI) involves very high capacity network access to radio telescopes in Netherlands, US, Russia, China, Australia, elsewhere; network access to require multiple DWDM wavelengths

The screenshot shows a web browser window with the URL <http://www.gloriad.org/gloriad/disciplines/astronomy>. The page title is "Astronomy".

Navigation Menu:

- Home
- GLORIAD Apps
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 - Atmospheric Science
 - Astronomy
 - Geosciences
 - Medical Sciences
 - Network
 - Grids/Computing
 - Others
- GLORIAD Team
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 - Operations
 - Monitoring System
 - Sponsors
 - GLORIAD Classroom
 - Education Outreach
 - Email Listservers
 - Chat Room
 - Research Tools

Astronomy Content:

Astronomy

Progress in astronomical research requires access to all the astronomical data, since insight comes from correlating data from different wavelengths and with different techniques, and correlating the observational results with astrophysical simulations.

Problems in making this vision a reality include lack of sufficient bandwidth and the inhomogeneity of the data and the and access methods.

The [International Virtual Observatory](#) project, scheduled for 2008, will produce 10 petabytes of data per year, yet the data will be on networks such as GLORIAD to solve the issue of bandwidth to transmit enormous sums of data. GLORIAD will enable US access IVO data resources in Russia and China and vice-versa. GLORIAD will enable real-time very long baseline interferometry between the Long Baseline Array in the U.S. and radio telescopes in the Netherlands, Russia, China, and Korea.

The [International Square Kilometer Ray Consortium](#) will require GLORIAD to provide network services for baseline interferometry between the Long Baseline Array (VLBA) with partner countries, and also for the distributed SKA paradigm.

[KOREA: Korean Virtual Observatory Project](#)

The virtual observatory projects are being developed at the national levels at about 15 countries including Korea. The Korean Virtual Observatory (KVO, <http://kvo.kao.re.kr>) was established in February 2003 by astronomers in Korea Astronomy and Space Science Institute and some universities.

Earth Sciences

US, Russia, China, Canada together comprise large percentage of earth's surface and already have large domestic infrastructure for sensing seismic activity, atmospheric conditions, environmental conditions, satellite-based imagery coverage, etc.

GLORIAD proposes to ensure higher capacity/easier data sharing between major earth science initiatives – seismic monitoring, satellite imagery, environmental monitoring, forestry/wildfire studies, etc.

Special emphasis in GLORIAD on extending access to Central Asia generally and to the Bishkek Geologic Proving Ground specifically

Deformation Field over Bishkek Proving G...GPS<i>(Project
http://www.gloriad.org/gloriad/projects/ru/project
ation Fi...

Deformation Field over Bishkek Proving Ground Development (Project proposed to start) (GeoScience)

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2D and 3D Deformation Field over Bishkek Proving Ground Development (Project proposed to start) (GeoScience)

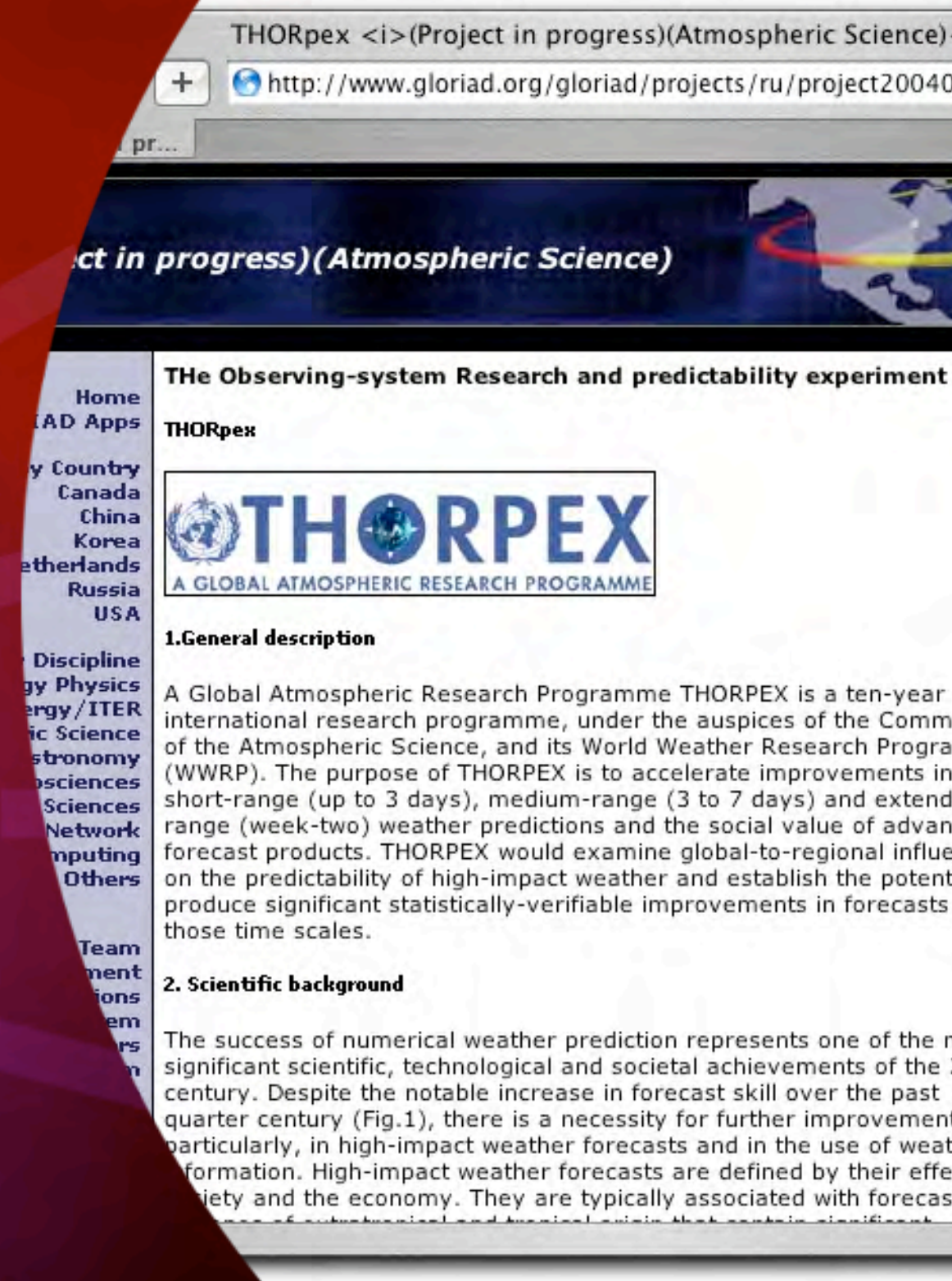
Organization who response for the project from Russian side: The Geophysical Center, RAS; The Geophysical Center, RAS **Principal Investigators (Russia):** Prof.A.M.Fridman, prof. G.A.Sobolev, prof. V.A.Zeigarnik

Organization who response for the project from US side: The Center for Global Earthquake Science, University of California, Berkeley **Principal Investigators (USA):** Prof. Bradford Hager, Prof. ...

Description The Bishkek Proving Ground (BPG), the Research Station, RAS; The Geophysical Center, RAS **Principal Investigators (USA):** Prof. Bradford Hager, Prof. ... Sci. has been developing since 1982.

Atmospheric Sciences

- Programs include general atmospheric modeling, climate change studies, weather prediction, etc.
- Data transmission requirements requiring GbE+ (also enormous shared computational and data storage)
- Special emphasis on International THORPEX program – established in 2003 as a 10-year global atmospheric R&D program – emphasis on mitigating effects of natural weather-related phenomena by providing much more accurate 1-14 day forecasts.



THORpex <i>(Project in progress)</i>(Atmospheric Science)


<http://www.gloriad.org/gloriad/projects/ru/project20040>

Project in progress)</i>(Atmospheric Science)

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THE Observing-system Research and predictability experiment

THORpex



1.General description

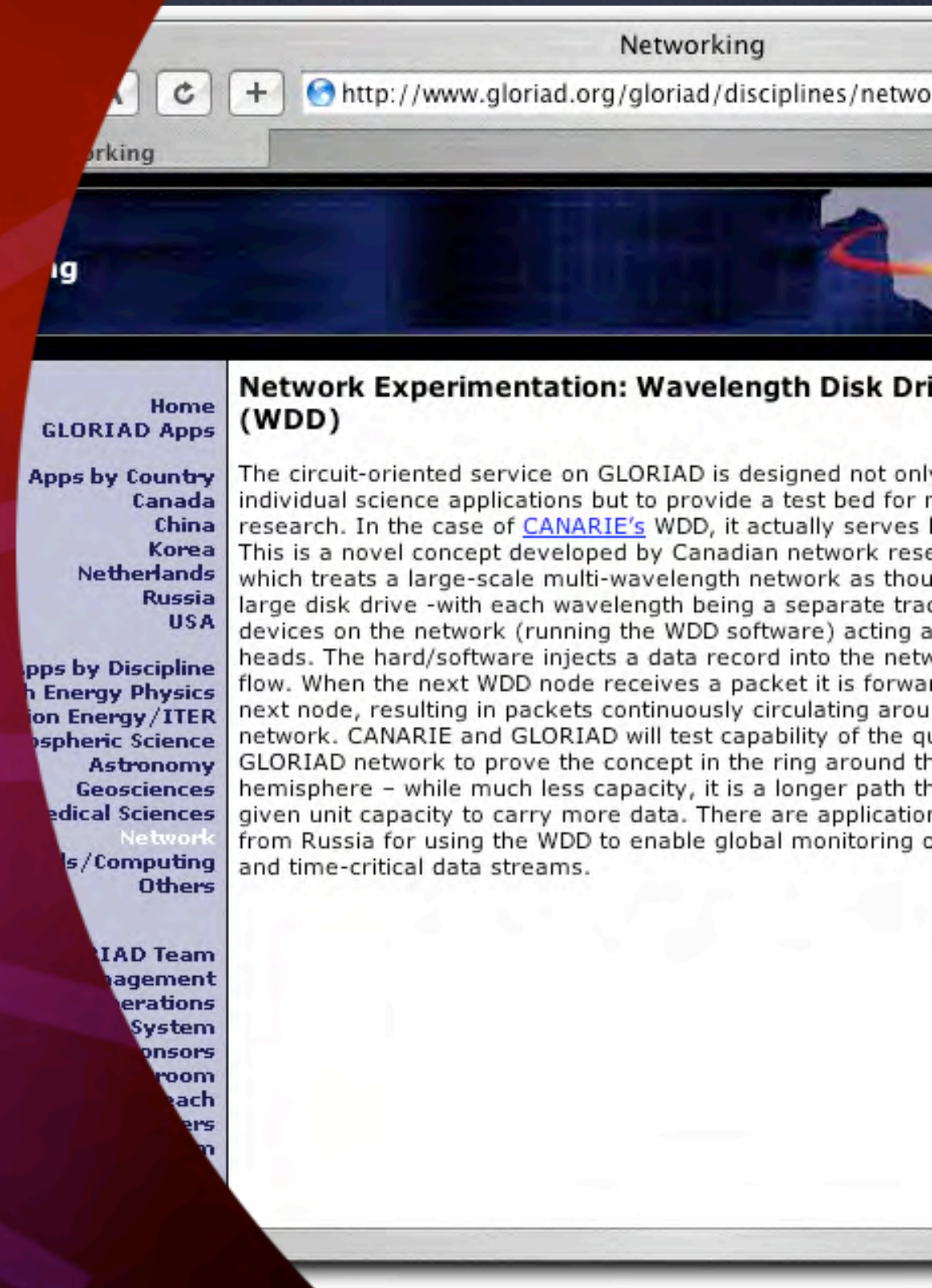
A Global Atmospheric Research Programme THORPEX is a ten-year international research programme, under the auspices of the Commission of the Atmospheric Science, and its World Weather Research Programme (WWRP). The purpose of THORPEX is to accelerate improvements in short-range (up to 3 days), medium-range (3 to 7 days) and extended range (week-two) weather predictions and the social value of advanced forecast products. THORPEX would examine global-to-regional influence on the predictability of high-impact weather and establish the potential to produce significant statistically-verifiable improvements in forecasts at those time scales.

2. Scientific background

The success of numerical weather prediction represents one of the most significant scientific, technological and societal achievements of the 20th century. Despite the notable increase in forecast skill over the past quarter century (Fig.1), there is a necessity for further improvement, particularly, in high-impact weather forecasts and in the use of weather information. High-impact weather forecasts are defined by their effect on society and the economy. They are typically associated with forecasts of extratropical and tropical origin that contain significant

Network Research

- With its hybrid architecture, GLORIAD will provide an experimental “sandbox” for network researchers – enabling experimentation without putting production services at risk
- One proposed project is the Canadian Wavelength Disk Drive (WDD) – treating a service across the GLORIAD ring as a “disk drive” – circulating data around the earth with “readers” and “writers” at various locations – useful for data needed by international parties at approximately the same time
- Another is the Canadian User Controlled Lightpath (UCLP)



Other Areas of Collaboration

- Grids and Shared use of Computational Resources
- Network Security
- Materials Science (ORNL's SNS)
- Bioinformatics/Bioengineering
- Telemedicine (US-Russia effort in cancer research)
- Nuclear Materials Protection and Non-proliferation programs
- Emergency Response
- Joint Anti-terrorism Programs

Medical Information System (IMIS, DIMOL) <i>(Project in progress)</i>(Medical Science) </i>

http://www.gloriad.org/gloriad/projects/ru/project20040621

Grids/Computing Others

GLORIAD Team Management Operations Monitoring System Sponsors GLORIAD Classroom Education Outreach Email Listservers Chat Room Search Tools

GLORIAD's sponsors include the US National Science Foundation, a consortium of science organizations and ministries in Russia and the Chinese Academy of Sciences.

GLORIAD's US home is at the NCSA of the University of Illinois at Urbana-Champaign.

telecommunications services are provided by

Fig.1. Author of the project DIMOL. From left to right: Gnedenko V.G., Faineberg E.M., Iosseliani D.G., Velikhov E.P.

Cardiology is one of the main and most rapidly developing directions of treating cardio-vascular diseases. The methods of intervening cardioangiography are intended for mass implementation; they are distinguished for being low traumatizing, provide patients to recover during minimum possible period of time. The positive results obtained and the high capacity of the method are caused mostly by the degree of its automation and computerization. The DIMOL complex provides practically full automation of this process, reduce the time required to make right decisions by doctors. It allows providing the cooperation between the

Other Applications

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Team Management Operations Monitoring System Sponsors

Other Areas

Other science disciplines supported by the GLORIAD network include: nuclear materials protection and materials accounting and control, next generation optical network research and design, use of the ORNL-sited Spallation Neutron Source, nanomaterials, bioinformatics, bioengineering, telemedical applications, and various educational programs.

Slideshow of GLORIAD Launch Ceremony

A quicktime-based slideshow of the opening ceremony for the GLORIAD network is available [here](#).

More information about the launch ceremony is available [here](#).

Presentation

- **Background/History**
- **GLORIAD Today, Tomorrow**
- **Partners and Networks**
- **Measurement Program**
- **Application Areas**
- **Education/Outreach Activities**
- **Challenges, Issues**

Education & Outreach

- Central Asian and Western Eurasian networking extension
- GLORIAD Classroom
- EduCultural Channel
- Collaboration Infrastructure (IP Telephony Network (using Cisco donation) and HEP/VRVS)
- “Simple Words” Essay Program
- “Junior Achievement” Partnership
- Virtual Science Museum of China
- “Great Wall” Society Programs
- Electronic Cultural Atlas Initiative

Presentation

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Challenges

- **Funding**
- **Multi-Cultural Issues, Challenges**
- **Security Issues**
- **Political Issues**
- **“Network Politics”**
- **Institutional Support of International Project**

Year 1 Plans

- **Grand Opening Ceremony, New Operating Agreement**
- **Complete Architectural Plans, Landing Sites/Equipment Deployment, New Circuits (Amsterdam, Moscow, Hong Kong, Busan)**
- **Governance Structure, Working Groups Operational**
- **GLORIAD Classroom**
- **EduCultural Channel**
- **Collaboration Infrastructure Deployed (IP Telephony, VRVS Reflectors)**
- **BRO Box deployed, integrated with router**
- **New Monitoring System (using Packeteer/Netflow product)**
- **New Web Site**
- **“Simple Words” Pilot in US**

This is all made possible by ...

- NSF (6+ years of support) and our sponsors in Russia, China, Korea (and others)
- Our partners in Russia, China, Korea, Netherlands, Canada, throughout the GLIF
- US partners - UT/ORNL (Homer Fisher, Bill Snyder), NCSA, UT/ORNL (again), Jim Olson, Mike Rieger, Bill Marra (Tyco), Starlight partners: Tom, Joe, Maxine; IRNC partners, Harvey Newman, Steve Goldstein, Tom Greene, Aubrey Bush, Yves Poppes, partners at US govt agencies (and many, many others)
- Email, the Internet, Trans-oceanic/continental circuits, “Friends and Partners”

Global Ring Network for Advanced Applications Development (GLORIAD)

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