Global Ring Network for Advanced Applications Development (GLORIAD) and Digital Divide Issues

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Animation by Chinese Academy of Sciences
Computer Network Information Center

International ICFA Workshop on HEP Networking, Grid and Digital Divide Issues for Global e-Science, May 24, 2005

Greg Cole, Research Director, UT-ORNL Joint Institute for Computational Sciences (PI)

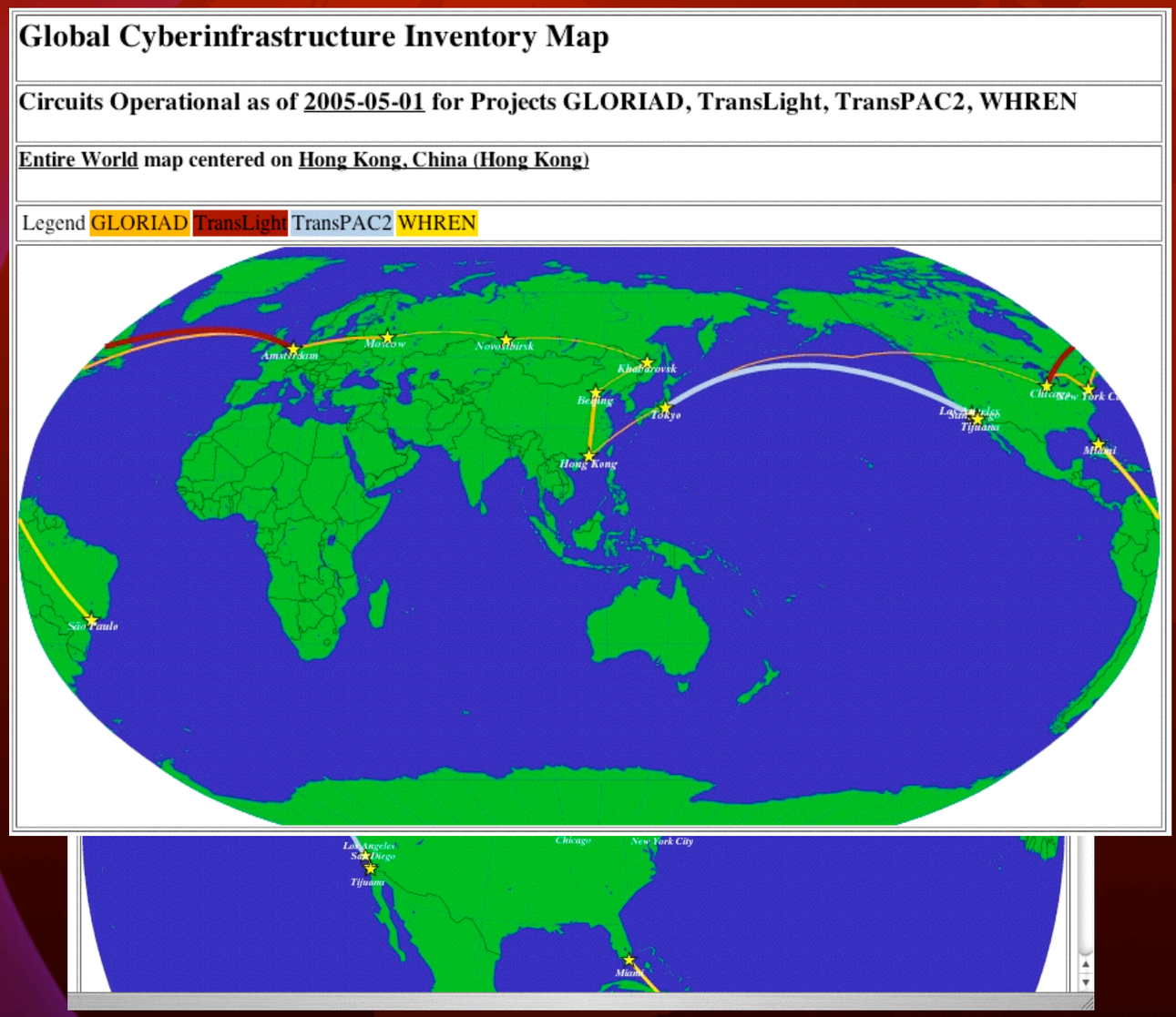
Natasha Bulashova, Research Scientist, UT-ORNL Joint Institute for Computational Sciences (Co-PI)

NSF IRNC Cooperative Agreement
University of Tennessee
$4.2M/5 years
Began January 1, 2005

http://www.gloriad.org/

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 - US-Europe
  - TransPAC2 - US-Japan/Asia
  - WHREN - US-Latin America
  - Pacific Wave - infrastructure for connections
- Follow-on to NSF HPIIS Program (1998-2004)



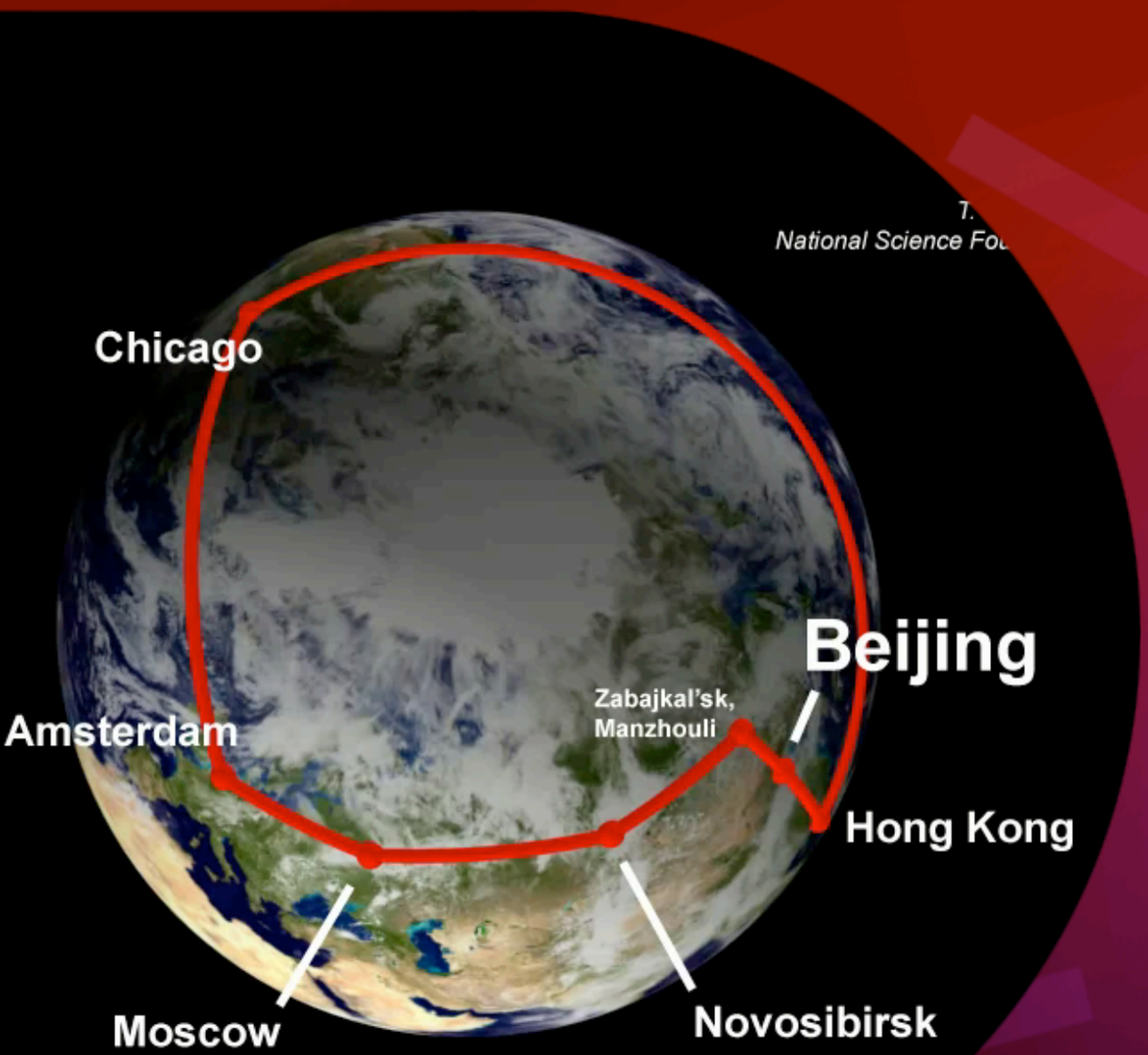
Presentation

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

Digital Divide

- Addressing “the divide” digitally
- Addressing local community infrastructure needs
- Addressing international infrastructure needs

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, 10 Gbps in early 2006, N×10G 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

Follow-on to NSF-/Russian MinSci-Funded MIRnet and NaukaNet programs (1998-2004)

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 “Internet2” type 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

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@icm1.icp.net,
"Dr. Alexei P. PLATONOV,Director,ROSNIIROS" <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 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 “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) Search Result 2
Subject: Gopher & Wais
Newsgroups: comp.infosystems.gopher View: Complete Thread (5 articles)
Date: 1993-04-20 12:33:46 PST Original Format

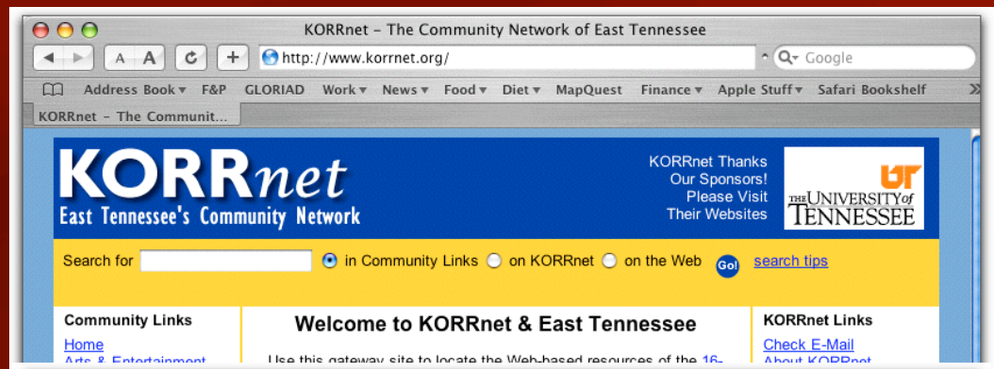
```
Hello All!

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!I 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
```

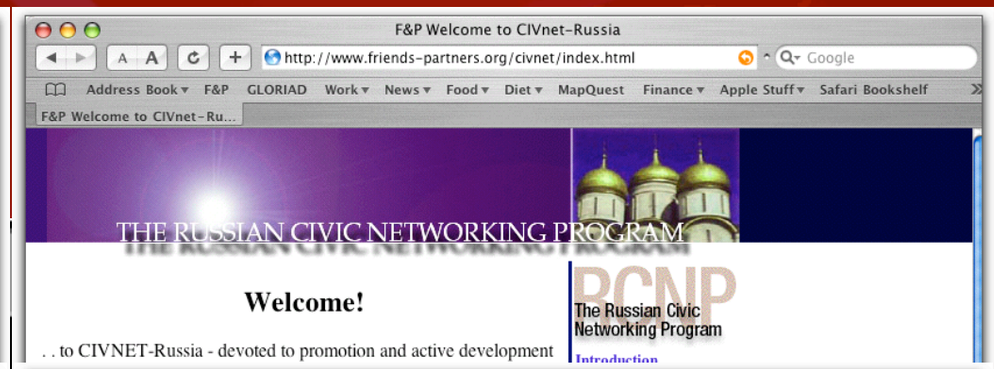
History

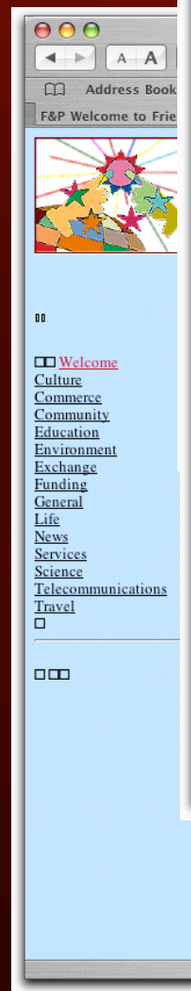
- We “e-met” during April 1993
- US-Russia Friends & Partners program began January 1994
- Based at Univ of Tennessee and Pushchino Biological Center until 2001
- Technical networking resulted from efforts at community networking (and recognition that we never had sufficient bandwidth for what we wanted to do)
- Focus always on local communications infrastructure

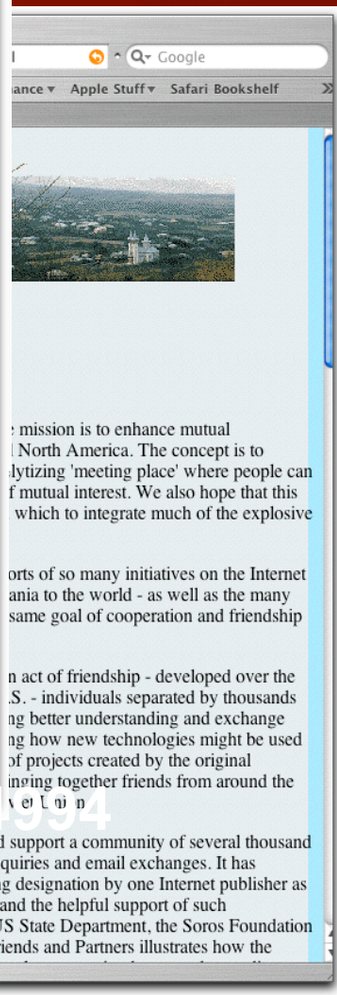
“Friends & Partners”

addressing *the divide* digitally









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

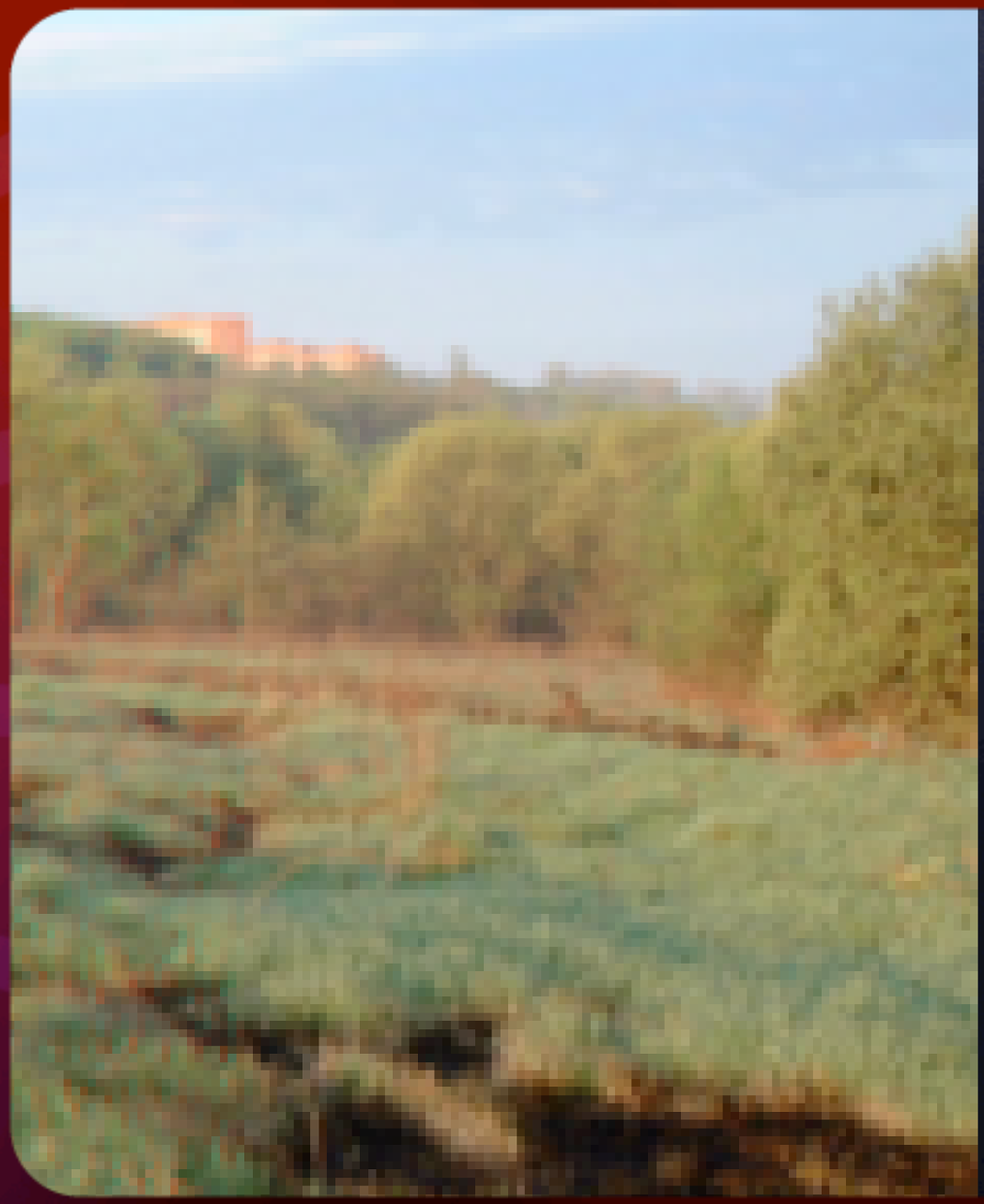
The following map shows the founding Chinese partners involved

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

Within 48 hours, 30,000 web accesses, 360 e

History

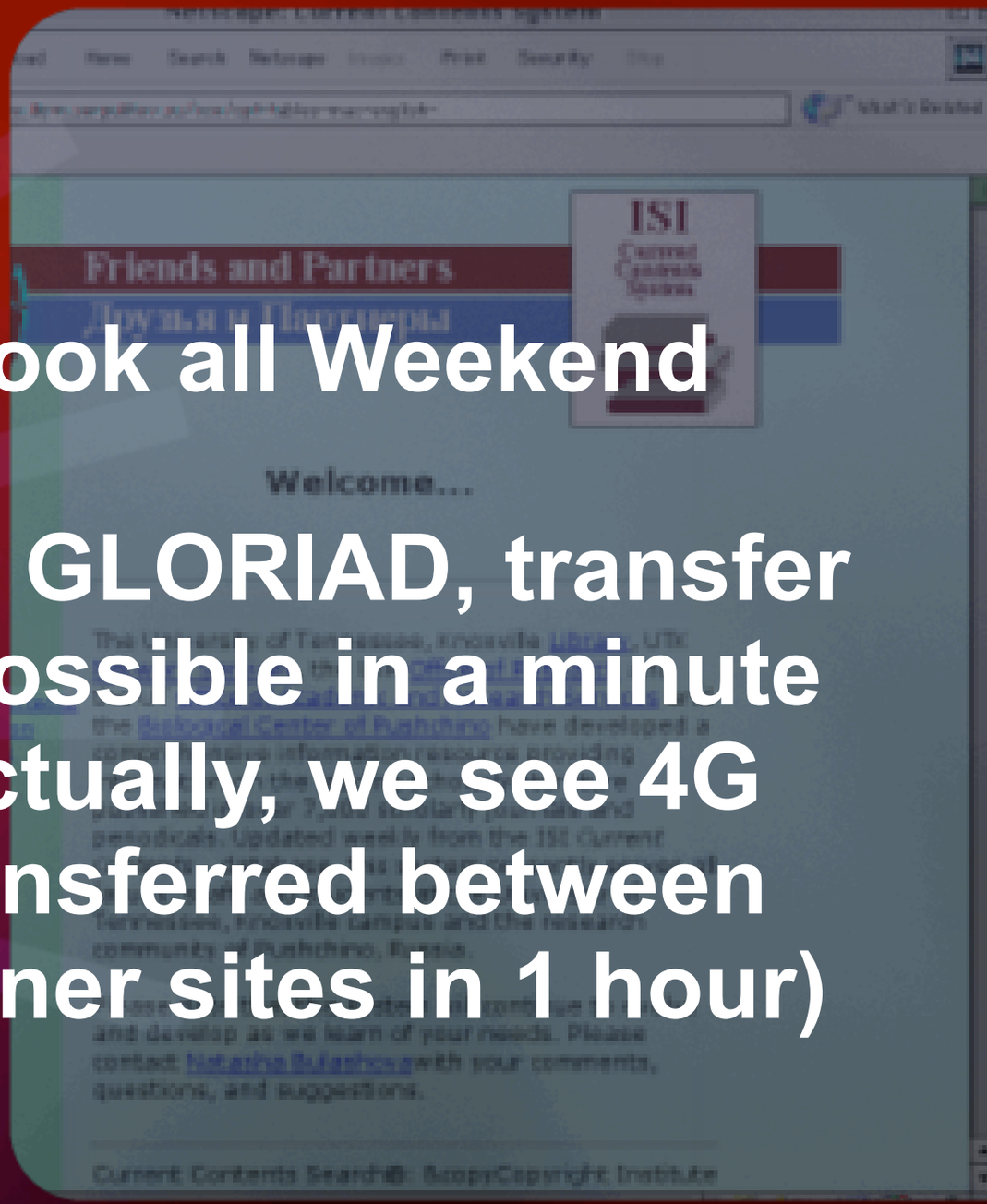
- Early days: entire South Moscow region behind a single 19.2K modem
- Our first grant (from NATO) enabled bandwidth increase to 256 Kbps
- Sun Microsystems donated workstation equipment to both teams
- US State Department grant for Gore-Chernomyrdin Commission meeting helped launch the project activities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



How to transfer 50M file

(Weekly: from Univ of TN to Pushchino)

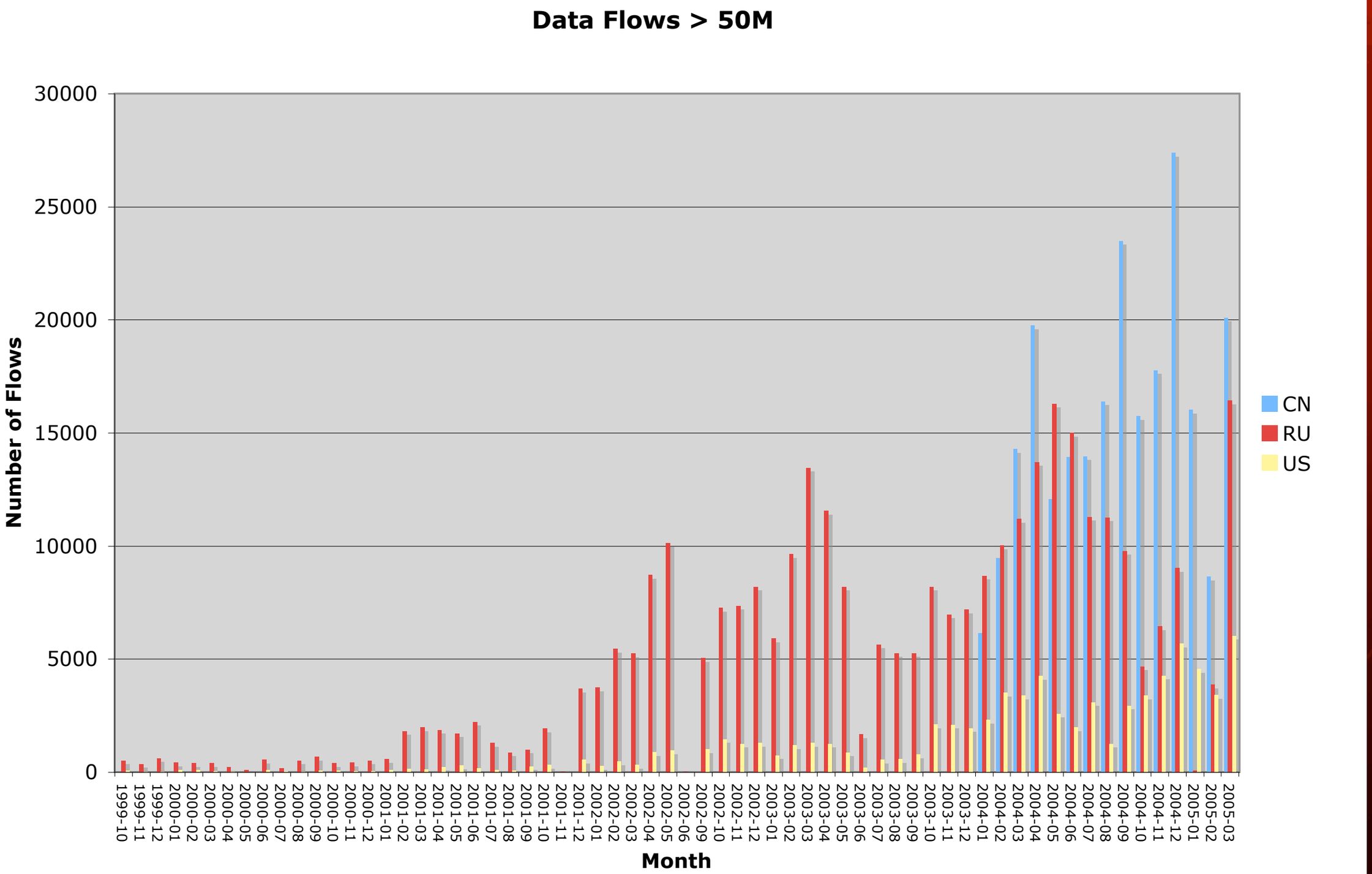
- Compress file
- UUencode it
- Split into 1000 uniform pieces
- FTP the 1000 files
- Uncompress the 1000 files
- Join into 1 file
- UUdecode it
- Uncompress it



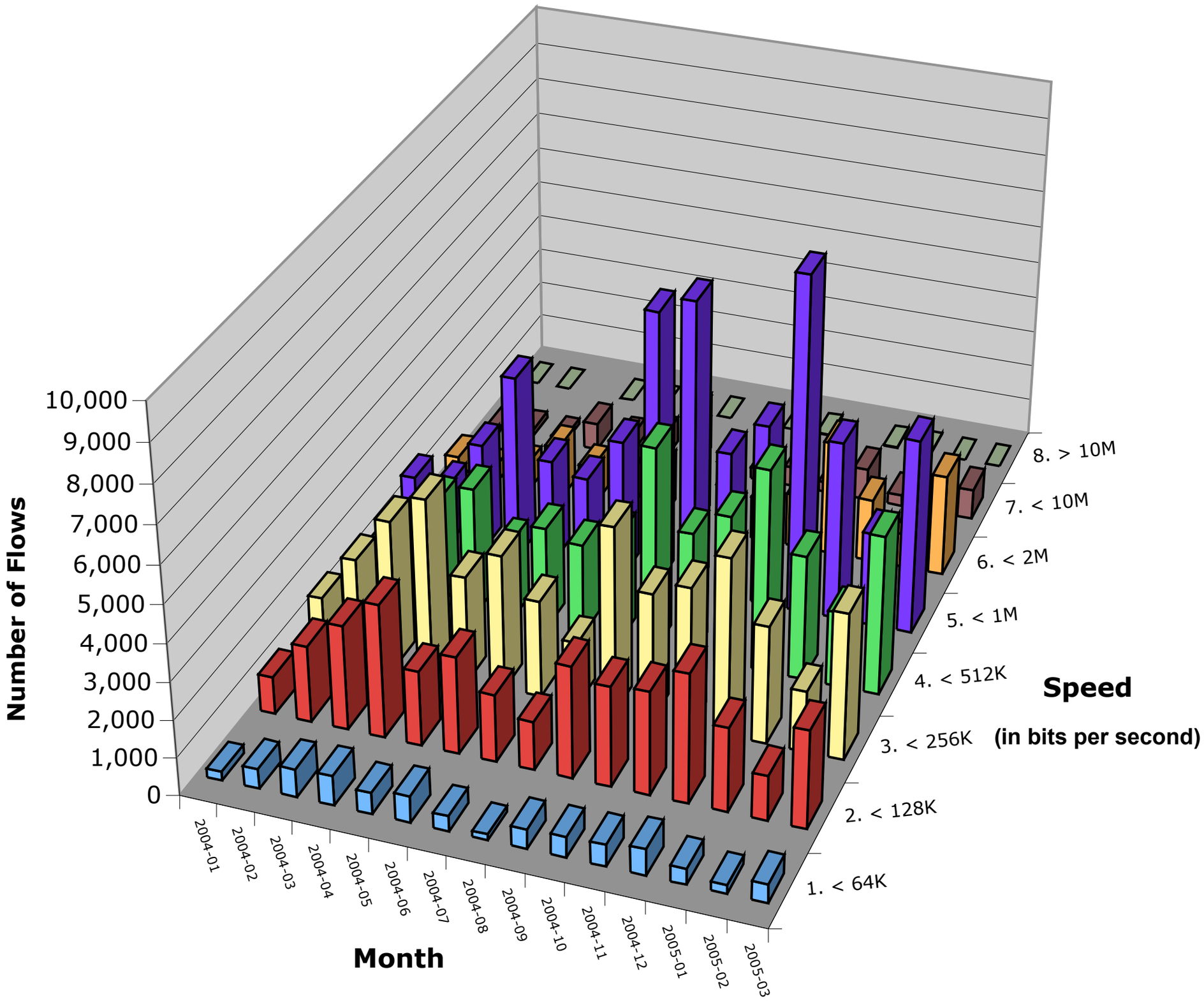
Took all Weekend

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

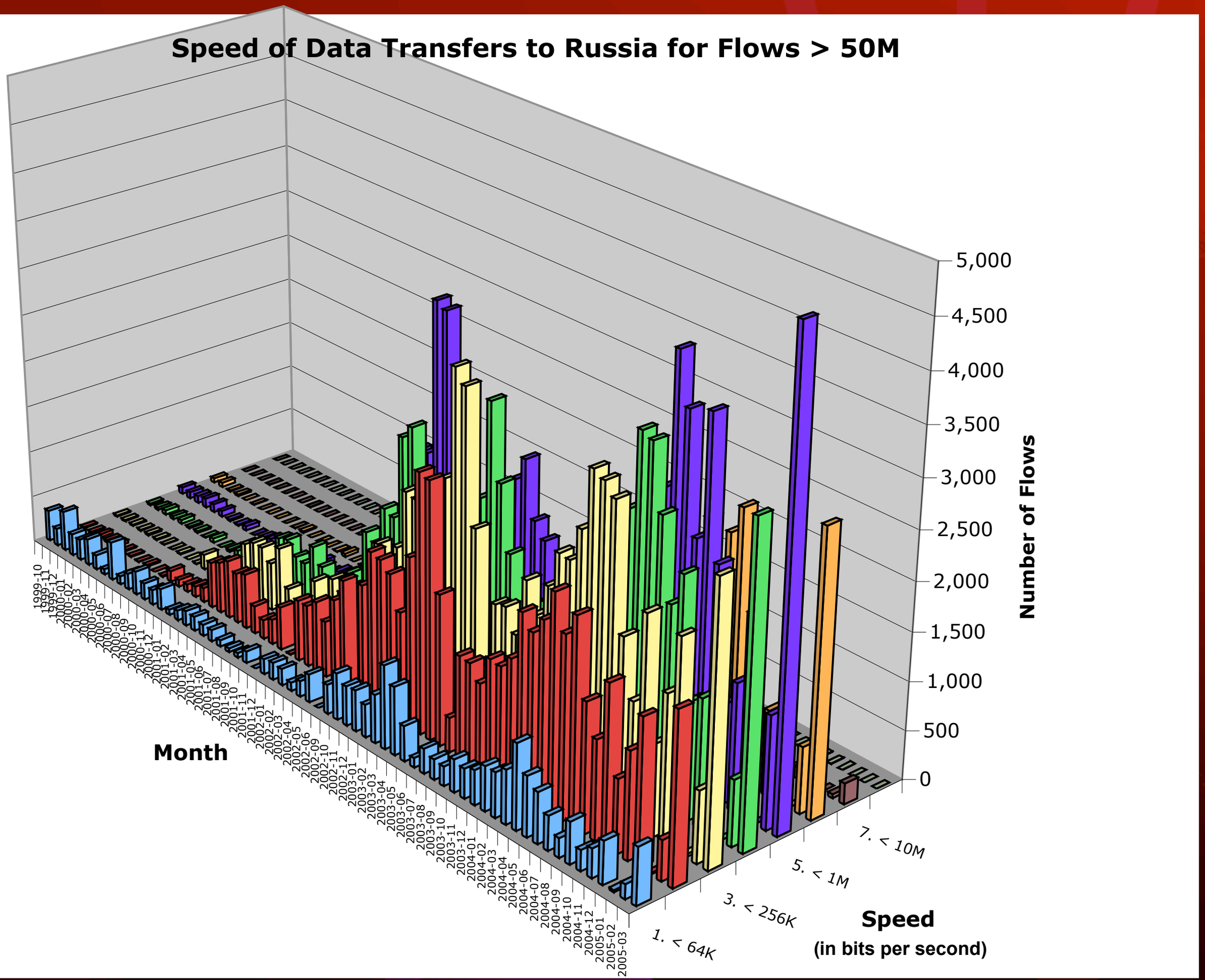
Growth in Data Flows > 50 Mbytes



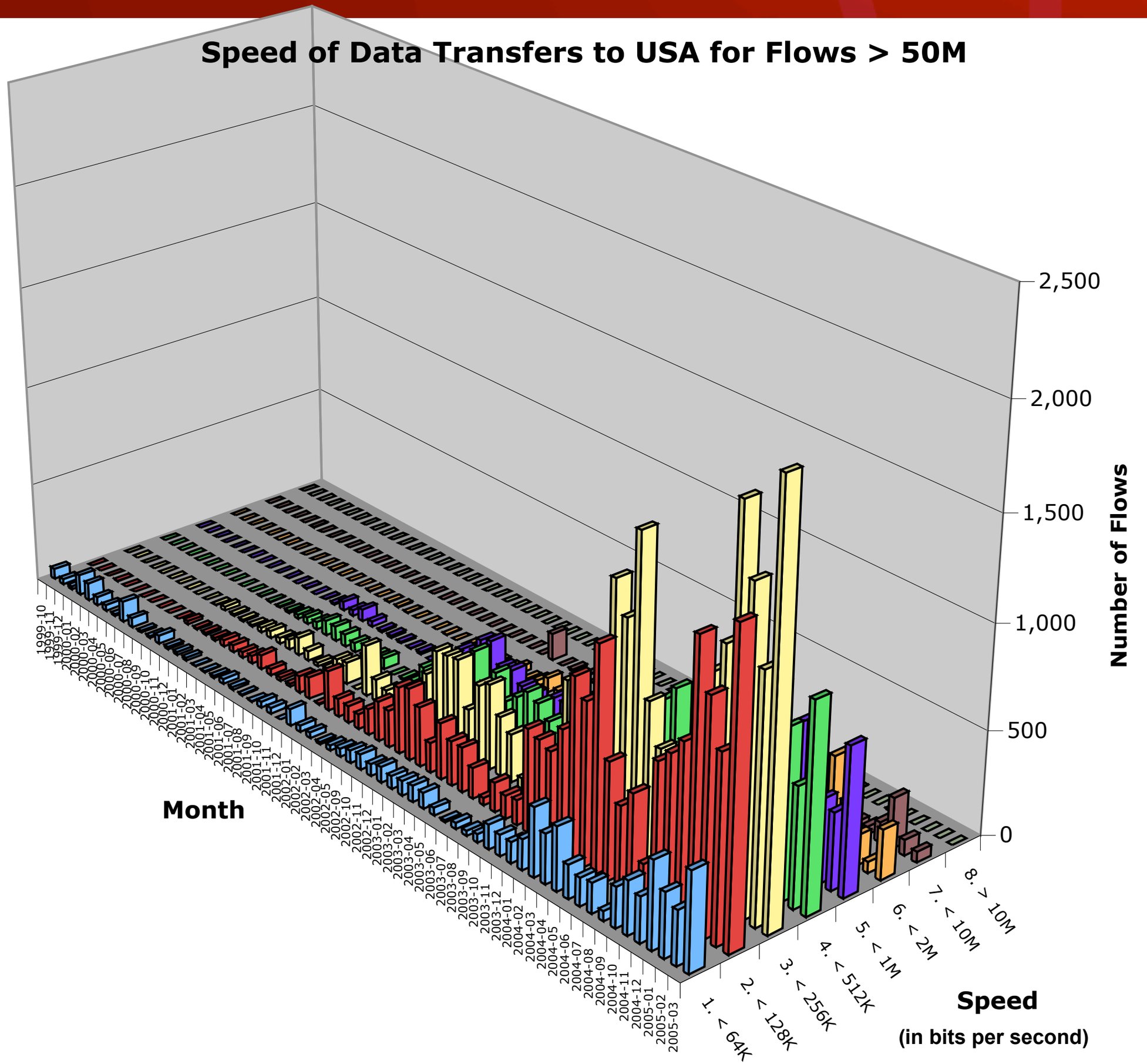
Speed of Data Transfers to China for Flows > 50M



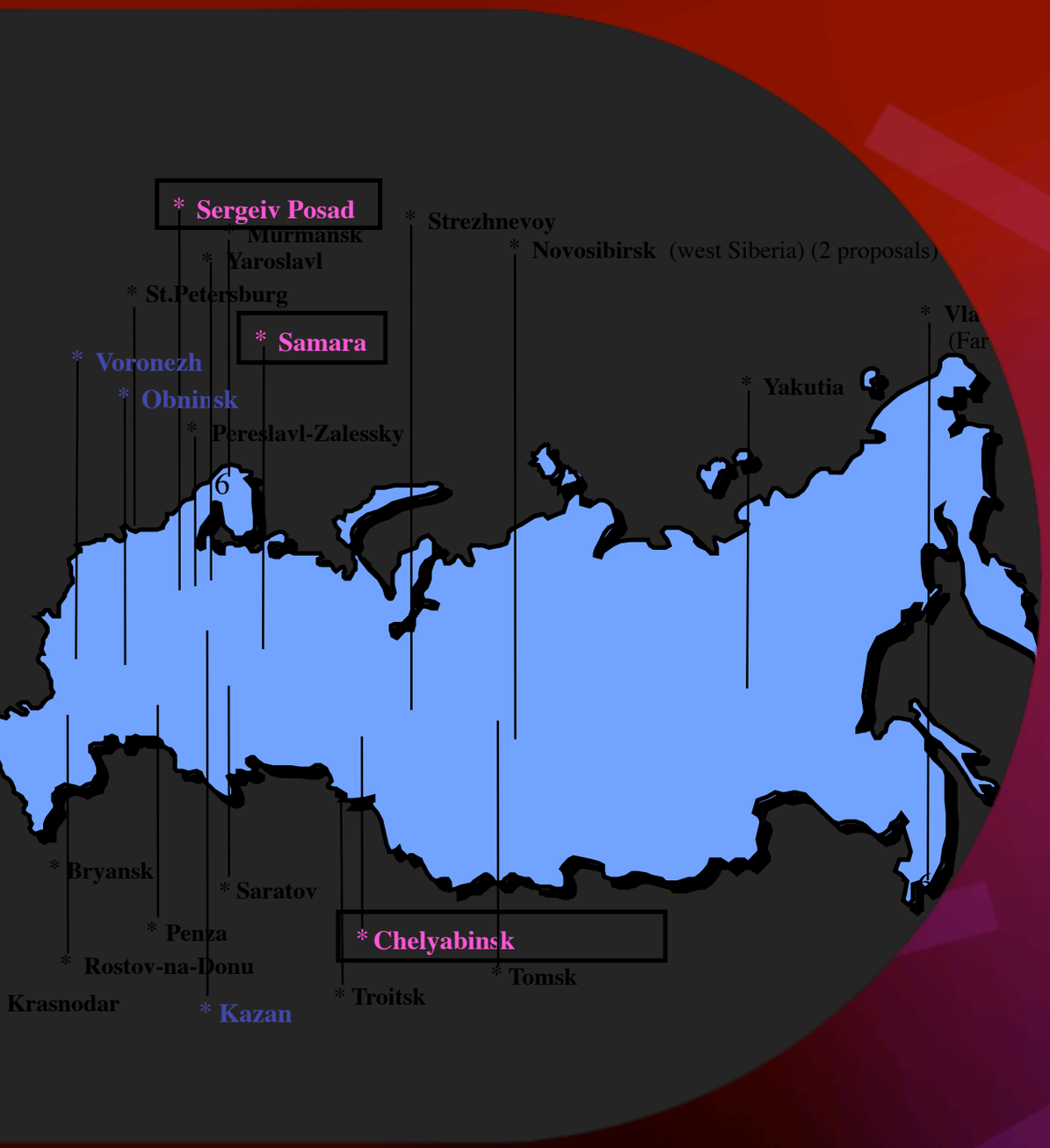
Speed of Data Transfers to Russia for Flows > 50M



Speed of Data Transfers to USA 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
- Now working on CIVGrid program

Early Beginnings of GLORIAD

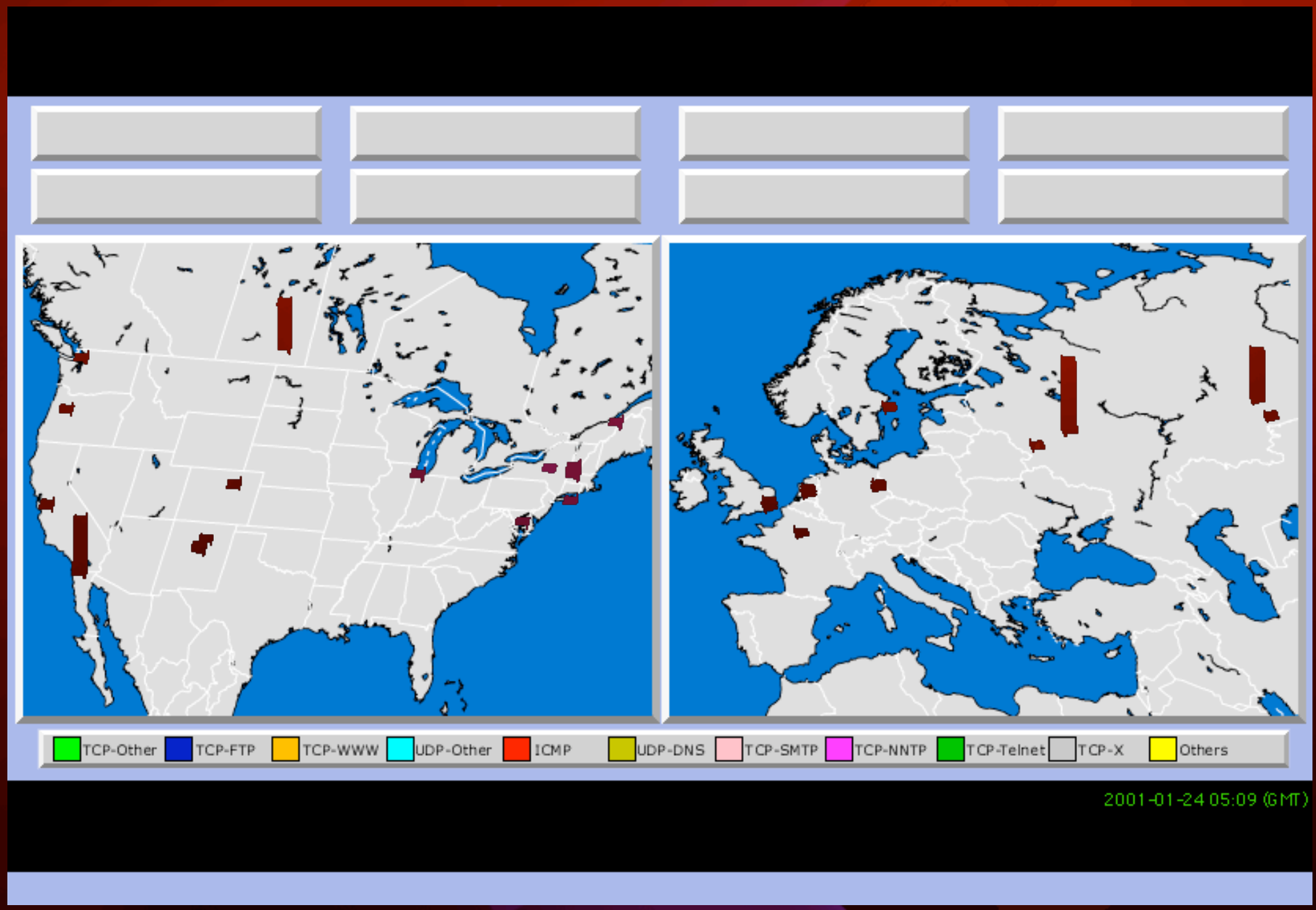
During time of F&P and CIVnet projects (mid-1997), we began working on high performance connectivity between US and Russia, applying for funding under the NSF High Performance International Internet Services (HPIIS) program.

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

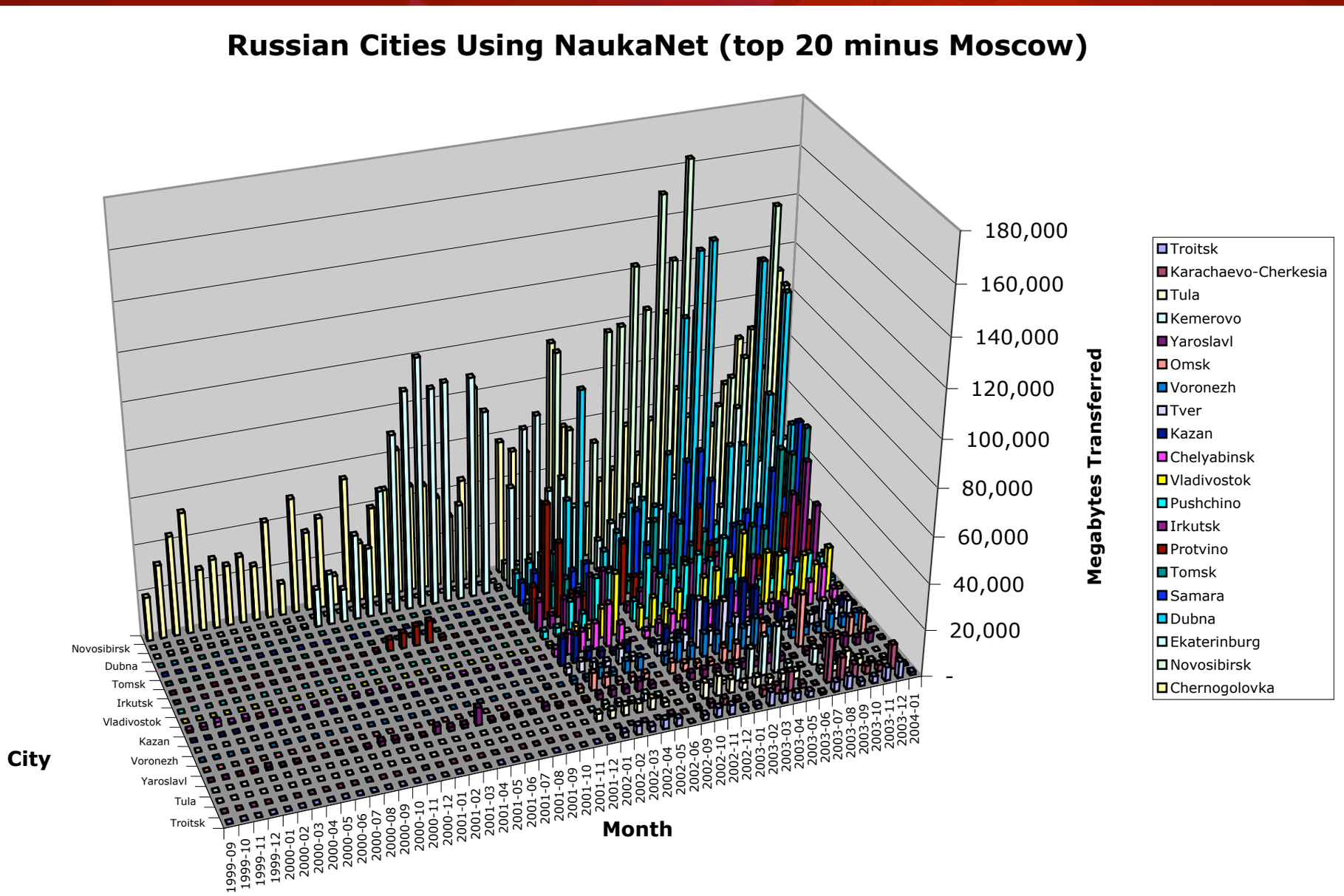
GLORIAD HISTORY

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



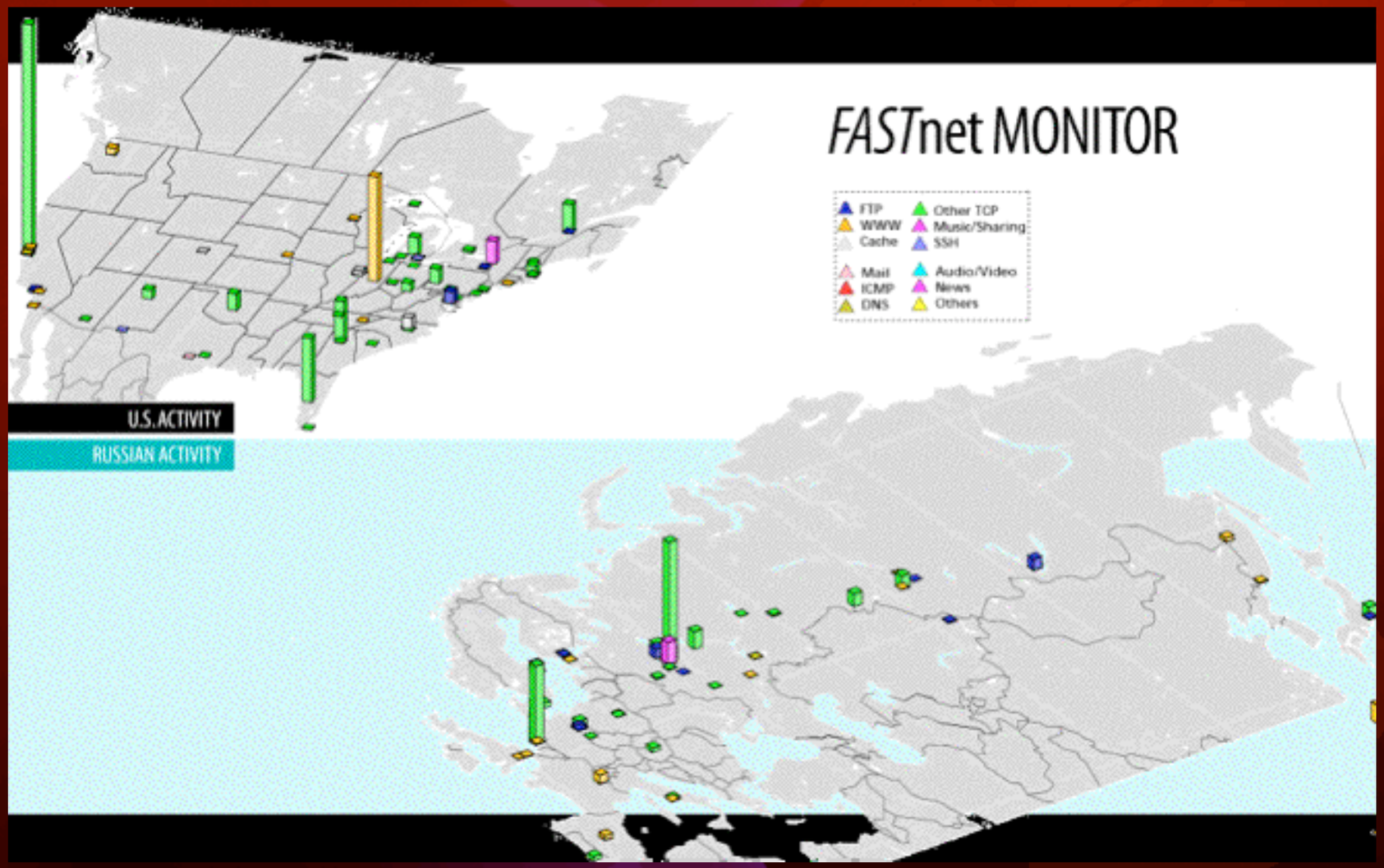
GLORIAD HISTORY

MIRnet served limited community in Russia; in December 2001, Expanded across Russia



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:

- Dramatically expand connectivity/bandwidth across Russia
- Keep going ...
- Extend access from Russian Far East to US
- Bring Chinese science community in as partner
- Introduce the developing "GLIF" 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

When/How?

1996: Local Networking

1998: Int'l Networking

1994: Community Building

2004: GLORIAD Launch

- 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

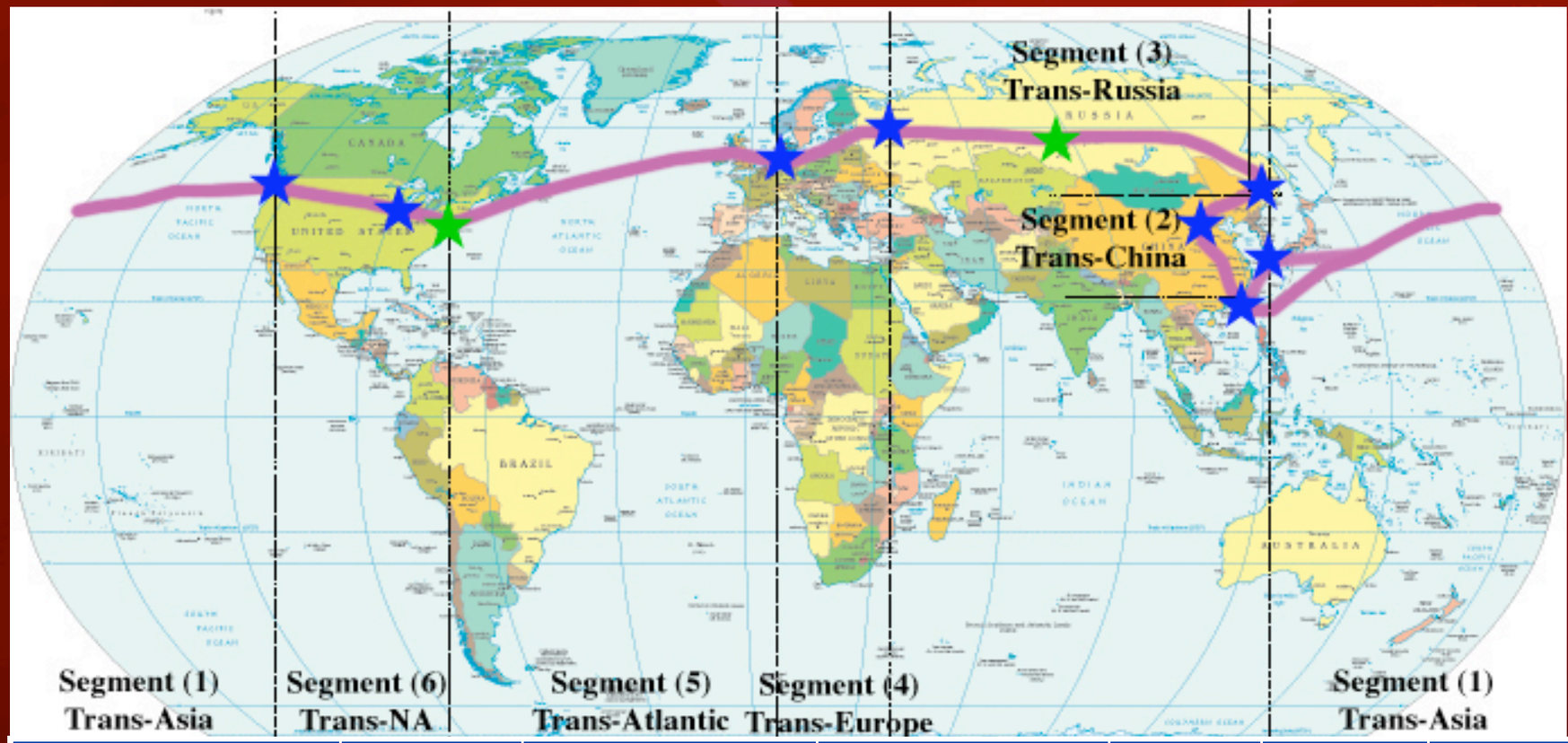
- Background/History
- GLORIAD Today, Tomorrow
- Partners and Networks
- Measurement Program
- Application Areas
- Education/Outreach Activities
- Challenges, Issues

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, 10 Gbps US-Korea-China link in July, 10 Gbps US-AMS and US-China circuits in January, 2006

The GLORIAD Network Topology

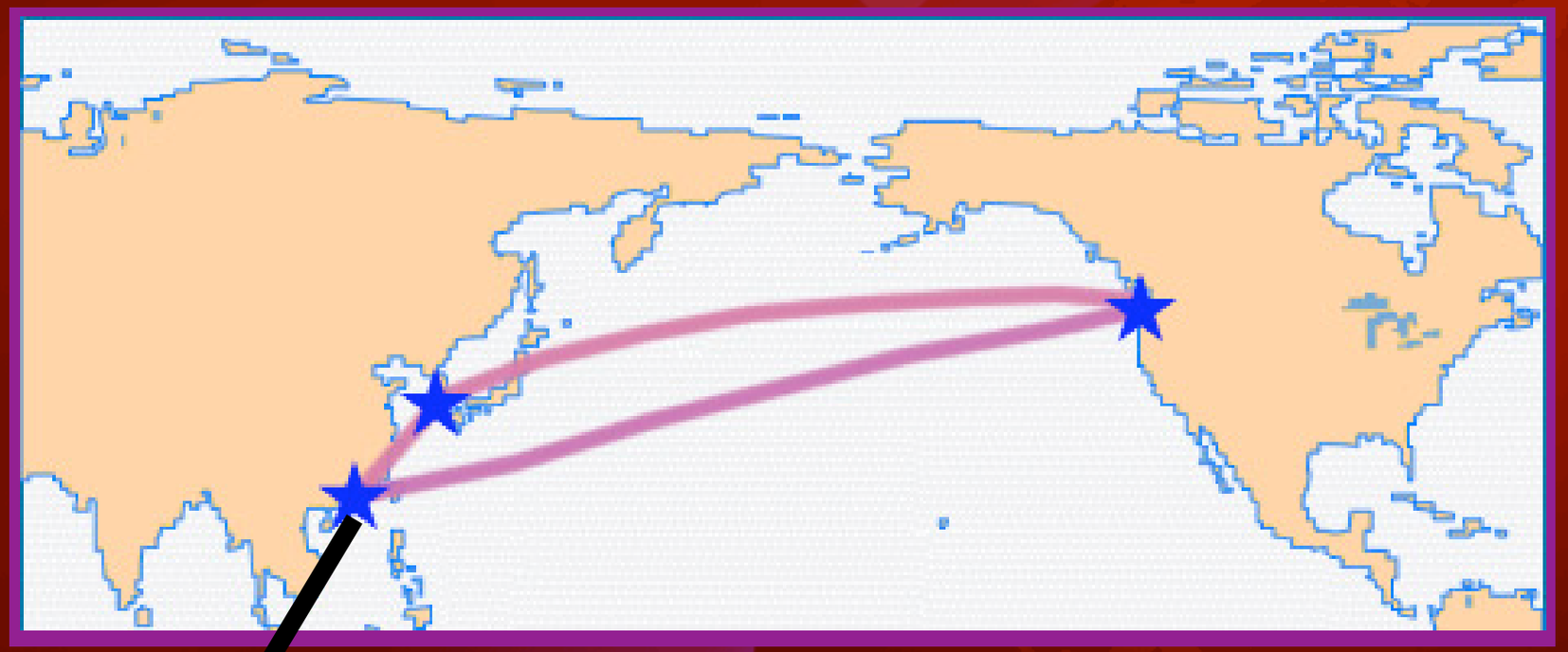
Current, Years 1-5



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)

GLORIAD Network

Today: 5/23/2005

GLORIAD Network

Date: 3/1/2006

GLORIAD Network

Date: 3/1/2007

Architecture Motivation

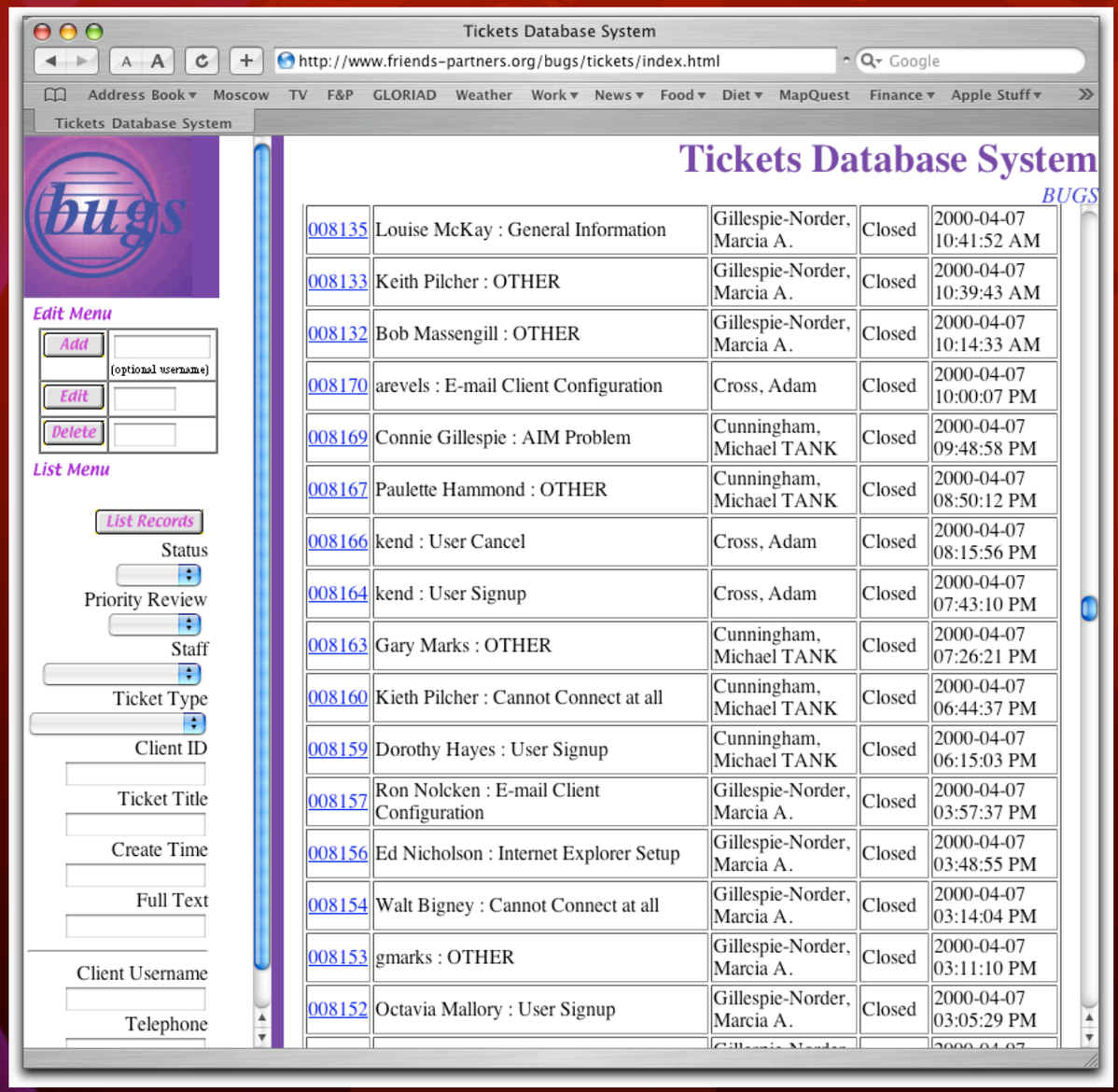
- General S&E Applications – needs met by “best effort” routed infrastructure (but minimize congestion/packet loss)
- Specialized Applications requiring high capacity, low-latency and/or controlled jitter (i.e., dedicated end-to-end circuits)
- Network research/experimentation testbed
- Backup/protection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

Network Design

- Using MSPP devices (i.e., Ciena CoreDirector, Cisco ONS 15454, etc.), provide own 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 just received 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

- Planning “distributed NOC”
- Deploying own trouble ticketing system (integrated with monitoring sub-systems)



Working Groups / Governance

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

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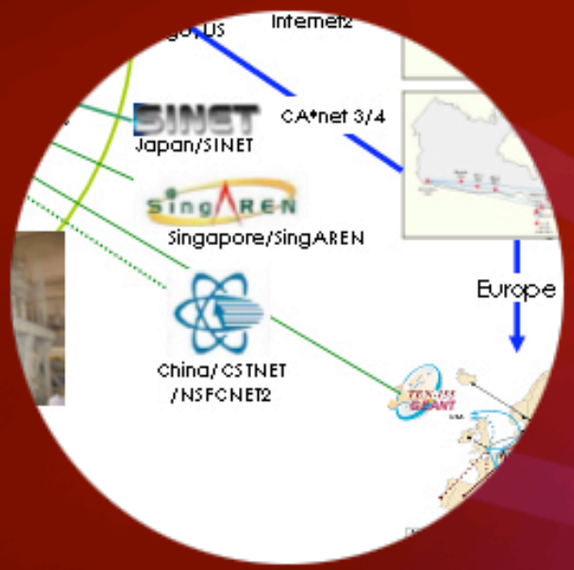
Who in Russia?

- 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 (RBNet)

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
- China Science & Technology Network (CSTnet)

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)

Who in Europe?

- 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.

Who Ties it Together?

- Tyco Global Networks: Trans-Atlantic and Trans-Pacific Provider; is both important service provider and research partner since the beginning of GLORIAD
- Russia: RosTelecomm
- China: China Netcom
- North America: CANARIE

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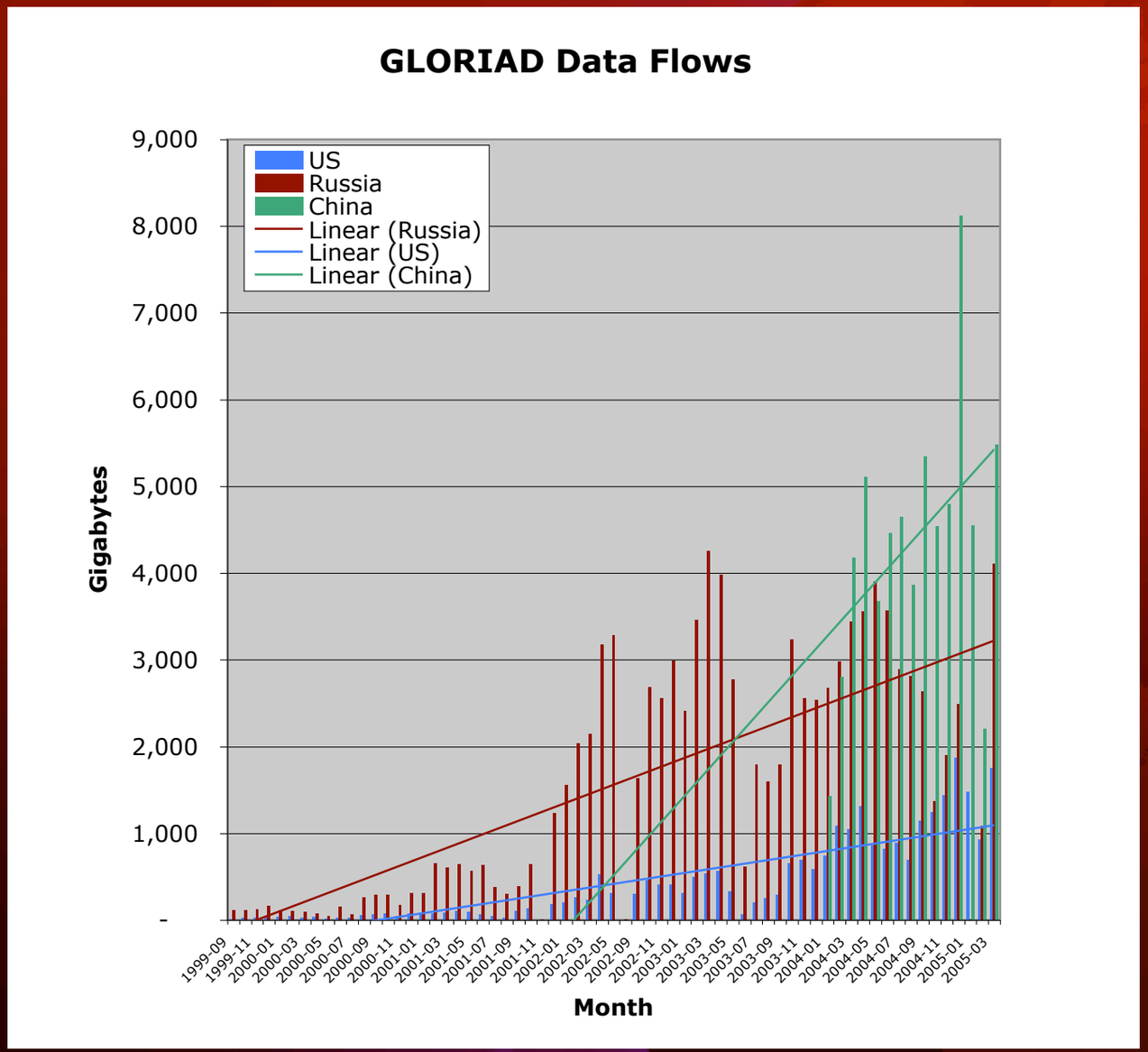
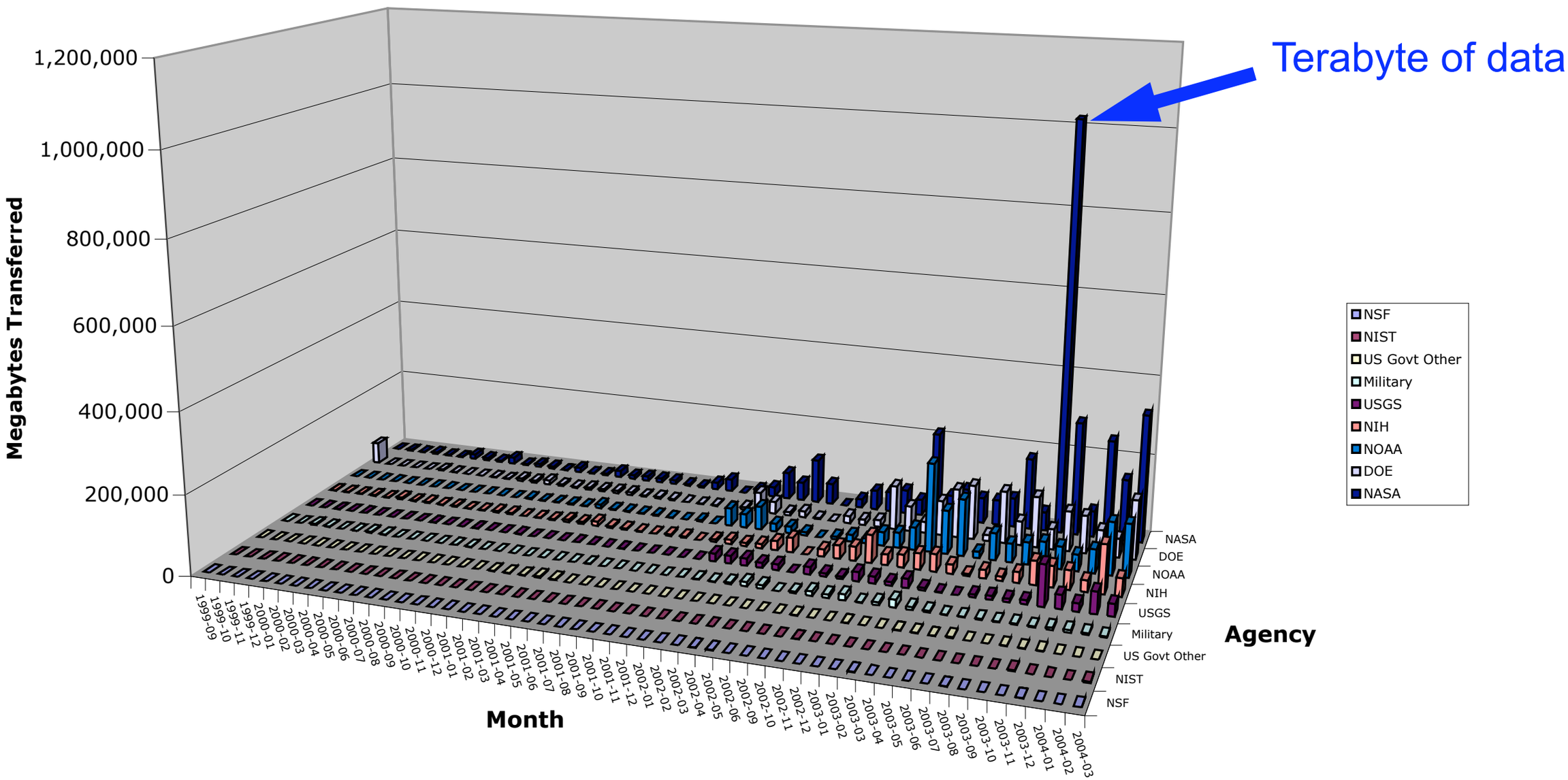
Monitoring Program

- 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



Top US Govt Agencies Supplying Data to Russia via GLORIAD



GLORIAD Traffic from China

January, 2004

to Russia

Institution	City	Megabytes	% Total
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

Institution	City	Megabytes	% Total
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

Institution	City	Megabytes	% Total
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

Institution	City	Megabytes	% Total
Fermi National Laboratory	Batavia	13,256	2.90
U of Michigan	Ann Arbor	12,467	2.73
Purdue University - W Lafayette	West Lafayet	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

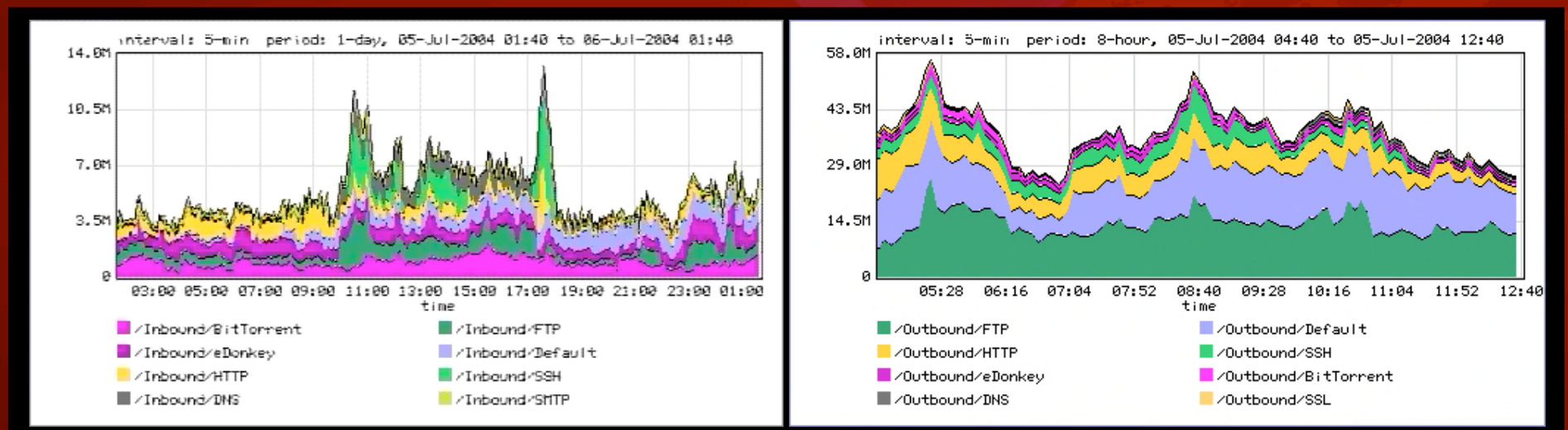
to Russia

Institution	City	Megabytes	% Total
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
Instiute 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

Institution	City	Megabytes	% Total
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 Application Utilization Monitoring System (using Packeteer Boxes)



- Monitoring
  - Institutional Use
  - Applications Use
  - Basic Performance metrics
  - Network “anomalies”

AMP (One-way) Measurements to Russia

NLANR 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
bmstu	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
vspu	182.00	463.21	1771.00	255.60	9.65	2005/3/9
vsu	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

NLANR
MEASUREMENT & NETWORK ANALYSIS

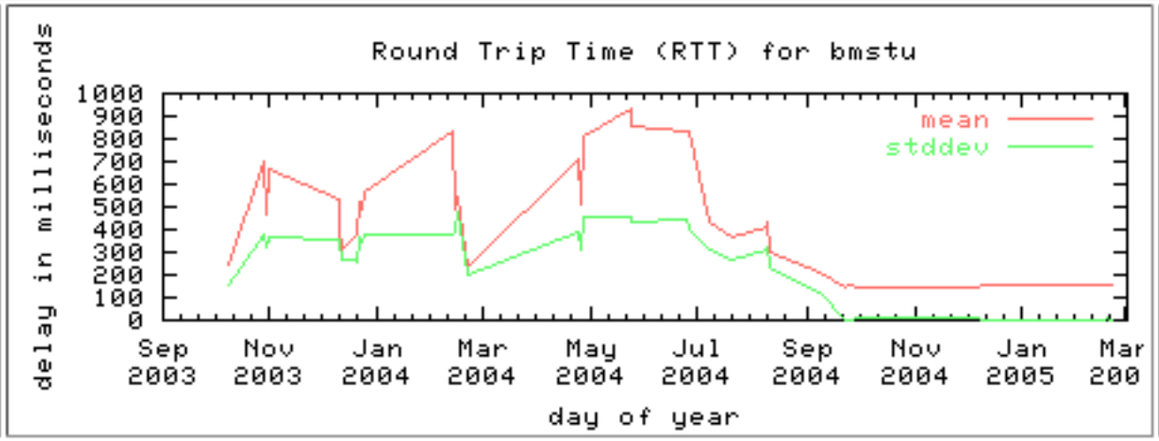
RTT And Loss Measurements

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

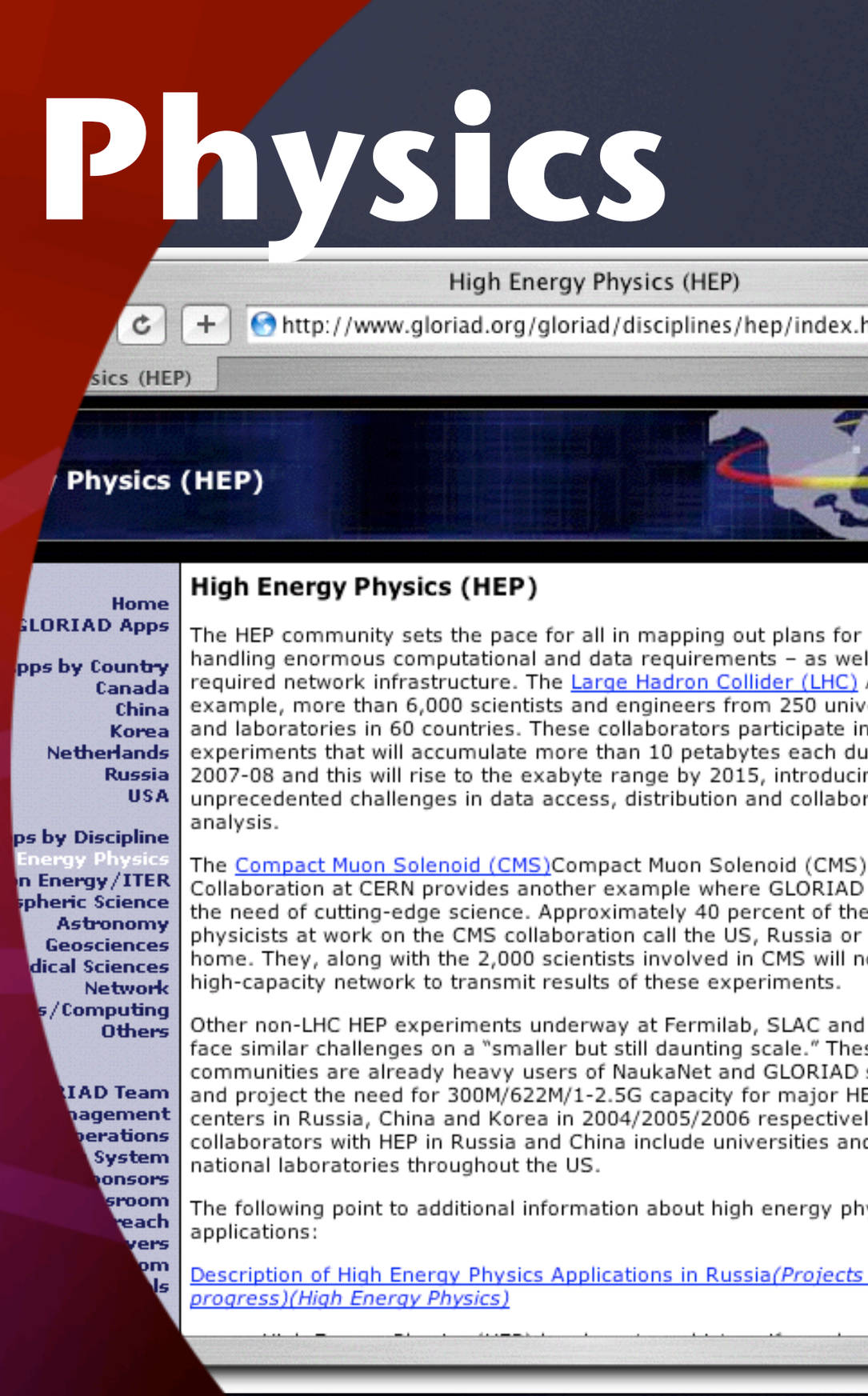
- Serving ITER, High Energy Physics, Astronomy, Atmos. Sciences, Earth Sciences, Bio Sciences, Telemedicine, Materials Sciences and many others
- Serving humanities and social sciences
- Serving Nuclear Non-Proliferation, Materials Protection, Anti-Terrorism, International Security
- Serving Educators: 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



Fusion Energy

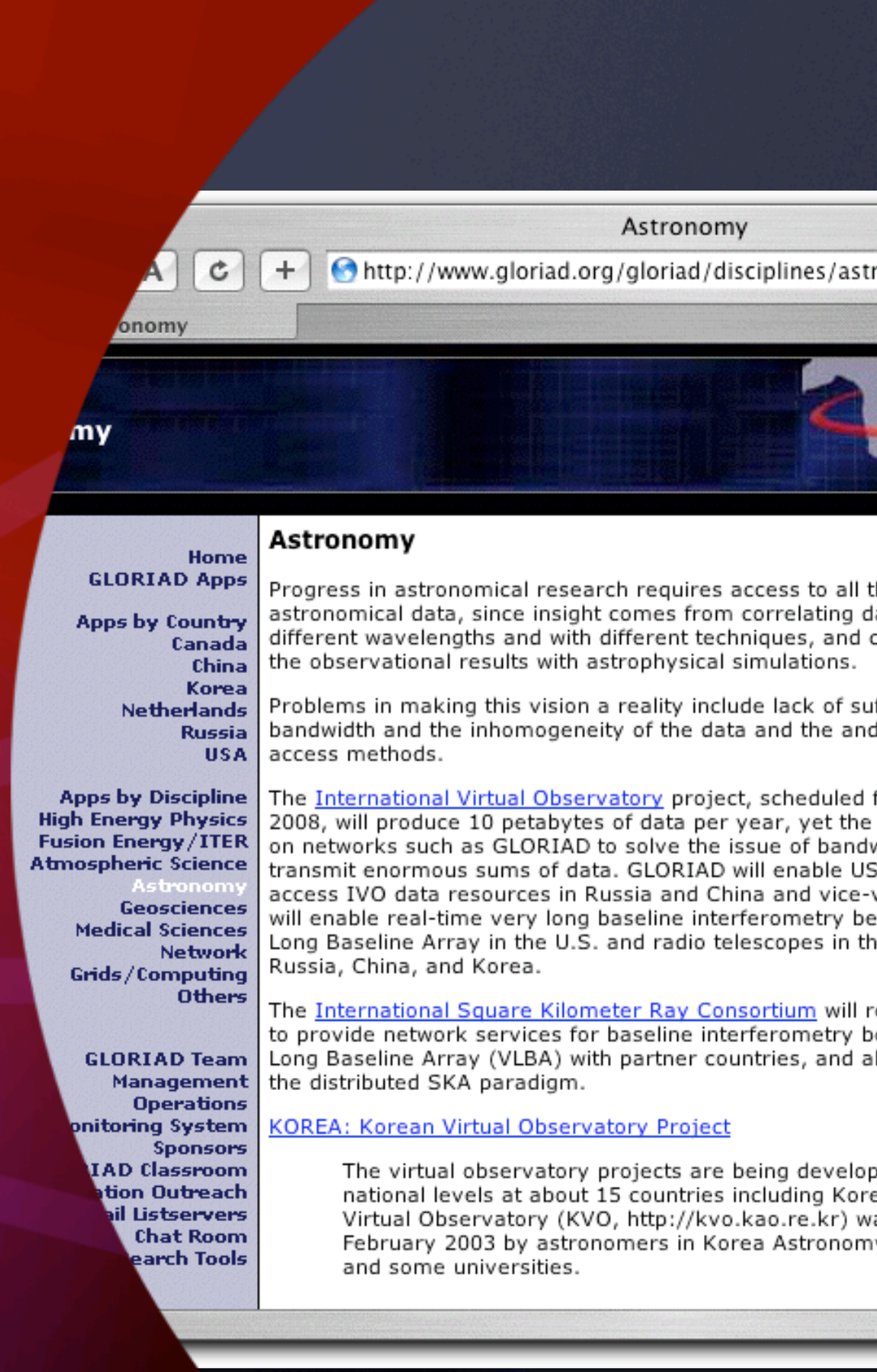
International Thermonuclear Experimental Reactor

- 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 (either France or Japan); #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 (at ORNL), need to cooperatively control experiments remotely, massive data storage and transmission requirements

GLORIAD/ITER-Grid Meeting, December 21, 2003

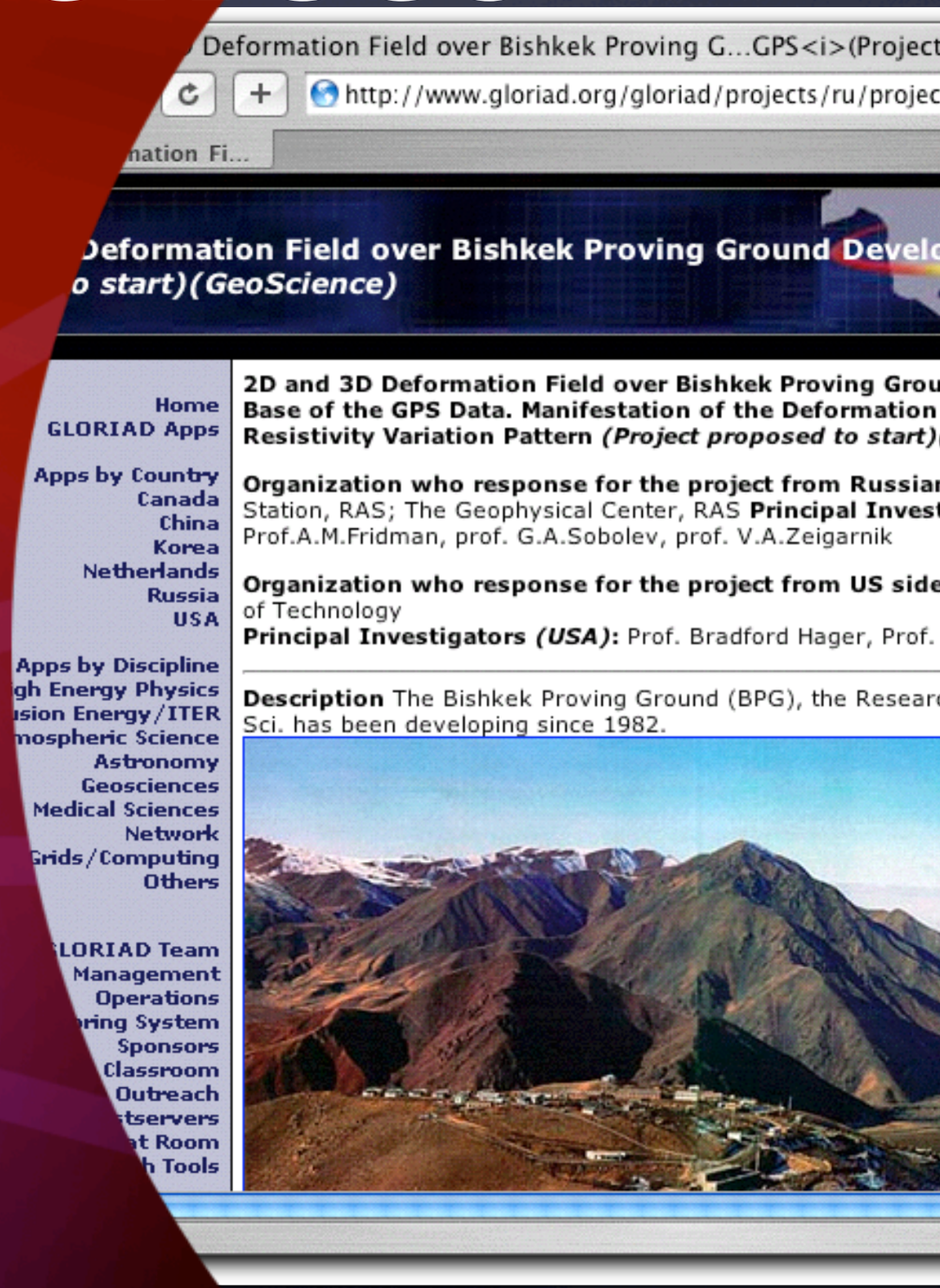
Astronomy

- 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



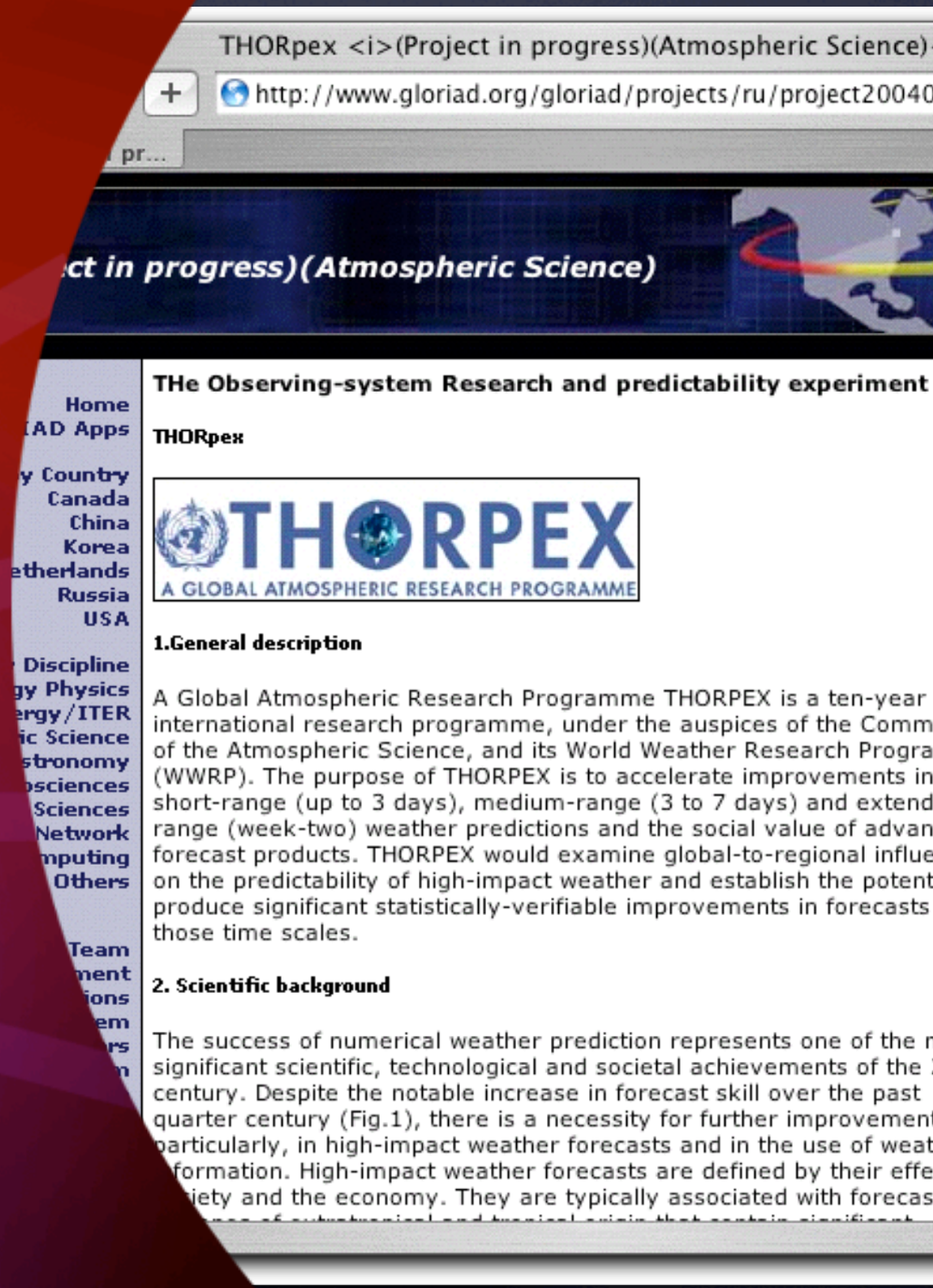
Earth Sciences

- 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



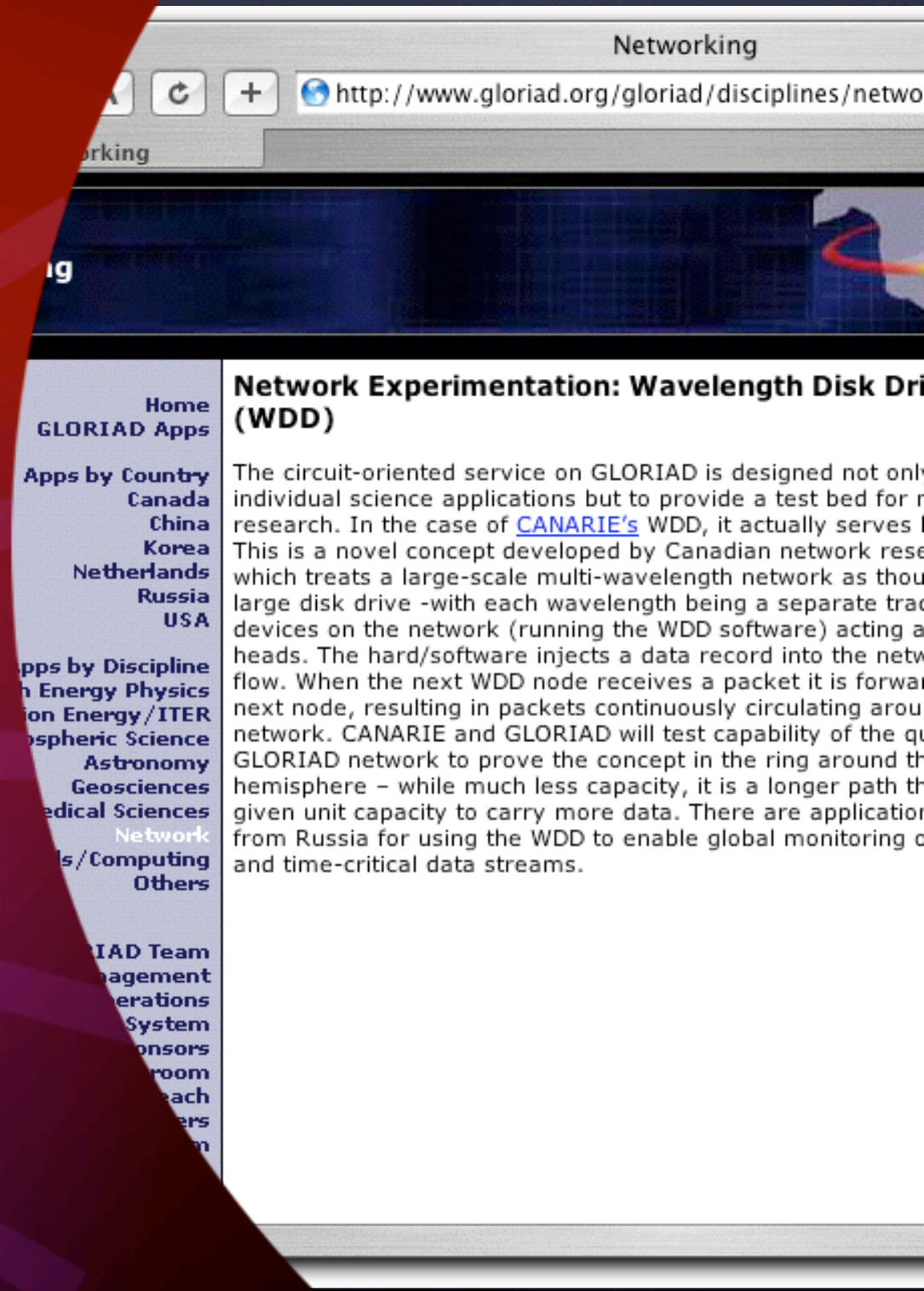
Atmospheric Sciences

- 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.



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

Presentation

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- 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, Pusan)
- 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
- 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/contintental circuits, “Friends and Partners”

Global Ring Network for Advanced Applications Development (GLORIAD) and Digital Divide Issues

Animation by Chinese Academy of Sciences
Computer Network Information Center

International ICFA Workshop on HEP Networking, Grid and Digital Divide Issues for Global e-Science, May 24, 2005

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