MIRnet Final Report for the 1999-2000 Program Year
ending June 30, 2000

US Principal Investigators: Greg Cole and Joe Gipson

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Steve Goldstein, Program Officer

Introduction

The following provides a summary of accomplishments of the second year of funded activity under the NSF cooperative agreement ANI-9730330 and referred to in the remainder of this report as “MIRnet”.

The inaugural video-conference for the US-Russian high performance MIRnet network was held between Moscow, Washington and other U.S. sites on September 17, 1999.

A 6 Mbps IP over ATM service has been operating reliably since July 26, 1999 for transit of MIRnet traffic terminating at the STAR TAP facility in Chicago and at the M9 telecommunications station in Moscow.

In December of 1999 a contract was finalized with Ameritech and, in January, local Chicago service established replacing the temporary arrangements graciously provided by Teleglobe during the first year of the project. Service from Chicago to Moscow is provided by Teleglobe and by the Russian provider RASCOM.

There have been three fairly major service outages during the past year — the first occurring September 29-30 due to a major fiber cut in Ohio (total down time was 22 hours) and the second occurring January 27-30 (problem related to Ameritech service change in Chicago) and the last on June 26-27, 2000 (total down time was 18 hours) due to a fiber cut in Chicago. Brief outages occurred on July 29, 1999 (brief Teleglobe problem), August 20, 2000 (4 hour outage due to Moscow/St. Petersburg fiber cut) and September 13 (fiber cut in Chicago).

While the MIRnet link continues to operate at the initially established level of 6 Mbps, much of the US MIRnet team’s efforts during the past year has focused on increasing capacity of the circuit to 155 Mbps. An excellent price from Teleglobe will enable this service increase with an additional $800K annual commitment from the US side and similar financial commitment from the Russian side. The Russian financial commitment has already been received; we continue efforts with DOE and other federal users of MIRnet services to secure the US commitment. Our primary goals for project development now are to put in place this new level of service by September 2000 and to dramatically increase the number of high performance applications.

Network Configuration and Institutional Routing

We are using the same networking equipment in Chicago and Moscow and the same basic configuration referenced in the first annual report - i.e. an ATM PVP between the two MIRnet ATM switches is configured for 6 Mbps with a 4 Mbps PVC configured for IP traffic and a 2 Mbps PVC for scheduled applications

Peering arrangements are in place with the vBNS , Argonne National Laboratory, and NASA’s NREN and NISN networks. On Monday, June 13, 2000, a major technical improvement was made to the MIRnet network. Linda Winkler of Argonne National Lab working with MIRnet co-PI Joe Gipson, completed peering arrangements be-

tween the MIRnet router in Chicago and the STAR TAP router. This arrangement now makes it possible to easily exchange traffic with all high performance networks peering with the STAR TAP router including the US Department of Energy's ESnet, the Abilene Network and various international networks such as TRANS PAC and Eurolink. Since this change was made, we have already observed sizable data flows between Russia and other countries - such as FTP flows between the Kurchatov Institute and CERN facilities in Switzerland. Most of the US educational/scientific high performance network world is now routed across MIRnet.

Domain		Traffic from US (bytes)	% Total
01. msu.ru	Moscow State University	562,839,674,893	53.9%
02. chg.ru	Chernogolovka Science Center	311,277,204,253	29.8%
03. ac.ru	FREEnet Web	70,037,186,399	6.7%
04. ras.ru	Russian Academy of Sciences	18,897,277,099	1.8%
05. ipmce.ru	Inst of Precision Mechanics & Computer Equipment	16,999,669,824	1.6%
06. rssi.ru	Russian Space Science Internet	16,798,740,613	1.6%
07. msu.su	Moscow State University	8,818,855,274	0.8%
08. free.net	FREEnet Web	5,020,067,190	0.5%
09. ccas.ru	Computig Centre of RAS	4,666,829,176	0.4%
10. uran.ru	Ural Branch of the Russian Academy of Science	2,641,025,084	0.3%
11. cplire.ru	Inst of Radioengineering & Electronics	2,550,162,916	0.2%
12. nmr.ru	Nuclear Magnetic Resonance Lab	2,526,018,390	0.2%
13. unicor.ru	University Knowledge Networks Corp.	2,495,821,698	0.2%
14. mephi.ru	MEPHI	2,466,807,511	0.2%
15. wdcb.ru	Geophysical Center RAS	2,143,171,904	0.2%
16. gpi.ru	General Physics Institute of Russian Academy of Science	1,860,971,983	0.2%
17. kiae.ru	Kurchatov Institute	1,486,869,504	0.1%
18. lasenet.ru	Institute on Laser and Information Technologies	1,179,794,046	0.1%
19. pmc.ru	Medical Center of RF President's Management Office	1,161,662,535	0.1%
20. museum.ru	Museums of Russia	952,117,241	0.1%
21. msu.net	Moscow State University	940,972,430	0.1%
22. gpntb.ru	State Public Library for Science and Technology	917,495,634	0.1%
23. decsy.ru	DEC Russia	667,938,176	0.1%
24. com.ru	Analytic TelecomSystems	568,514,916	0.1%
25. novgorod.ru	Novgorod	533,502,722	0.1%
26. Other	Other	3,286,723,691	0.3%
Total		1,043,735,075,102	100.0%

This table illustrates 25 network domains in Russia responsible for 99% of the terabyte of traffic transferred across MIRnet to Russia during this first year of operation.

In Russia many new Moscow based institutions have been added during the past year. Moscow State continues to be the primary user as is the scientific city of Chernagolovka. Other institutions added during the last several months include the prestigious Kurchatov and the Bauman Institutes. The Russian Academy of Science's network is routed across MIRnet, as is MEPHI and the Russian Space Science Internet (RSSI). A table illustrating Russian network domains for which MIRnet has been routing traffic during the past year is included at left. Also included is a table showing the US networks from which information was transferred.

While much progress has been made in this area during the past year, Russian connectivity for use of MIRnet remains a serious weakness. While arrangements for connectivity of institutions in St. Petersburg were proposed after a US delegation visited Moscow and St. Petersburg in September 1999, there is still no use of MIRnet in St. Petersburg. Also, while there is very strong interest on the part of several scientific institutions outside of Moscow and St. Petersburg to connect and, while in many cases there is sufficient local network capacity to enable some high performance applications, these institutions have not been approved nor routed across MIRnet.

Domain		Traffic to Russia (bytes)	% Total
01. nlanr.net	NLANR Network Center	277,286,015,750	26.4%
02. gatech.edu	Georgia Tech	94,919,814,992	9.1%
03. anl.gov	Argonne National Laboratory	58,574,929,102	5.6%
04. unh.edu	U of New Hampshire	55,712,422,175	5.3%
05. iastate.edu	Iowa State University	54,590,711,620	5.2%
06. mit.edu	Mass. Inst. of Technology	45,137,383,344	4.3%
07. nd.edu	U of Notre Dame	40,012,382,442	3.8%
08. nasa.gov	NASA	33,153,516,891	3.2%
09. unc.edu	U of North Carolina	32,527,803,536	3.1%
10. ucar.edu	Univ. Corp for Atmospheric Research	23,161,680,390	2.2%
11. nih.gov	Nat'l Inst. Of Health	22,787,672,292	2.2%
12. utk.edu	U of Tennessee, Knoxville	22,751,001,881	2.2%
13. pitt.edu	U of Pittsburgh	21,039,783,117	2.0%
14. wisc.edu	U of Wisconsin-Madison	14,492,366,791	1.4%
15. colorado.edu	U of Colorado Boulder	13,638,947,116	1.3%
16. berkeley.edu	U of California Berkeley	9,748,921,613	0.9%
17. uchicago.edu	U of Chicago	9,354,919,951	0.9%
18. ucsd.edu	U of California San Diego	9,079,996,949	0.9%
19. columbia.edu	Columbia University	8,875,318,319	0.8%
20. cornell.edu	Cornell University	7,283,233,724	0.7%
21. caltech.edu	California Institute of Technology	6,972,887,432	0.7%
22. vt.edu	Virginia Tech	6,881,060,316	0.7%
23. rutgers.edu	Rutgers State U of NJ	6,405,255,794	0.6%
24. fsu.edu	Florida State University	6,337,151,903	0.6%
25. nmsu.edu	New Mexico State University	6,154,804,740	0.6%
26. Other	Other	161,675,479,929	15.4%
Total		1,048,555,462,109	100.0%

This table shows the 25 US domains responsible for Russian traffic represented in the table above.

The biggest challenge for the MIRnet project in the year ahead is to eliminate the restrictions placed on access to Russian scientists and and to begin extending the reach of MIRnet to quality scientific and educational institutions across Russia. There is a very good strategy in place for doing so — contingent on putting in place the 155 Mbps service referenced earlier in the report.

Network Monitoring and Reporting

24x7 monitoring of the MIRnet link is established on a UNIX server with special software designed to page four MIRnet team staff members in the event of any network failures. This system works adequately but as the capacity and use of MIRnet grows in the next year, a transition from this simple system to a true 24x7 network operation center facility is necessary. Efforts are currently underway to subcontract NOC services and some network engineering support to the engineering team at the University of Indiana. They provide this same service for the Abilene network, TRANPAC, Eurolink, and STAR TAP. Economically it does not make sense to try to duplicate those services locally when the increased costs for utilizing services at IU are only marginal.

The MIRnet-HPIIS web-site is maintained on the US-Russia Friends and Partners servers in Knoxville and in Moscow. As mentioned in the previous annual report the site uses an underlying database for better site management and end-user services. This rather large web-site is now available entirely in both English and Russian languages. We also maintain listservers, web-based archives, and a chat room (which we have still not used).

MIRnet Usage Monitoring

During the first quarter of the second year's activity the MIRnet team in the US and with Natasha Bulashova from the Russian team completed and put in place a new system for monitoring and reporting MIRnet usage. The MIRnet administrative data analysis system (MADAS) is designed to monitor and illustrate usage in easily understandable graphs and tables (updated every 10 minutes, every hour, and every 24 hours) which show usage by timeline, protocol, top users, destination domains, source domain, etc. The new system is in place on the MIRnet web-site in Knoxville and in Moscow at:

http://www.friends-partners.org/friends/mirnet/madas/
http://www.friends-partners.ru/friends/mirnet/madas/

The Moscow and Knoxville machines are synchronized with the rsync software that we implemented in August. The publicly accessible version of this system (which does not contain domain or host machine statistics) is located at:

http://www.friends-partners.org/friends/mirnet/activities/perf.stats
http://www.friends-partners.ru/friends/mirnet/activities/perf.stats

The MADAS system is a very important component of the MIRnet Access Scheduling System on which work continues. MADAS provides a database and software system for capturing all data representing usage of the MIRnet network. This includes participating hosts, IP services, volume of data transferred, and date and time of use.

Promotional efforts and identification of potential users

A brochure was prepared and printed during the early part of this project year briefly describing MIRnet and providing basic project contact information. This brochure has been distributed widely. While activities to date have focused on providing for reliable

network service and expanding the pool of potential networks in the US and Russia able to use MIRnet, efforts now are shifting toward identifying appropriate applications benefiting from high performance network service.

Mailing to US scientists and educators

A personalized letter mailing is being prepared now which will be sent to over 1,000 scientists and educators who have been funded to work on various US/Russian scientific and educational projects. The database for this mailing is largely complete. A summary of records from this database is included in the appendix. It illustrates the nature of partnerships being funded by such agencies as the National Science Foundation, US Department of Energy, the Civilian Research Defense Foundation (CRDF) and the National Institutes of Health. We are currently gathering additional information from agencies such as NASA and US Department of State. While the initial mailing will go out in mid-July, we are plannning a second follow-up mailing to additional scientists and educators in early September.

The latest version of the database is available on the web at:
http://www.friends-partners.org/mirnetusers/

Federal Agency Partnerships

Much effort has been devvoted since November 1999 to securing interest and financial support of the US DOE in expanding MIRnet services. Conversations, meetings, and correspondence with other agencies such as NASA, US Dept of State, NOAA, and DOD indicate widespread and growing interest in high performance applications beneficial to existing federally sponsored US-Russia programs.

We are currently planning a meeting at the NCSA access center in Washington DC during the first week of August, 2000 of different federal agencies and other organizations interested in use of MIRnet services. The focus of this meeting is to discuss high performance applications and to highlight potential applications from the meeting participants.

"MIRnet News" Newsletter

The first bi-monthly issue of the "MIRnet News" newsletter will be published in time for the August meeting in Washington and published regularly thereafter. It has become clear during the last year that there is a need for a print periodical describing MIRnet, updating interested parties on its progress, and highlighting high performance US/Russian applications. While the first issue will focus more on a description of the MIRnet network and project, the second issue (to be distributed in late September) will highlight applications.

Russian Travel

There were four trips made to Russia this year in connection with growth and expansion of MIRnet - two of which were funded under the MIRnet grant. The first, funded by MIRnet, was a September visit by John Jamison, who at the time was serving as chief STARTAP engineer, and agreed to go to assess the Russian networking environ-

ment in Moscow and in St. Petersburg, and to encourage (with the assistance of NSF's Bob Borchers) the creation of an access point in St. Petersburg. The trip coincided with the video conference between Moscow State University and the "Chataqua" event in the US - in many respects an 'inaugural event' for the MIRnet project. While this trip was successful on many points, the problem remains of no access point for St. Petersburg institutions.

Meetings were held in Moscow in October/November 1999. Project Director Cole met with Russian participants Bulashova and Platonov to discuss interest of US DOE (and particularly the Oak Ridge National Laboratory) and the Kurchatov Institute in utilizing MIRnet to support their many collaborative activities. At this time strategy was discussed for encouraging interest on both sides in expanding the MIRnet circuit and services to a much larger capacity. While several meetings and discussions related to MIRnet were held on this trip, the travel funding was provided by the Eurasia Foundation for work on the US/Russian Civic Networking Program.

Oleg Bulashova travelled to Moscow during late February, 2000 to install videoconferencing equipment at Kurchatov Institute (in time for Feb. 22 event) and to meet and work with RBnet engineers.

The final trip to Russia made during this project year, funded under the MIRnet grant, was that taken by Project Director Cole to continue discussions about expansion of MIRnet and involvement of US DOE in that expansion.

Events and General Usage

Since its initial operation in July 1999, the MIRnet network has carried an enormous amount of traffic between the US and Russia. Analysis of usage date shows a sizeable number of applications between Moscow State University and various educational institutions in the US. These applications have included FTP, video conferencing, video streaming, web and other applications.

Another very interesting set of applications has been monitored between the network in Chernogalovka and the NLANR network center in California. Chernogalovka provides the root cache for the Russian web; it both feeds and draws cache information from the central repositories at the NLANR facility. Chernogalovka provides services for the entire Russian academic community including the web cache, but also including FTP archives of public domain and open source software.

Events

(1) On September 14th we held our first high quality video conference using MIRnet. The occasion involved linking two high performance network workshops - one in the US called the "Chatauqua 99 Workshop" in Boston, Mass., and a similar workshop in Moscow organized by the Russian Academy of Science and Moscow State University. The event coincided with a meeting of the Gore/Chernomyrdin telecommunications working group and thus involved visiting US delegation headed by Dr. Bob Borchers of the US National Science Foundation. The videoconference marked a special "inaugural" milestone in the development of the MIRnet project.

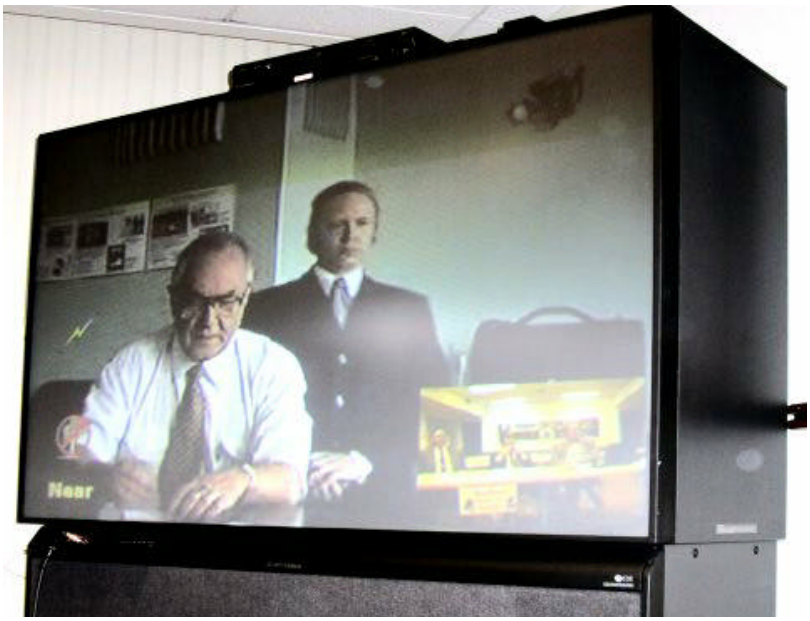
(2) Our most publicly visible (and in many ways most successful) public event was held on February 22nd. The event was a two-hour video conference involving the Kurchatov Institute in Moscow, the National Science Foundation in Washington DC, the Oak Ridge National Laboratory, and the University of

US participants interact with Dr. Evgenii Velikhov, President of the Moscow Kurchatov Institute and other Russian academicians during the February 22 video-conference between Moscow, Washington, Knoxville and Oak Ridge.

Tennessee in Knoxville - hosted by UT Vice President Dr. Dwayne McCay, incoming ORNL Deputy Director Lee Riedinger, and the Kurchatov Institute President and Academician Evgeni Velikhov.

The event featured discussions and presentations by ORNL's Al Trivelpiece, NSF's Steve Goldstein and Bob Borchers, and various scientists at the Oak Ridge National Laboratory and the Kurchatov Institute. The science discussed and demonstrated involved a "radio propagation analysis" project between ORNL and Kurchatov involving facilities in Vladivostok, Russia and a joint project involving nuclear reactor facilities. In brief, the event was much better than hoped - both technically, but more importantly, in terms of the content shared and the enthusiasm expressed for expanding capabilities and reach of this new facility. The videoconference was a first important step in our efforts to illustrate the potential of high performance networking to meet the US Department of Energy's needs for its many project activities in Russia. It is part of our general strategy for increasing the bandwidth and the reach of MIRnet throughout Russia. A copy of the powerpoint slides which were used to drive this rather unique four site presentation and video conference are included in the appendix of this report.

(3) A follow-up event was held on June 14th between the Kurchatov Institute, the National Science Foundation, Oak Ridge National Laboratory, and Argonne National Laboratory. The reason for staging the event was related to the visit to Oak Ridge by former Senator majority leader Howard Baker and DOE Deputy Secretary Rose Gottemoeller as part of a blue ribbon panel established by DOE Secretary Richardson to review US/ Russian programs - particularly those related to nuclear non-proliferation activities. The event involved David Hill, Larry Amiot, and Jeff Bender from Argonne National Lab; NSF's Steve



Academician Ponimarev-Stepnoi (seated, on screen from Moscow) of the Kurchatov Institute addresses the June 13, 2000 video-conference involving participants from Moscow, Washington, Chicago and Oak Ridge.

Goldstein, and MIRnet Project Directors Natasha Bulashova and Greg Cole from the NCSA access center in Washington DC; a large group from the Oak Ridge National Laboratory (including DOE panelists), and featured a surprise visit by Russian Academician and Kurchatov Vice-President Nicholai Ponomorov-Stepnoi. The discussion was frank and interesting for all participants. The MIRnet network and all conference end-points performed flawlessly for the duration of the 45-minute session. This event represents a second major milestone in our efforts to illustrate to the DOE the potential of a much larger MIRnet circuit. The MIRnet team wishes to express its gratitude to David Lambert and others at ORNL who worked so hard to make this event possible, and a special word of thanks to Linda Winkler and Larry Amiot of Argonne National Laboratory who worked over several days to make appropriate network changes and to facilitate the video conference itself with equipment managed from Argonne.

Of course, these videoconferences are merely a part of the "overhead" as we work to expand the MIRnet program. The value of MIRnet results from the thousands of data flows by partnering scientists, educators, and engineers in Russia, the US, and other connected international high performance networks. A more complete summary of usage since September 1 is found at the end of this report. These usage statistics provide an interesting but incomplete picture of the value of this network, which ties together scientist and educators from nearly all first tier US educational institutions, scientific laboratories, and research facilities, and a growing number of scientific institutions and facilities in Russia.

Other Activities

In late February, we completed negotiations with Teleglobe for a 155 Mbps circuit between Moscow and Chicago. The US cost for this 155 Mbps service would be about $110,000 per month. This compares very favorably to the $46,667 per month that we are currently paying for 6 Mbps. We have assurances from Russian partners that the Russian cost for this increase will be met assuming we identify US funds (from DOE, NASA, others) to meet the monthly increase.

In May 2000, we were notified that our REU (Research Experience for Undergraduates) application was granted for $12,500 enabling us to hire two undergraduate students to work on the MIRnet projects. One of these students will work full-time during the summer and half-time during the academic year; the other student is to work half-time during the academic year. We have already hired the first student for this grant, Nick Poore, who will work full-time on MIRnet from July 5th through the end of August, and who will then begin working half-time. Initial tasks assigned are related to improvements to the MIRnet administrative data analysis system for MIRnet traffic monitoring and reporting. Later responsibilities focus on the MIRnet access scheduling system. We feel that both projects are challenging, interesting and very relevant for the project and for the student's education. We will be hiring another student to begin work on the project in September.

Issues and Challenges

While up time for MIRnet has been greater than 95%, there have been several unscheduled outages. A few of these have been related to unfortunate cable breaks. Since the MIRnet circuit is not restored, these have been commplete service outages. One outage, however, was due to Ameritech's failure to notify Teleglobe (and the University of Tennessee) of a network change. This resulted in our worst outage of 4 days.

A more critical issue on which a lot of time and effort was spent during the early part of this project year (July and August) was related to Moscow State University's decision to cut off advertisement of routes to and from MIRnet. Evidently it had been their intention to more selectively choose US networks and institutions which were to be routed across MIRnet (although in the original proposal and in all discussions it was clear that the entire vBNS would be routed). It took quite a bit of time and effort on the part of MIRnet management, the National Science Foundation, and even individuals in the diplomatic service in Moscow to resolve the problem and to get service restored on MIRnet. The outage in late June through July 21st gives us the latter official start date (even though the network was working in June). The difficulties associated with this have largely eased now; the event represents the single biggest challenge we have had to face on MIRnet to date.

Another critical issue has been the failure to install networking equipment in St. Petersburg to enable access by several institutions which have expressed interest and have appropriate applications. Quite a bit of time and effort was expended by the US MIRnet team, the National Science Foundation and by STAR TAP's chief engineer John Jamison on travel to Russia largely to discuss US concerns about lack of connectivity in St. Petersburg. The issue, however, still remains unresolved. Our efforts to increase the size of MIRnet and work again with the RBnet network should eliminate the concerns related to St. Petersburg (as RBnet maintain excellent network presence there and has expressed its own desire to route St. Petersburg institutions).

Program Plan for Year 3

The next year for MIRnet promises to be an exceptionally busy one. In the following pages we outline major program improvements and activities which fall under the two general categories of extending capacity of the physical link and expanding the base of applications.

(1) Extend Capacity of Link to 155 MBPS

The first goal is extending the capacity of the link between the US and Russia to 155 Mbps and to extend the "reach" of MIRnet in Russia to institutions — not only throughout Moscow and St. Petersburg, but to other academic centers in Russia. We have had numerous discussions with international network companies and with academic network management in Russia and feel this broad and aggressive goal is within reach this next program year. While our initial program plan involved increasing to 34 Mbps during this third year, the quote we have received for the international connection and the configuration and demand we expect of the network dictates that we move to 155 Mbps during this year. While motivation is largely obvious (increased bandwidth means true high performance applications and more of them) moving to higher bandwidth also allows our Russian partners to relax the very tight control over who is routed over the network in Russia and enables us to work more directly with our original partners at RBnet (Russia Backbone Network) on extending the reach of MIRnet to institutions throughout Moscow, St. Petersburg, Novosibirsk, and the other scientific cities and institutions.

(2) Expand Number of Scientific Applications

The second goal is to expand the number of high level scientific applications utilizing MIRnet services - the more challenging of the two broad program goals.

While rather constant monitoring of the MIRnet link shows appropriate applications between networks in the US and Russia and while we are confident of the project's success at facilitating and encouraging applications that would otherwise not be possible, we will work to increase dramatically the number of appropriate applications and to document the stories behind these applications in order to benefit other potential MIRnet users and to expand again the number of applications. There are several components of our strategy for accomplishing this.

The first relates to the program goal mentioned above: increasing the size of the network and extending its reach to institutions and facilities throughout Russia. While MIRnet reaches most of the very best institutions in Moscow, the Russian high performance network connected with MIRnet does not come anywhere close to making available to US scientists the facilities and expertise that MIRnet offers the Russian scientists (basically we currently offer to Russian connected institutions the entire US high performance scientific community) thus, a realization of this second goal is very much related to our success with the first.

Second, we intend to increase knowledge of MIRnet among the scientific community. Towards this goal, we have completed in the past few weeks a rather large database describing US/Russian scientific partnerships funded by such agencies as the National Science Foundation, the US Department of Energy, NASA, NIH, and the Civilian Research Defense Foundation. This database is on-line and available for searching at:

http://www.friends-partners.org/mirnetusers/

We are preparing a mailing to go out in mid-July to all of the US scientists listed in this database covering some literature about MIRnet and the first issue of the bi-monthly newsletter referenced earlier. Most of the institutions employing these individuals are already routed across MIRnet. We simply wish to make them aware of this infrastructure for supporting their continuing work with Russian partners and to solicit their suggestions and advice for development and expansion of MIRnet services. This mailing is related to our broader activities of developing a community in the US and in Russia with interest in the success of this project.

Third, we plan to continue the work in which we've been involved over the last year in soliciting participation of of organizations funding joint work between the US and Russia. We are organizing a meeting to be held during early August, 2000 at the NCSA access center in Washington DC of several federal (and non-federal) agencies responsible for funding project activities in Russia and with valid application for high performance network services to support scientific and educational exchange. In the past few weeks we have had discussions with organizations such as NSF, DOE (including several national laboratories and DOE headquarters in Washington DC), DOD (the Army JAG School at the University of Virginia), NASA, the US State Department, the US Department of Commerce, NOAA, and some non-federal agencies such as IREX, the World Bank, the Civilian Research Defense Foundation, and others. Our intention is to have the first of a planned series of meetings where we can demonstrate MIRnet capabilities and have participants discuss their own applications. This is another part of our strategy in developing and supporting a community of individuals and organizations that have a stake in the success of MIRnet.

Finally, our fourth strategy involves completion of the MIRnet Access Scheduling System (MASS). One reason for under-utilization of high performance networks to date is the newness of the technology and inexperience within the scientific community in utilizing the technology. But, these high performance networks are not yet viewed as a stable, reliable resource. For high performance applications such as video conferencing, high volume data transfer, remote instrumentation, telemedicine, etc., the networks promise the *likelihood* of resource availability because the networks themselves are generally over-provisioned. While this has been adequate for the testing period through which the networks have gone during the last few years, we are now reaching a point where the technologies work reasonably reliably (for example H.323 video conferencing is a reliable vehicle for meetings, etc - assuming sufficient local technical support) and demand is expected to rise. But, users cannot feel comfortable with establishing regular applications without being able to reserve basic network service.

Therefore, one very important component of MASS is the ability for users to register their applications and to reserve use of the network for certain applications and time periods with reasonable assurance that the resources they need will be available.

While much research and experimentation has been done with various quality of service solutions, the solution we are proposing for MIRnet involves instead a "segmented pipe" through which we run differentiated classes of services which can be reserved, and which are managed to ensure reasonable network service. The reservation system will involve a registry of users, applications, and networks, and a reservation database with which users can reserve service for specified dates and times. The actual approval of requests is to be policy driven as much as possible and mostly automated so that users receive immediate response and can be reasonably assured of the network's meeting their needs for whatever events they have scheduled. The database system must interact with the MIRnet end point routers in Moscow and Chicago periodically updating access control lists which govern which PVCs the end-to-end traffic traverses.

Through this system we can formalize the provision of network services so that users can feel confident about the network meeting their needs. We trust this will lead to an increased confidence in the network eventually resulting in increased use.

Some parts of this system already exist. For example, the user registration database exists and is available currently at the following URL: http://www.friends-partners.org/mirnetusers/

The elements of the system which do not yet exist include the network description component (by which partnerships are described in terms of networks they intend to use) and the scheduling component. Also, the policy database that will drive most decision-making on the service requests is yet to be implemented.

One large component of the MASS system is complete however - the MIRnet administrative data analysis system (MADAS) by which we monitor back end use of the network. This sub-system is completely operational now and will be used for providing regular reports to users about their scheduled and unscheduled use of the network illustrating what was requested and then what services were consumed. This system is a part of our general strategy of moving during the fourth and fifth year to a system by which we can begin to associate cost with use, ultimately providing a network operation that is financially sustainable without external grant funding.

There is another element to use of this system which we have recently learned is an important one to users such as US DOE and US DOD which have serious security

concerns. We have had several discussions with DOE (which, interestingly, has expressed interest in helping develop this system) in which they have indicated they do not wish large use of the network without an audit trail indicating users and their applications (indeed, one individual has suggested that DOE will want every use logged). The MASS system is interesting to this audience since it does provide a registration process - both of users and of specific applications. The MADAS component provides an audit trail of requests but also a complete accounting of actual use. While we had not factored this need into our initial planning, it is becoming an even more important justification for MASS as we anticipate DOE and/or DOD funding necessary for expansion of MIRnet services.

Our Russian partners, Natasha Bulashova, and network engineers and management at RBnet indicate strong Russian interest in development of this system. Indeed, Russian Director Bulashova is working in the US this summer on this same system. We anticipate the system being available for testing by September 1, 2000 and in full production use by the end of October 2000.

Additional Items for Work Plan

Changes within network operations at the University of Tennessee have made it impossible to establish the 24x7 network operations center promised in previous reports. While we have established reasonable alternatives - using a special UNIX hosted software system and a series of four pagers to ensure that the network monitoring is covered 24x7- this is not a good approach for network monitoring — particularly as MIRnet grows to a much larger and more heavily used service. We are in discussion currently with Indiana University about subcontracting 24x7 NOC service to them. They are already providing such coverage for other international networks and for the Abilene network. The cost for adding MIRnet coverage is only marginal. We expect to have 24x7 coverage of MIRnet in place during August 2000.

Additional issues from our last annual report relate to support for IPv6 and M-bone. To date, there has been no call for use of IPv6 tunneling for MIRnet, although we are ready to implement a tunnel as soon as applications warrant. However, we have just recently begun discussions — initiated by Moscow State University — to provide multi-cast support so that MIRnet is a part of the MBONE. We anticipate this being in place in July 2000.

Another issue relates to cache services. While the MIRnet project itself does not provide direct technical support for a web cache, one of the major applications of MIRnet this past year has been to support the web cache at Chernagalovka which itself functions as the root cache server for the Russian academic community. This has been a good success for the MIRnet network during the past year. While the interaction between Chernagalovka and NLANR facilities in the US have consumed a rather large amount of bandwidth (about 270 Gbytes), it has not impacted the network to the point of affecting other applications, and appears to be a quite reasonable use of the network.

During the past year we have not pushed the establishment of either senior technical or corporate advisory groups as we anticipate changes in MIRnet management due to the planned increased of the circuit to 155 Mbps, and to increased work with the Russian Institute for Public Network and their RBnet network which provides academic network services across Russia. Once these changes are in place, we will cooperatively (with Russian partners) establish both a corporate and a senior advisory board with representatives from federal and corporate agencies, and a technical advisory group made up of senior network engineers in the US and Russia.

One of the first tasks of senior advisory board will be assisting in securing funds for continuing a regular series of meetings of interested MIRnet users and partners.

MIRnet Technical Committee Report

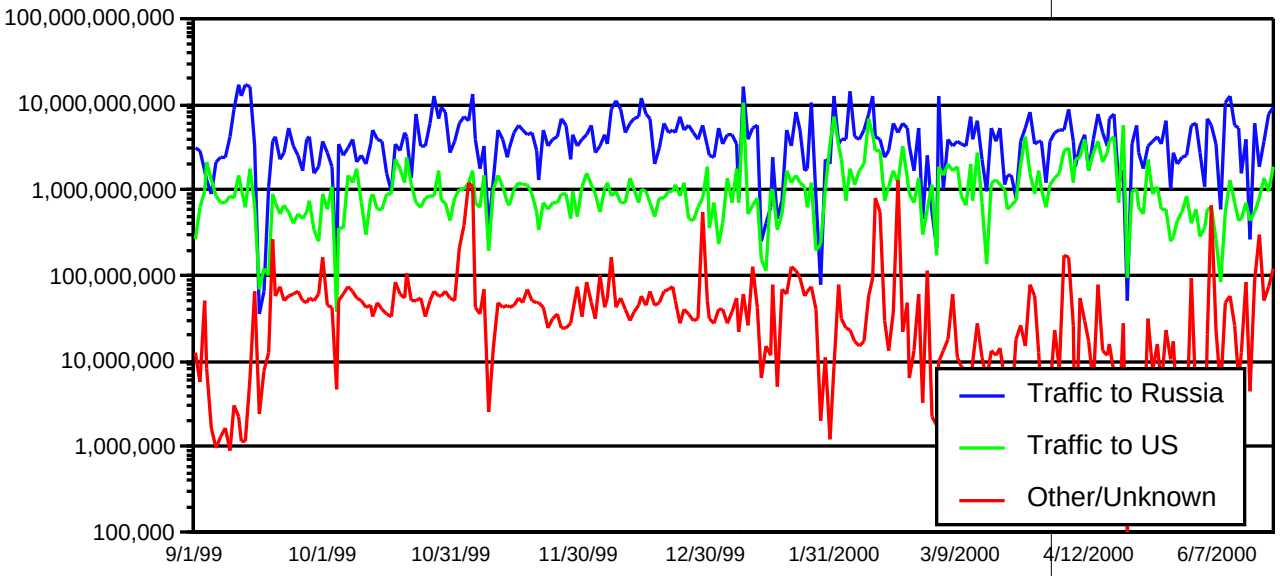
The MIRnet technical team includes staff from the University of Tennessee, Friends and Partners Foundation, Moscow State University, Russian institute of Public Networking with occasional assistance from network engineering staff at STAR TAP. Work during the second program year has focused on operations, monitoring and usage analysis of the MIRnet link. Three meetings have been held this year between the joint US-Russian team. Cole, Bulashova and Platonov met during in Moscow in November, 1999 and, again, in April, 2000. Bulashov and staff of RBnet met during February, 2000. Also, STAR TAP engineer John Jamison met with engineering team members in Moscow and St. Petersburg during September, 2000. Most of the technical committee's work has been conducted by email and by telephone. Current efforts are focusing on including MIRnet on the MBONE. Plans for the next year are focused on increasing the capacity of MIRnet to 155 Mbps, channelizing this link to provide for different classes of service, and completion of the MIRnet Access Scheduling System (MASS). Plans also include subcontracting 24x7 NOC operations to Indiana University.

Conclusion

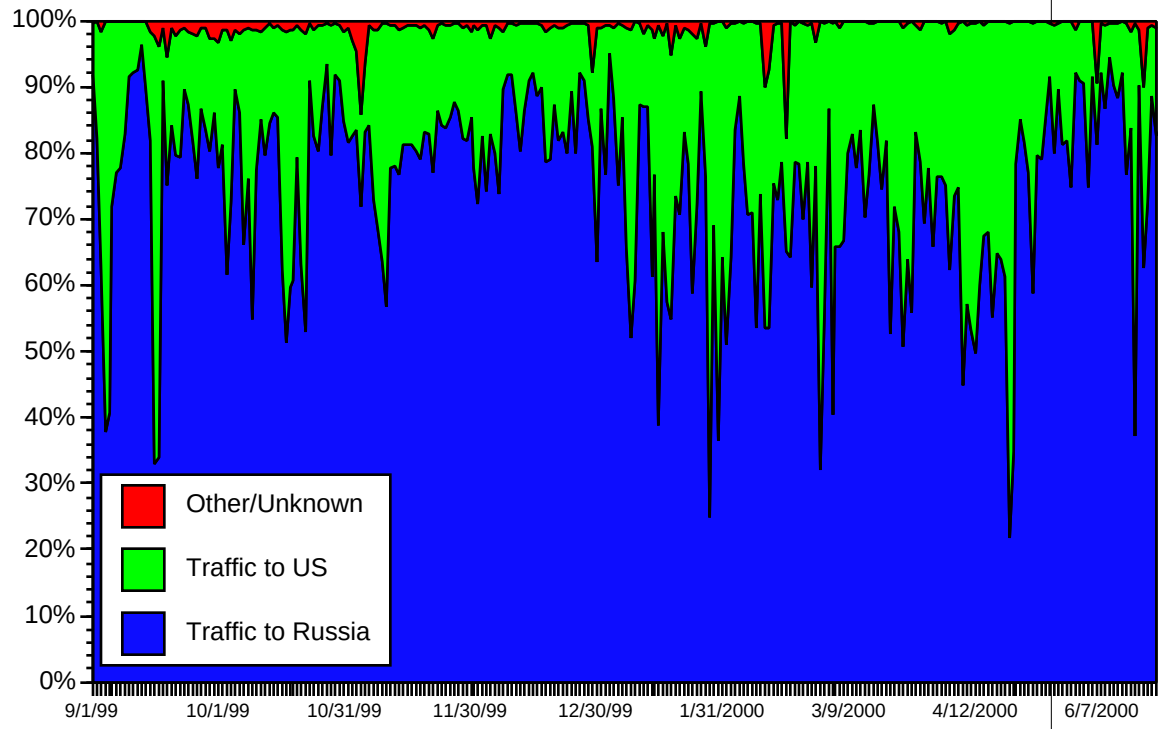
During this second year of the MIRnet project we have nearly completed the first year of reliable network operation of MIRnet, and have made much progress toward our ultimate 5 year goal of implementing a 155 Mbps service and plan to extend the reach of MIRnet to academic/scientific institutions across Russia. During the past year we have completed a sophisticated system for monitoring actual use of the network and observed (and been a part of) several interesting and relevant applications. Knowledge and use of MIRnet will continue to grow as we work to expand size and reach of the network, and continue our promotional activities to reach those scientist and educators who are already partnering with colleagues in Russia and who have potential need for MIRnet services. By the time we submit our third annual report we anticipate describing a much larger service reaching many academic and scientific institutions throughout Russia, and a new system in place for registering users and providing reasonable assurances that their application needs will be met. We will also be documenting during this year high performance applications which clearly demonstrate and justify the continued need for high performance network services between the US and Russian scientific communities.

MIRnet Utilization Report
September 1, 1999 - June 30, 2000

Daily Traffic Flows
September 1, 1999 - June 30, 2000



Traffic Flow Percentage
September 1, 1999 - June 30, 2000



Source: MADAS

http://www.friends-partners.org/friends/mirnet/madas/index.html
http://www.friends-partners.ru/friends/mirnet/madas/index.html

EXPLANATION

This report describes usage of the US-Russian high performance network, MIRnet, over the first year of its operation.

The information is gathered from the MADAS system which collects utilization information every 10 minutes from the MIRnet router in Chicago.

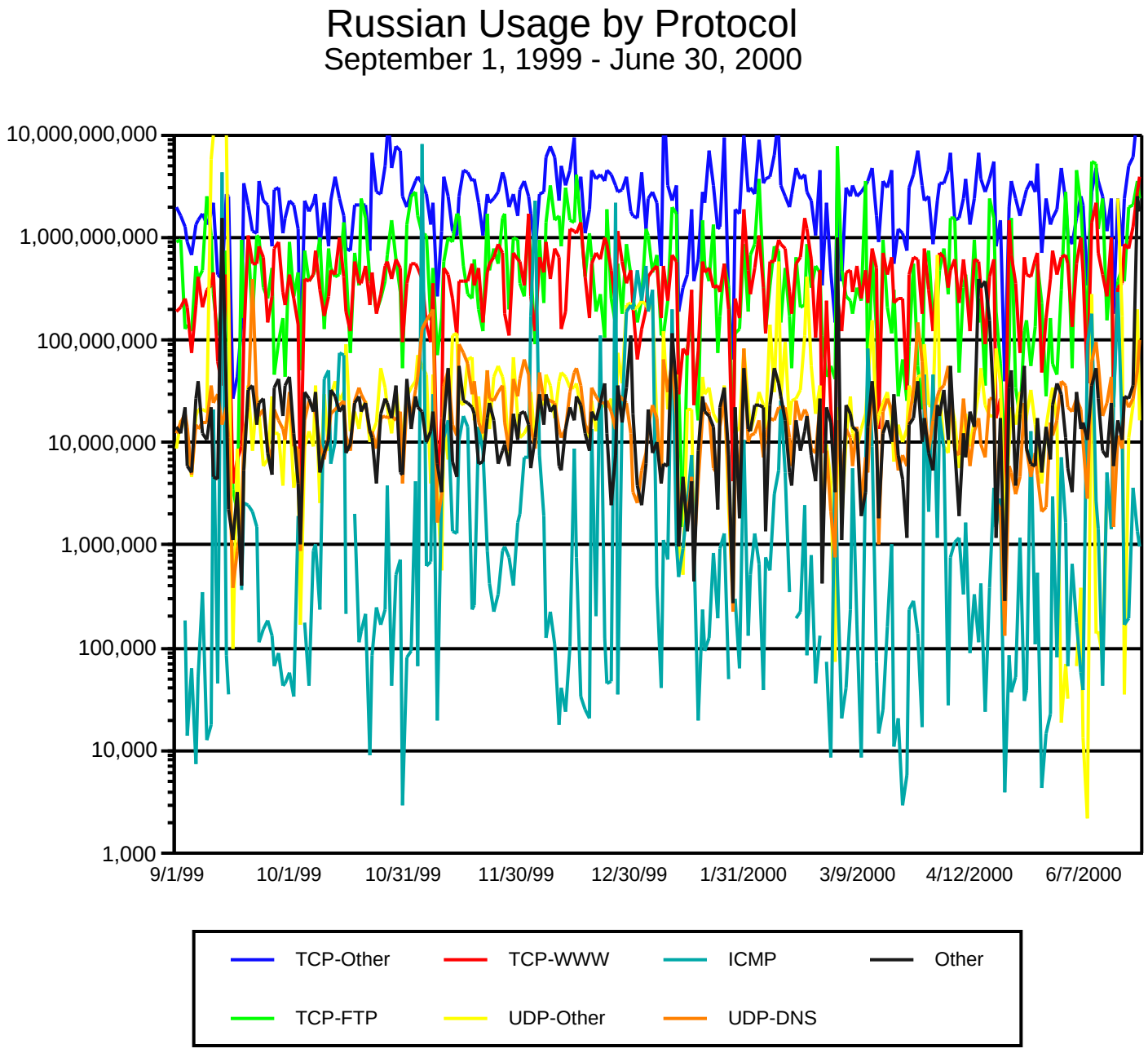
The charts on this page illustrates total daily traffic throughput (in megabytes) to Russia (from the US) and to the US (from Russia) as well as total percentage of traffic flows between US and Russia.

More information can be found at the MIRnet Administrative Data Analysis System (MADAS) at the URLs listed at left.

RUSSIAN TRAFFIC ANALYSIS BY TCP/IP PROTOCOL

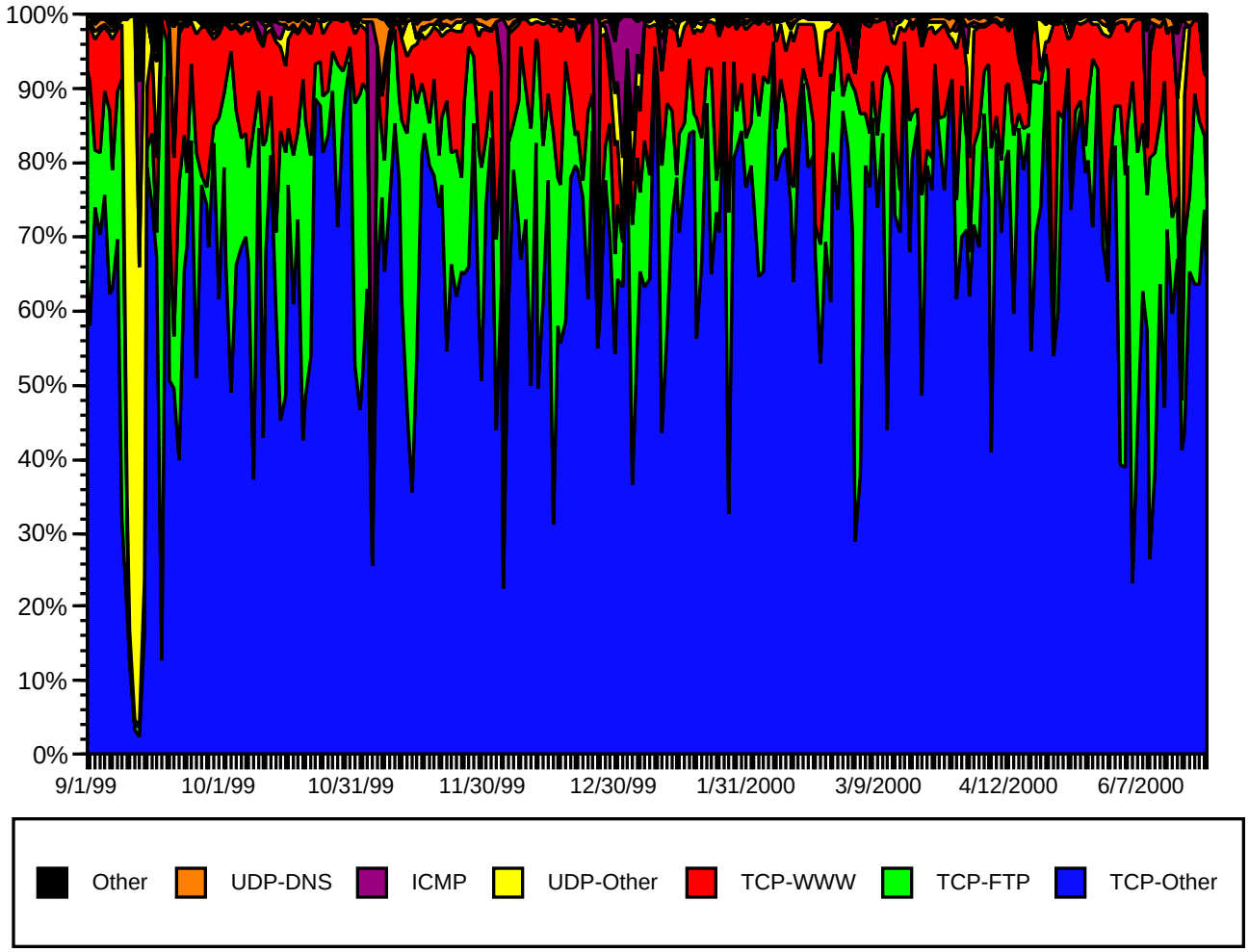
The following two graphs illustrate the protocols used for the majority of traffic destined for Russia via MIRnet.

The first illustrates the 6 most popular protocols (with all others grouped under "Other") with total number of bytes transferred per protocol. The chart on the facing page shows the same data but by percentage of total daily flow by protocol.



Russian Usage by Protocol, Percentage Daily Traffic

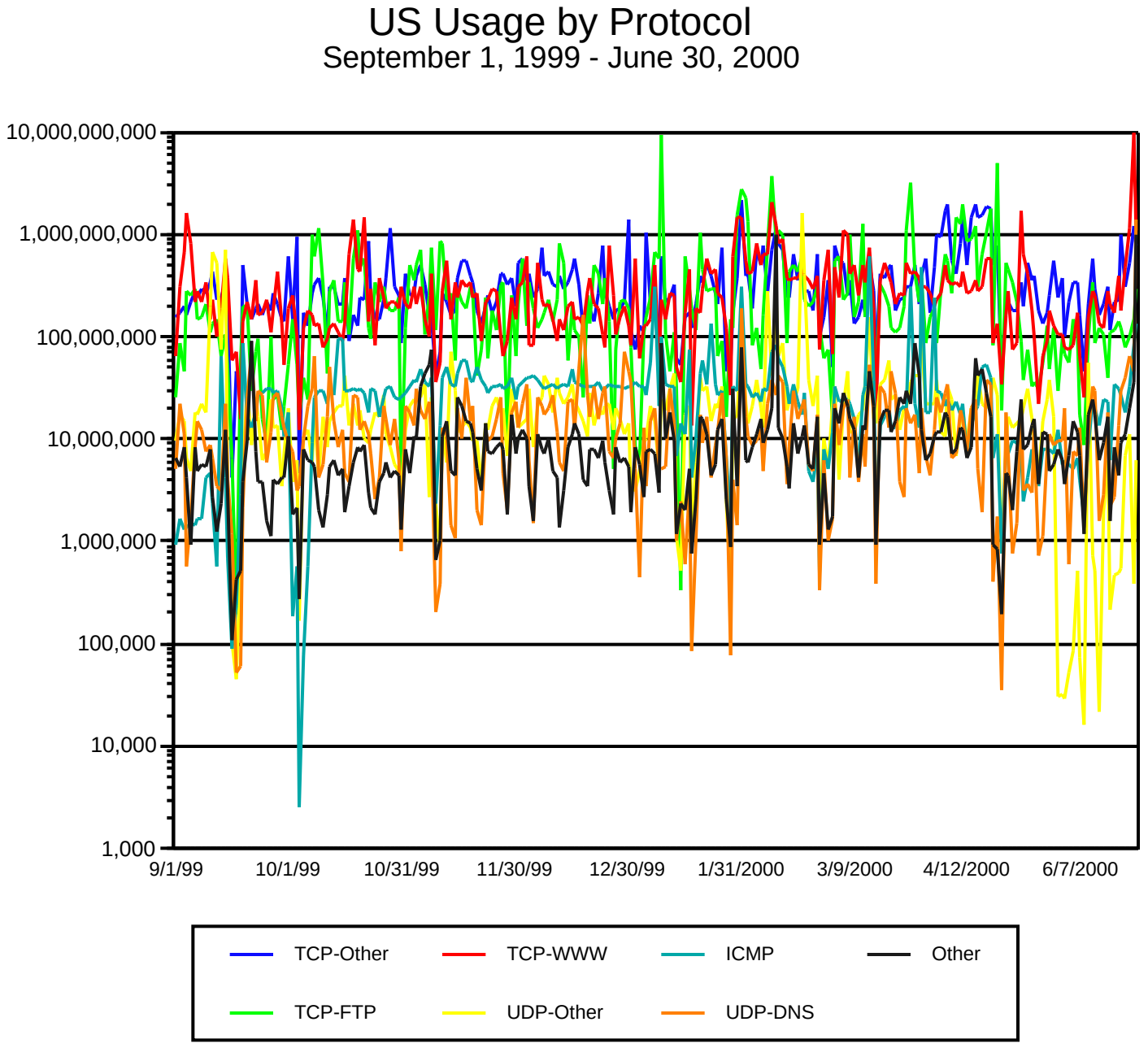
September 1, 1999 - June 30, 2000

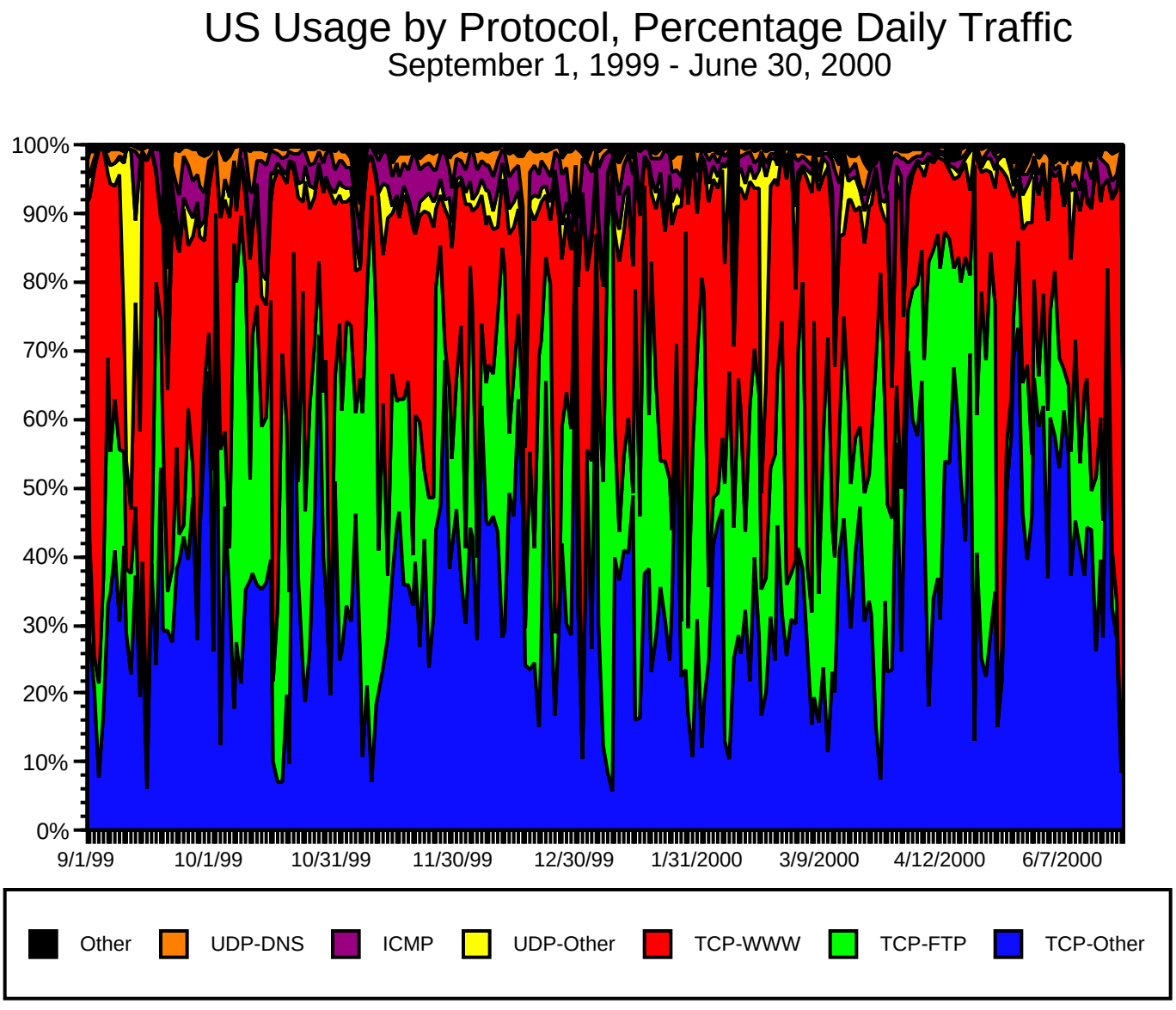


US Traffic Analysis by TCP/IP Protocol

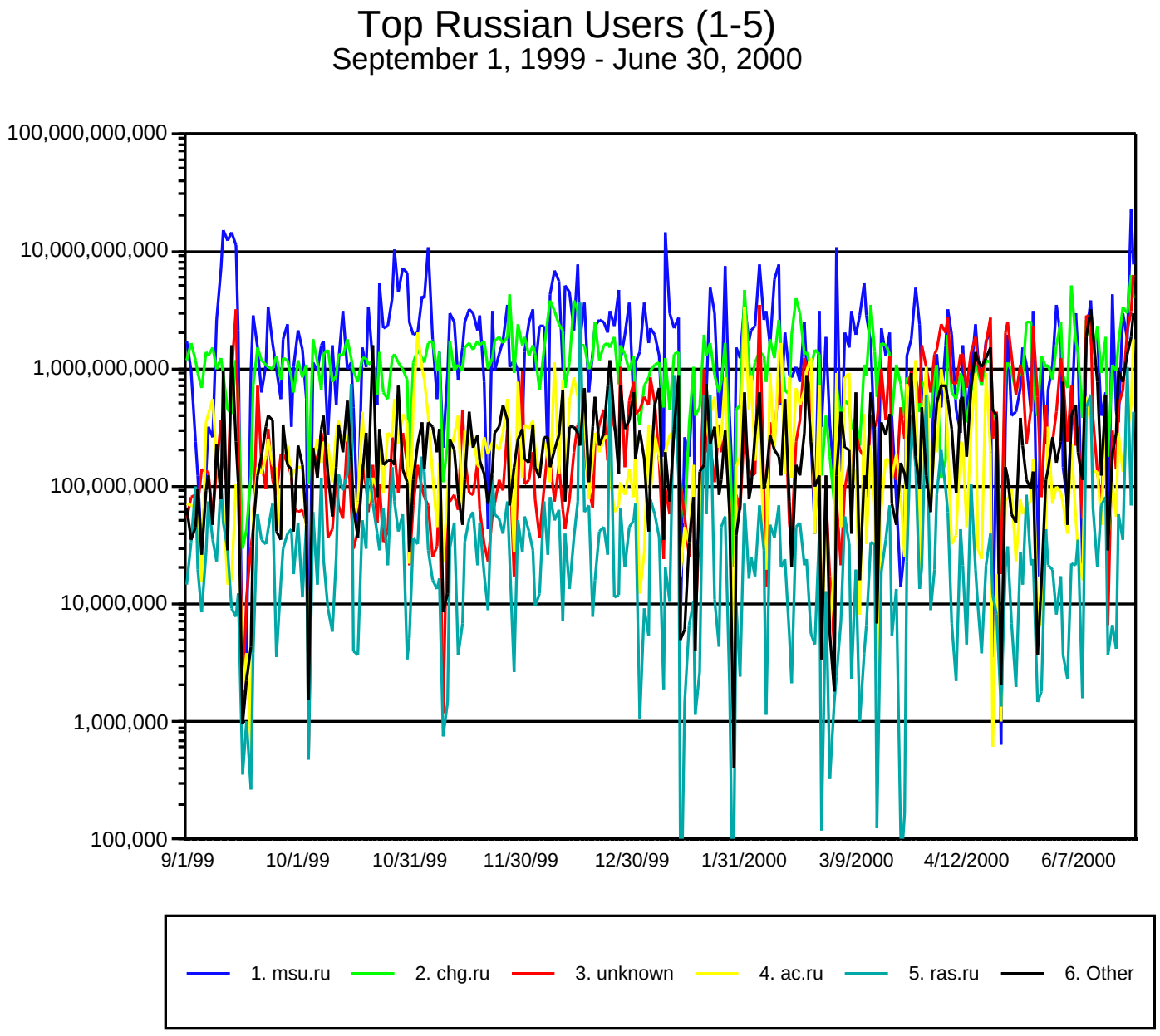
The following two graphs illustrate the protocols used for the majority of traffic destined for the US (from Russia) via MIRnet.

The first illustrates the 6 most popular protocols (with all others grouped under "Other") with total number of bytes transferred per protocol. The chart on the facing page shows the same data but by percentage of total daily flow by protocol.

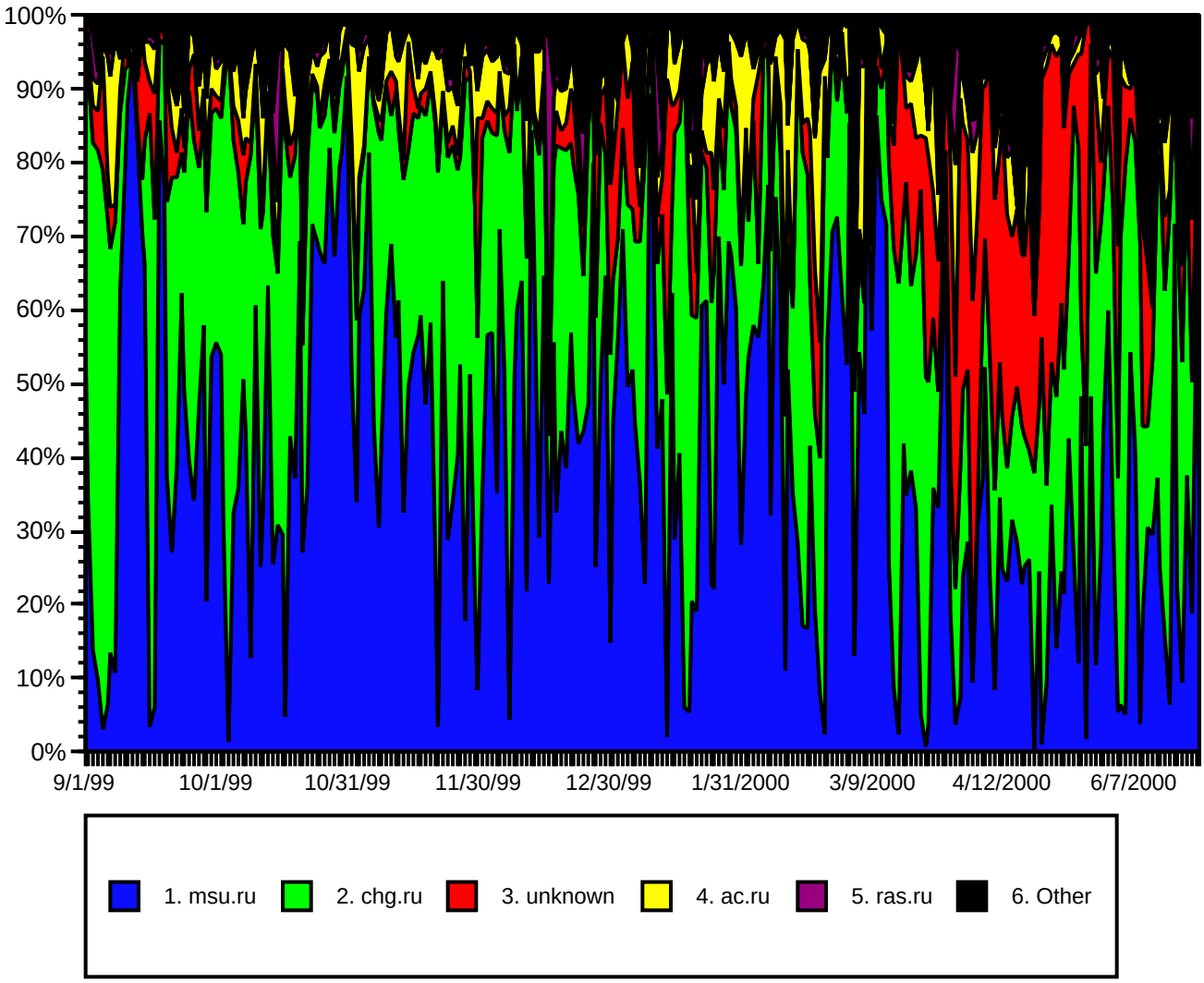



US Usage by Protocol, Percentage Daily Traffic
September 1, 1999 - June 30, 2000
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9/1/99
10/1/99
10/31/99
11/30/99
12/30/99
1/31/2000
3/9/2000
4/12/2000
6/7/2000
Other
UDP-DNS
ICMP
UDP-Other
TCP-WWW
TCP-FTP
TCP-Other

The following two graphs show the top domains in Russia receiving traffic via MIRnet over the time period September 1, 1999 - June 30, 2000. The second graph illustrates the same data as in the first but shows the percentage of the data flow represented by each domain.

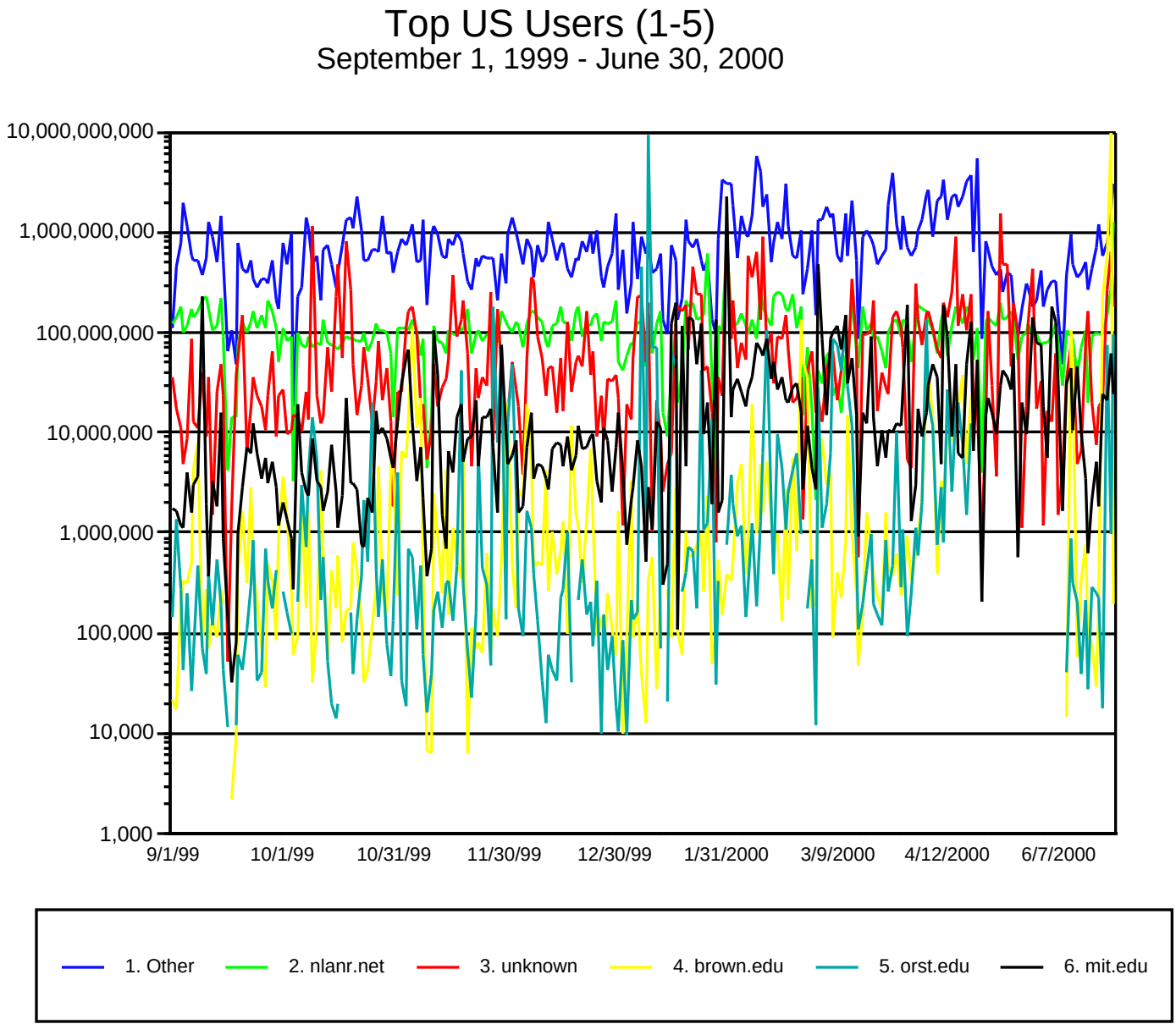


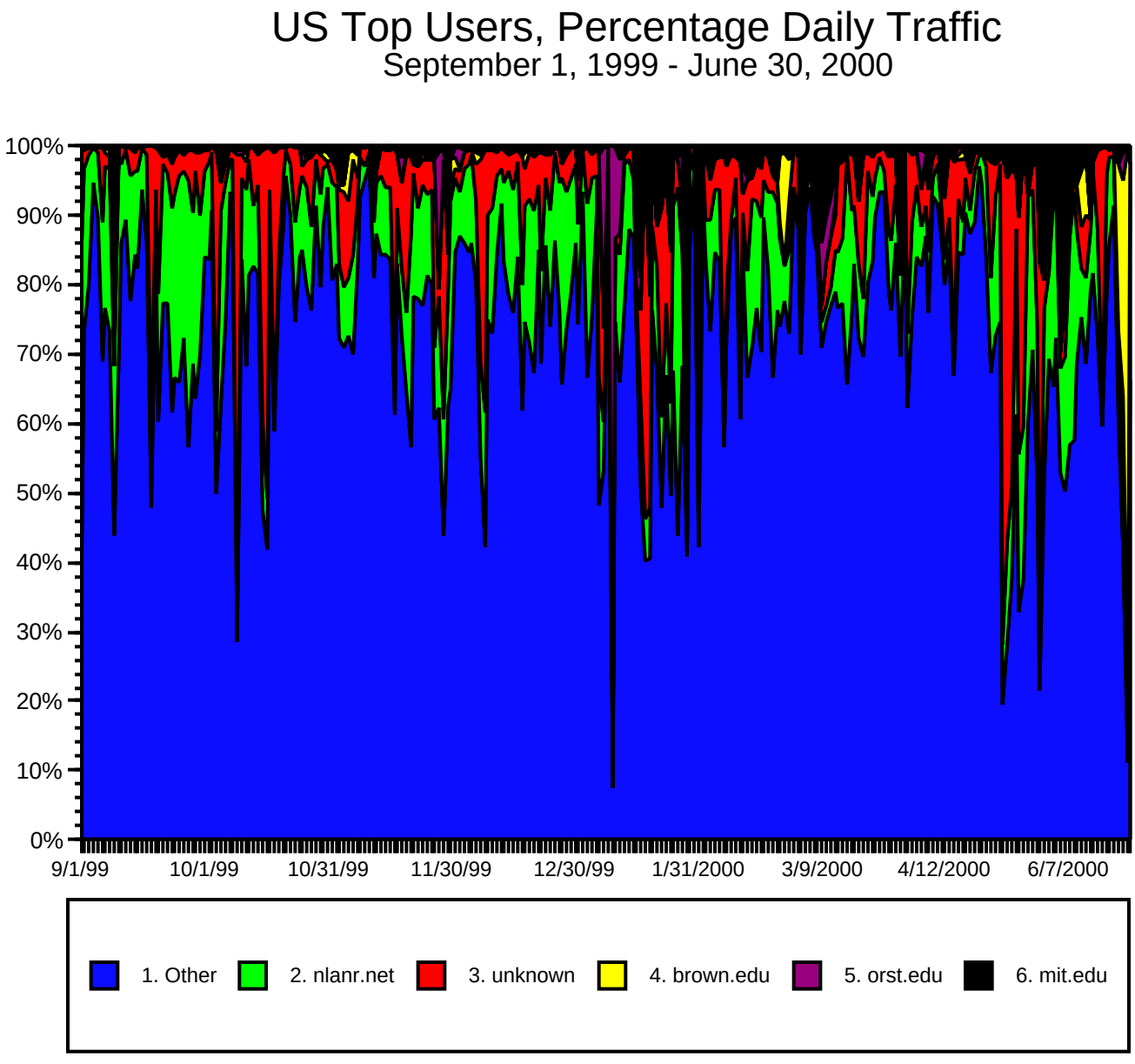
Russian Top Users, Percentage Daily Traffic
September 1, 1999 - June 30, 2000



US Traffic Analysis by Destination Domain

The following two graphs show the top domains in US receiving traffic via MIRnet over the time period September 1, 1999 - June 30, 2000. The second graph illustrates the same data as in the first but shows the percentage of the data flow represented by each domain.




US Top Users, Percentage Daily Traffic
September 1, 1999 - June 30, 2000
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9/1/99
10/1/99
10/31/99
11/30/99
12/30/99
1/31/2000
3/9/2000
4/12/2000
6/7/2000
1. Other
2. nlanr.net
3. unknown
4. brown.edu
5. orst.edu
6. mit.edu

The tables below illustrate Russian domains receiving traffic from US hosts via MIRnet. The second table shows the US domains responsible for the data transferred.

Domain		Traffic from US (bytes)	% Total
01. msu.ru	Moscow State University	562,839,674,893	53.9%
02. chg.ru	Chernogolovka Science Center	311,277,204,253	29.8%
03. ac.ru	FREEnet Web	70,037,186,399	6.7%
04. ras.ru	Russian Academy of Sciences	18,897,277,099	1.8%
05. ipmce.ru	Inst of Precision Mechanics & Computer Equipment	16,999,669,824	1.6%
06. rssi.ru	Russian Space Science Internet	16,798,740,613	1.6%
07. msu.su	Moscow State University	8,818,855,274	0.8%
08. free.net	FREEnet Web	5,020,067,190	0.5%
09. ccas.ru	Computig Centre of RAS	4,666,829,176	0.4%
10. uran.ru	Ural Branch of the Russian Academy of Science	2,641,025,084	0.3%
11. cplire.ru	Inst of Radioengineering & Electronics	2,550,162,916	0.2%
12. nmr.ru	Nuclear Magnetic Resonance Lab	2,526,018,390	0.2%
13. unicor.ru	University Knowledge Networks Corp.	2,495,821,698	0.2%
14. mephi.ru	MEPHI	2,466,807,511	0.2%
15. wdcb.ru	Geophysical Center RAS	2,143,171,904	0.2%
16. gpi.ru	General Physics Institute of Russian Academy of Science	1,860,971,983	0.2%
17. kiae.ru	Kurchatov Institute	1,486,869,504	0.1%
18. lasenet.ru	Institute on Laser and Information Technologies	1,179,794,046	0.1%
19. pmc.ru	Medical Center of RF President's Management Office	1,161,662,535	0.1%
20. museum.ru	Museums of Russia	952,117,241	0.1%
21. msu.net	Moscow State University	940,972,430	0.1%
22. gpntb.ru	State Public Library for Science and Technology	917,495,634	0.1%
23. decsy.ru	DEC Russia	667,938,176	0.1%
24. com.ru	Analytic TelecomSystems	568,514,916	0.1%
25. novgorod.ru	Novgorod	533,502,722	0.1%
26. Other	Other	3,286,723,691	0.3%
Total		1,043,735,075,102	100.0%

Domain		Traffic to Russia (bytes)	% Total
01. nlanr.net	NLANR Network Center	277,286,015,750	26.4%
02. gatech.edu	Georgia Tech	94,919,814,992	9.1%
03. anl.gov	Argonne National Laboratory	58,574,929,102	5.6%
04. unh.edu	U of New Hampshire	55,712,422,175	5.3%
05. iastate.edu	Iowa State University	54,590,711,620	5.2%
06. mit.edu	Mass. Inst. of Technology	45,137,383,344	4.3%
07. nd.edu	U of Notre Dame	40,012,382,442	3.8%
08. nasa.gov	NASA	33,153,516,891	3.2%
09. unc.edu	U of North Carolina	32,527,803,536	3.1%
10. ucar.edu	Univ. Corp for Atmospheric Research	23,161,680,390	2.2%
11. nih.gov	Nat'l Inst. Of Health	22,787,672,292	2.2%
12. utk.edu	U of Tennessee, Knoxville	22,751,001,881	2.2%
13. pitt.edu	U of Pittsburgh	21,039,783,117	2.0%
14. wisc.edu	U of Wisconsin-Madison	14,492,366,791	1.4%
15. colorado.edu	U of Colorado Boulder	13,638,947,116	1.3%
16. berkeley.edu	U of California Berkeley	9,748,921,613	0.9%
17. uchicago.edu	U of Chicago	9,354,919,951	0.9%
18. ucsd.edu	U of California San Diego	9,079,996,949	0.9%
19. columbia.edu	Columbia University	8,875,318,319	0.8%
20. cornell.edu	Cornell University	7,283,233,724	0.7%
21. caltech.edu	California Institute of Technology	6,972,887,432	0.7%
22. vt.edu	Virginia Tech	6,881,060,316	0.7%
23. rutgers.edu	Rutgers State U of NJ	6,405,255,794	0.6%
24. fsu.edu	Florida State University	6,337,151,903	0.6%
25. nmsu.edu	New Mexico State University	6,154,804,740	0.6%
26. Other	Other	161,675,479,929	15.4%
Total		1,048,555,462,109	100.0%

The tables below illustrate US domains receiving traffic from Russian hosts via MIRnet. The second table shows the Russian domains responsible for that traffic flow.

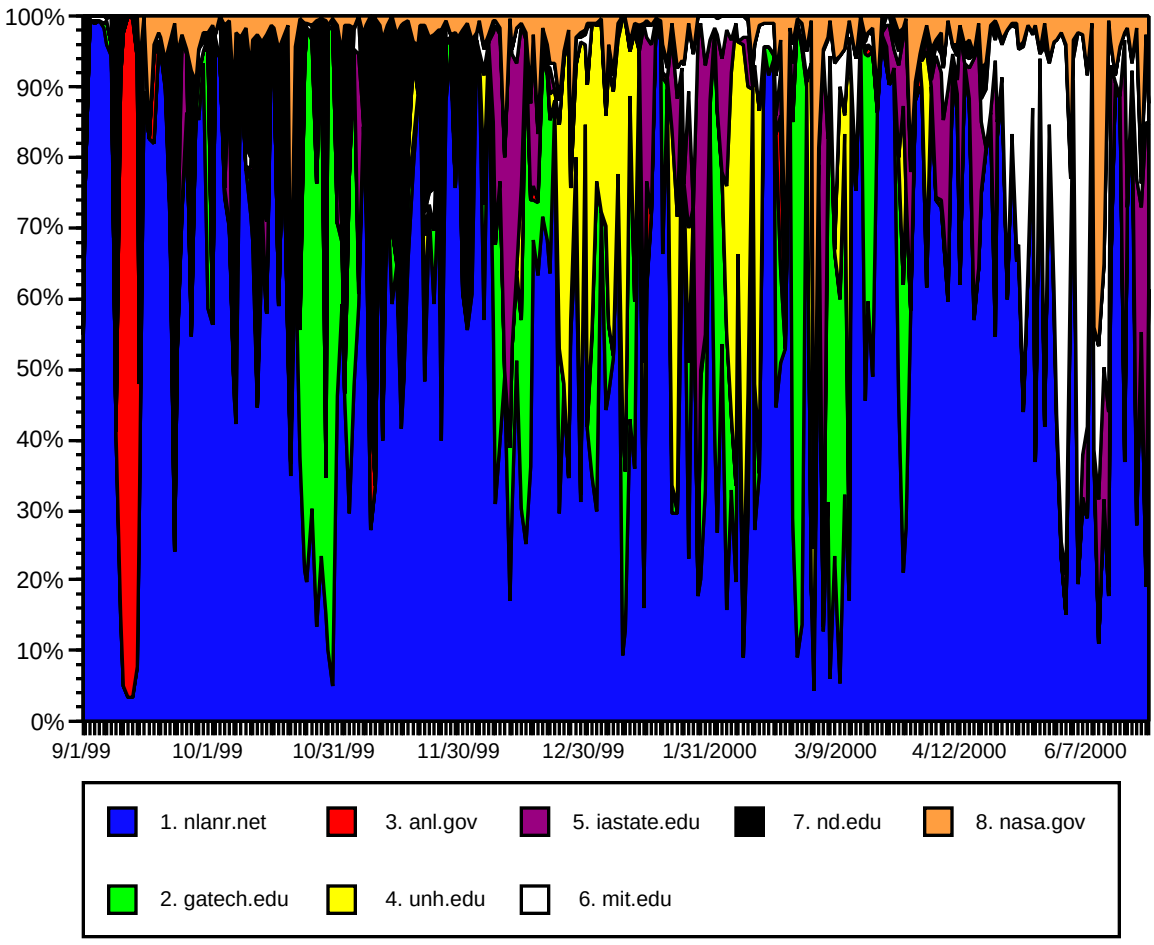
Domain		Traffic from Russia (bytes)	% Total
01. nlanr.net	NLANR Network Center	29,973,269,665	10.3%
02. brown.edu	Brown University	13,860,904,949	4.8%
03. orst.edu	Oregon State Universite	11,500,337,092	4.0%
04. mit.edu	Mass. Inst. of Technology	8,994,324,995	3.1%
05. gatech.edu	Georgia Tech	7,487,323,981	2.6%
06. berkeley.edu	U of California Berkeley	7,448,796,632	2.6%
07. uwm.edu	U of Wisconsin Milwaukee	6,321,094,083	2.2%
08. uiuc.edu	U of Illinois Urbana-Champaign	6,070,713,286	2.1%
09. uic.edu	U of Illinois Chicago	6,014,492,844	2.1%
10. washington.edu	U of Washington	5,716,909,607	2.0%
11. upenn.edu	U of Pennsylvania	5,520,905,151	1.9%
12. nd.edu	U of Notre Dame	5,272,532,251	1.8%
13. cornell.edu	Cornell University	5,253,896,506	1.8%
14. harvard.edu	Harvard University	4,539,342,710	1.6%
15. umd.edu	U of Maryland	4,274,571,699	1.5%
16. usc.edu	U of S California	4,174,463,205	1.4%
17. utexas.edu	U of Texas, Austin	4,136,593,833	1.4%
18. umn.edu	U of Minnesota	3,902,085,324	1.3%
19. columbia.edu	Columbia University	3,696,222,570	1.3%
20. wisc.edu	U of Wisconsin-Madison	3,532,919,833	1.2%
21. nih.gov	Nat'l Inst. Of Health	3,355,038,425	1.2%
22. princeton.edu	Princeton University	3,181,618,965	1.1%
23. anl.gov	Argonne National Laboratory	3,032,416,000	1.0%
24. purdue.edu	Purdue University	2,979,259,966	1.0%
25. ucf.edu	U of Central Florida	2,752,903,033	0.9%
26. Other	Other	128,024,003,569	44.0%
Total		291,016,940,174	100.0%

Domain		Traffic to US (bytes)	% Total
01. msu.ru	Moscow State University	77,473,957,636	27.0%
02. decsy.ru	DEC Russia	45,849,964,797	16.0%
03. chg.ru	Chernogolovka Science Center	31,505,727,826	11.0%
04. ac.ru	FREEnet Web	27,176,996,716	9.5%
05. keldysh.ru	Keldysh Institute of Mathematics	25,887,401,585	9.0%
06. sgm.ru	Vernadsky Geological Museum	16,325,115,605	5.7%
07. ipmce.ru	Inst of Precision Mechanics & Computer Equipment	10,114,912,351	3.5%
08. msu.su	Moscow State University	8,871,188,118	3.1%
09. itep.ru	Institute of Theoretical and Experimental Physics	8,373,623,394	2.9%
10. rsuh.ru	Russian State University of Humanities	3,652,669,635	1.3%
11. ras.ru	Russian Academy of Sciences	3,564,408,906	1.2%
12. pmc.ru	Medical Center of RF President's Management Office	2,385,368,372	0.8%
13. bmstu.ru	Bauman State University	2,025,576,776	0.7%
14. rssi.ru	Russian Space Science Internet	1,840,181,114	0.6%
15. free.net	FREEnet Web	1,610,253,283	0.6%
16. museum.ru	Museums of Russia	1,104,859,288	0.4%
17. stankin.ru	Stankin Institute	1,027,608,161	0.4%
18. root-servers.net	Root Servers	950,181,206	0.3%
19. lpi.ru	Lebedev Physics Institute of RAS	935,833,732	0.3%
20. rea.ru	Plekhanov Russian Academy of Economics	913,216,703	0.3%
21. kiae.ru	Kurchatov Institute	907,645,207	0.3%
22. mephi.ru	MEPHI	861,208,790	0.3%
23. relarn.ru	RELARN Network	734,939,561	0.3%
24. novgorod.ru	Novgorod	714,510,183	0.2%
25. Other	Other	12,339,248,618	4.3%
Total		287,146,597,563	100.0%

The charts on these pages illustrate the top US and Russian domains serving as source for traffic destined for networks in the other country.

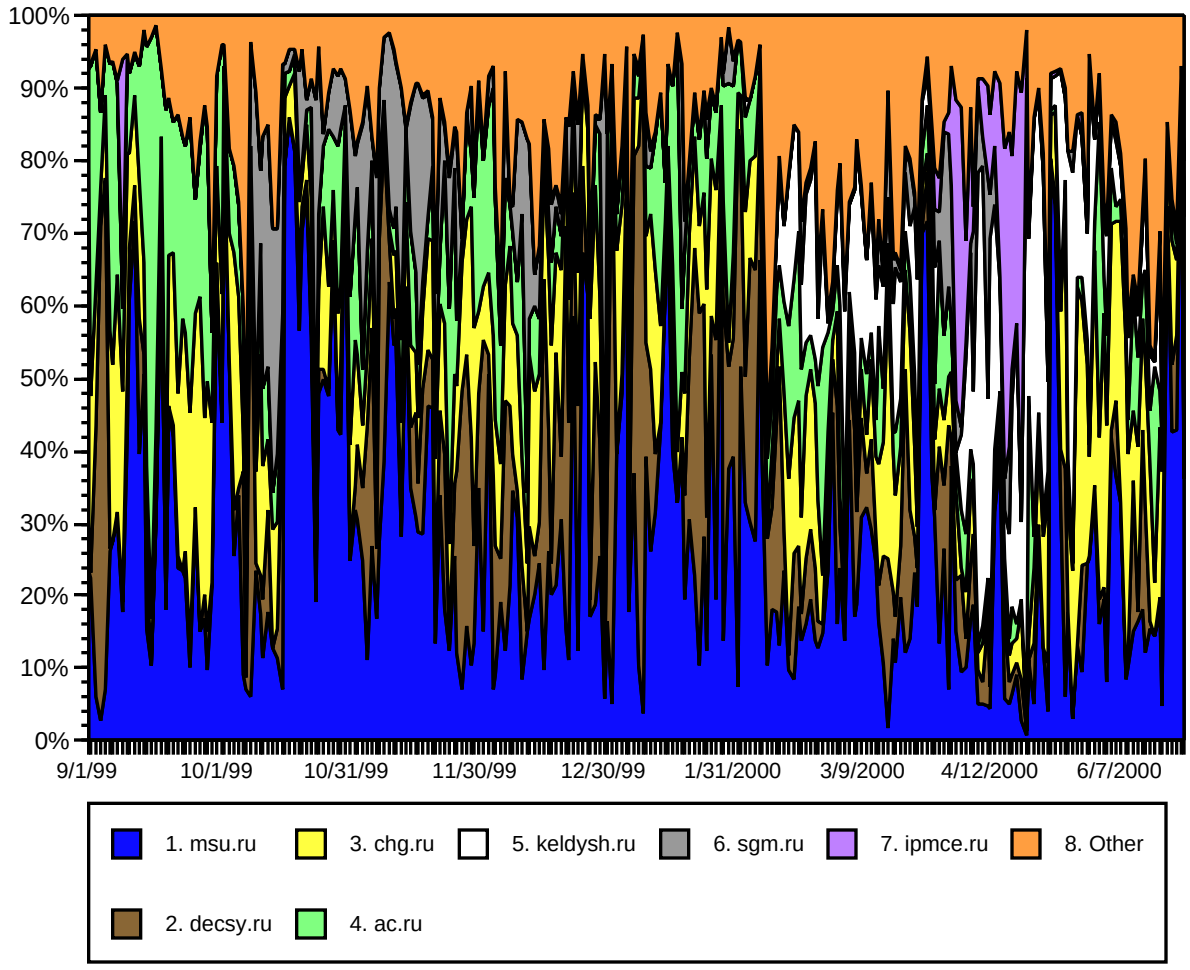
Top 8 US Domains for Russian Traffic, Percentage Daily Traffic

September 1, 1999 - June 30, 2000

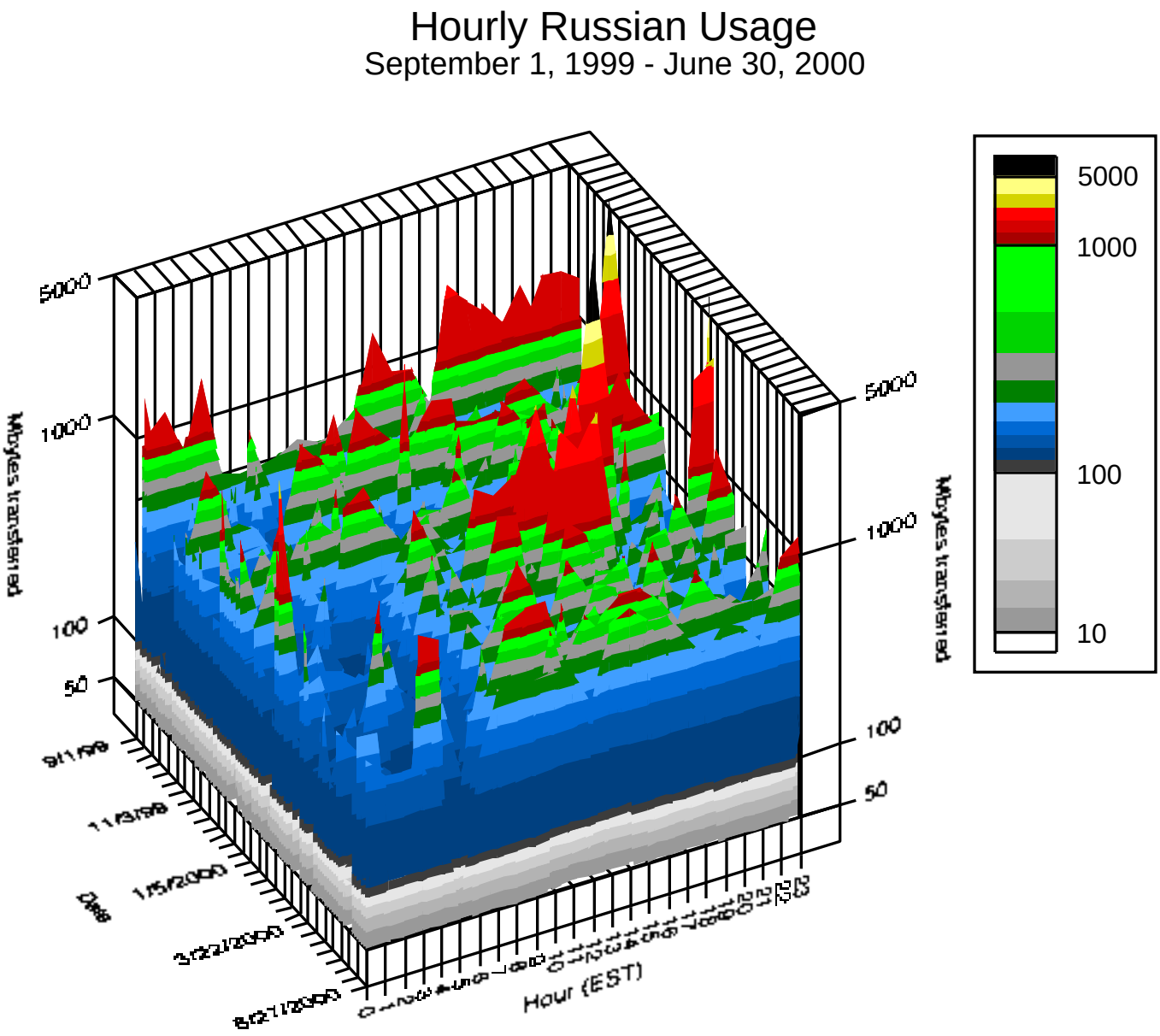


Top 8 Russian Domains for US Traffic, Percentage Daily Traffic

September 1, 1999 - June 30, 2000

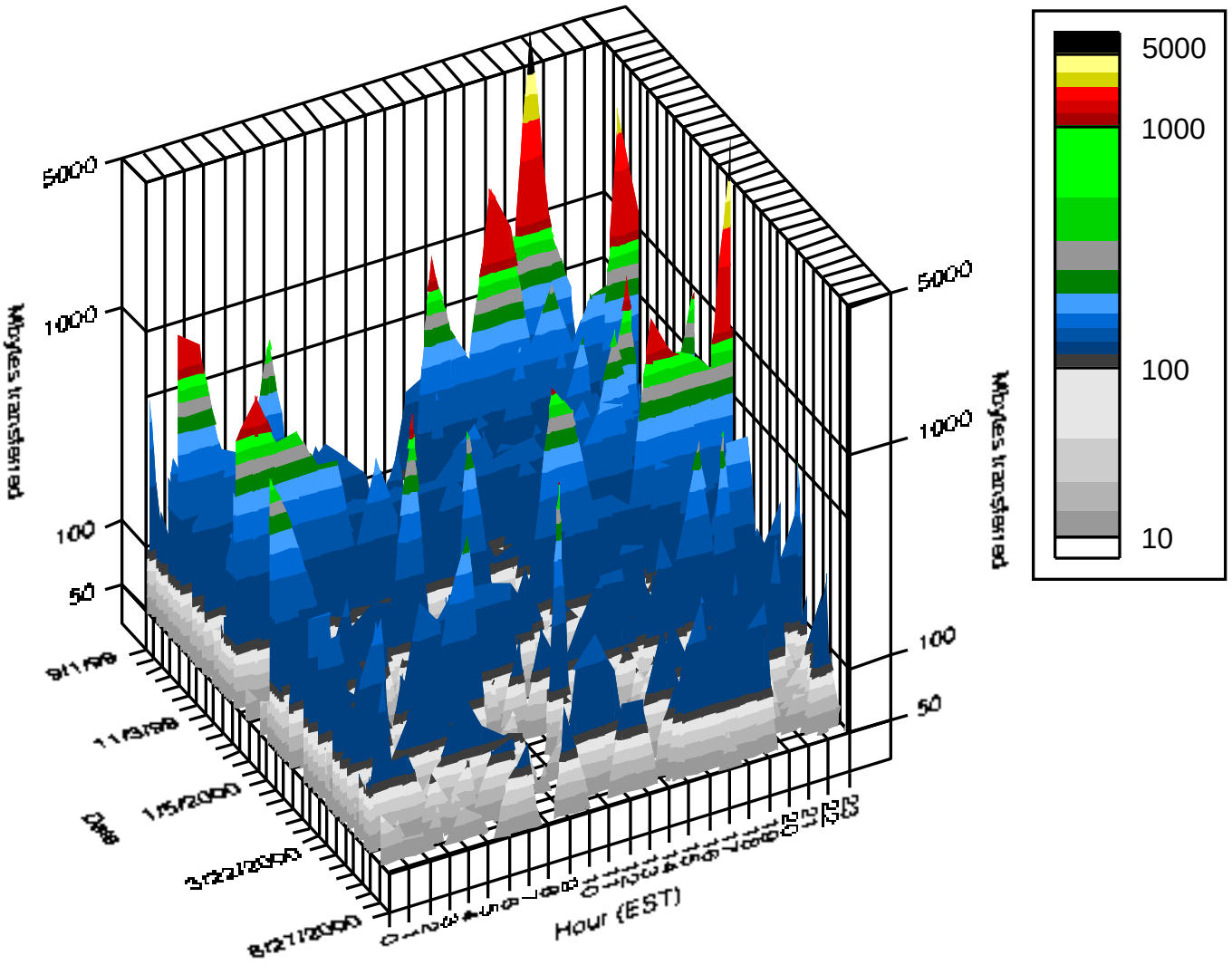


The following two charts illustrate total megabytes transferred to Russia (and, in second chart, to US) across MIRnet per day and per hour.



Hourly US Usage

September 1, 1999 - June 30, 2000



MIRnet Financial Report

(Available upon request.)