Proposal to the NSF

Supplement to Westnet

"T-3 Upgrade

NCAR - University of Colorado"

Amount Requested: $103,850

Submitted by

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1. PROPOSED UPGRADE

Westnet and the University of Colorado at Boulder request a supplemental allocation to Westnet to upgrade to T-3 speed the existing T-1 the link between the NSFNet backbone at the National Center for Atmospheric Research (NCAR) and the University of Colorado at Boulder (UCB). As seen from the existing topology shown in Figure 1, UCB serves as the "drain" for the entire state of Colorado and Wyoming. Funds are requested for equipment on each end of the line (routers and DSU) as well as installation and 18 months charges for the T-3 circuit (minus our current cost for the T-1).

In the following sections, we explain why this upgrade is timely and expedient, provide the technical details and a budget request, and conclude with brief biographical sketches of the Principal Investigators.

2. JUSTIFICATION

There are several major reasons why this upgrade is important, and why it needs to be done now.

2.1 Existing Traffic

The line between NCAR and UCB drains two states - Colorado and Wyoming. UCB is connected intrastate via four T-1 circuits to: Colorado School of Mines, Colorado State University (CSU), University of Colorado at Denver, and US West Advanced Technologies. These circuits are "drained" via the single T-1 trunk to NCAR. Also, note that the University of Wyoming is in the process of upgrading its link to Colorado State University to T-1 before the end of summer 1991.

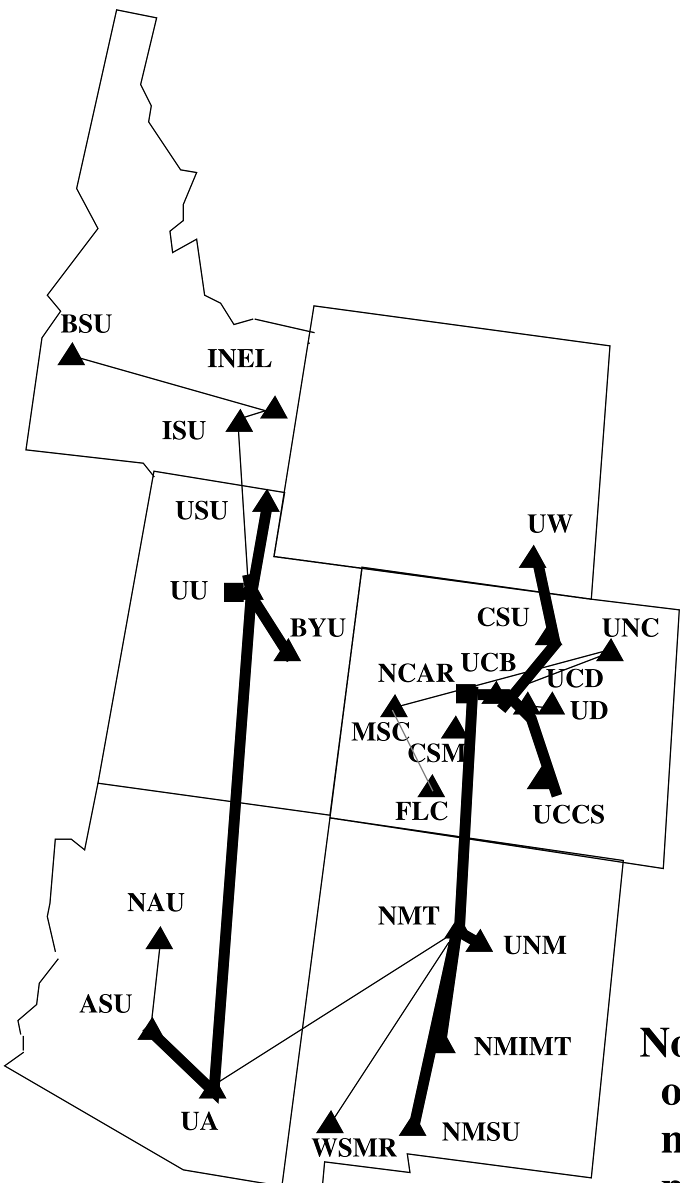
UCB is consistently among the top 20 users of the NSFNet. In addition, UCB and CSU are the largest users of NCAR. Intrastate traffic to NCAR such as this traverses the NCAR-UCB line, but doesn't register in the NSFNet tally. Colorado SuperNet connects over fifty sites, including all community colleges and major universities, major corporations such as Martin Marietta and HP, small start-ups and technology incubators, K-12 schools, state library systems, etc.

Samplings of the existing T-1 trunk show 5-minute peaks of usage at 50%. Past experience has shown that there is a "hidden demand" for bandwidth. Every time Westnet has upgraded circuits, traffic has very shortly thereafter far exceeded previous capacity. In many cases, it was not possible to a priori predict the rapid growth ensuing upon the upgrade to T-1. We believe this will be the case here also.

2.2 Latency

There are several active applications that need faster response time than provided by the existing T-1 line. One involves multi-disciplinary climactic algorithmic research, involving researchers at UCB in Computer Science, Atmospheric Physicists, and a Connection Machine located at NCAR. All systems involved in the computations - the CM-2, Ardent graphics stations, etc. - are capable of speeds far in excess of T-1; the line latency is the major factor limiting distributed visualizations.

FIGURE 1
WESTNET MAP
Summer 1991



Legend - Circuits

9.6 kbps

56 kbps

T-1 (1.544 Mbps)

Legend - Routers

cisco Gateway

IBM NSS

Note: This map depicts only Westnet's primary nodes. Currently, Westnet provides connectivity to more than 70 sites in the 5 1/2 state region.

2.3 Imminent Growth

Moreover significant increases in traffic are imminent. For example, considerable load will be placed on the NCAR-UCB line from re-engineering of the NASA Science Internet. This will result in several separate 56 kbps WAN lines to UCB being replaced with the NCAR-UCB link. A second major factor is the selection by NASA of UCB to house a large portion of the EOS terrabyte memory. This also will significantly increase traffic on the link to the backbone. Some of these new demands will provide considerable public benefit (see attached example in appendix 1) and are deserving of good performance.

At the end of July, NCAR's backbone will be upgraded to T-3. Traffic analysis shows that Westnet traffic is 70% of the traffic to the NSS at NCAR.

Also, CSU has recently installed a central Computer Visualization Laboratory (CVL). (This facility is described in Appendix B.) CSU purchases Cray Y/MP-864 time from NCAR. A number of researchers at CSU conduct numerical experiments which include a dynamic visualization component. This capability has caused the CVL to connect directly to the Westnet gateway at CSU via a cisco 2E2T MCI card, allowing high transmission speed to UCB and thence to NCAR. We expect to see increasing usage of this facility in the near future.

2.4 Why This Particular Upgrade is Expedient

One of the more distinctive aspects of the NCAR-UCB connection is that both ends have operative FDDI rings deployed. Unlike many proposed T-3 links, which terminate onto slower speed Ethernet, the potential exists for true 45 Mbps utilization.

The proposed link connects to cisco gateways less than 2 miles apart. As such, personnel may move easily between the sites during debugging, configuration and optimization. Furthermore, the proximity of the sites renders it relatively inexpensive as the distance charges are low. One of the gateways is at the location of the Westnet NOC, and the other is at NCAR. Both locations possess mature, capable networking staff equal to the task.

Westnet currently has a T-1 point of presence (POP) in four of the six states it serves. T-1 to Wyoming will be in place before the end of summer 1991. An upgrade to T-1 in Idaho is now being negotiated with Idaho National Engineering Laboratory to complete the provision of T-1 to all Westnet states. It is highly likely that the Westnet POP in several other states will require upgrades to T-3 within the year. This particularly includes Arizona (with two existing in-state T-1 connections and one in process) and New Mexico (with three T-1 in-state connections and possibly three in process). Both of these circuits are showing 5-minute peaks of traffic between 1/3 and 1/2 of T-1. Burst traffic over shorter periods of time is expected to exhibit higher peaks than at 5-minute averages.

2.5 Moving into the Future

Westnet staff must begin mastering T-3 technology - to maintain currency and project confidence. In need, location, expertise, and opportunity, the Westnet regional line is an appropriate T-3 extension. Beyond the actual use, the opportunity for an early test of a FDDI/T-3/FDDI backbone connection may offer valuable experience to the various participants. NSFNet leadership has stated that its goal is to have a national T-3 network, not just a T-3 backbone. It is time to begin deployment of T-3 into the mid-levels, where warranted.

3. TECHNICAL PLAN

Figure 2 depicts the hardware configuration. At each end, a cisco AGS-3+ includes a T-3 card and an FDDI interface. The T-3 Interface is connected to a T-3 DSU, which is then connected to a full duplex US West dedicated T-3 circuit.

The T-3 circuit will be run in parallel with the existing T-1 circuit between NCAR and UCB until it has proven reliable and robust. Then, the four T-1 circuits coming into the existing cisco gateway will be transferred to the AGS-3+. The two AGS-2's will be recovered. One belongs to NCAR and will be recovered by them. The other is owned by Westnet, and will be recovered and used at a new Westnet site (to connect possibly a high school or a small college or university).

4. BUDGET

Funding is requested for hardware (configuration as per Figure 2), and 12 months of net circuit charges. (Here, we assume 4 months of overlap, so we subtract 8 months of T-1 circuit charges. This may seem conservative, but past experience indicates that one always encounters unexpected problems with leading-edge technology. This will allow sufficient time to overcome problems, and familiarize ourselves with this new technology.)

Hardware			
AGS-3+ Gateways*	2	$8,610	$17,220
C-Bus*	2	$1,540	$3,080
Non-volatile*	2	$1,369	$2,738
FDDI Interfaces*	2	$2,800	$5,600
FDDI Applique*	2	$7,000	$14,000
T-3 Applique*	2	$1,400	$2,800
T-3 Interface*	2	$4,200	$8,400
T-3 DSU's**	2	$10,000	$20,000
Total Hardware		$36,919	$73,838
Circuit			
Installation***	1	$1,400	$1,400
Monthly Charges***	12	$2,851	$34,212
T-1 Credit	8	$700	<$5,600>
Net Circuit			$30,012
Total			
Total			$103,850

* Prices include cisco's standard 30% discount

** Prices quoted over the phone by T-3Plus

*** Price quote obtained from US West Communications (Appendix C)

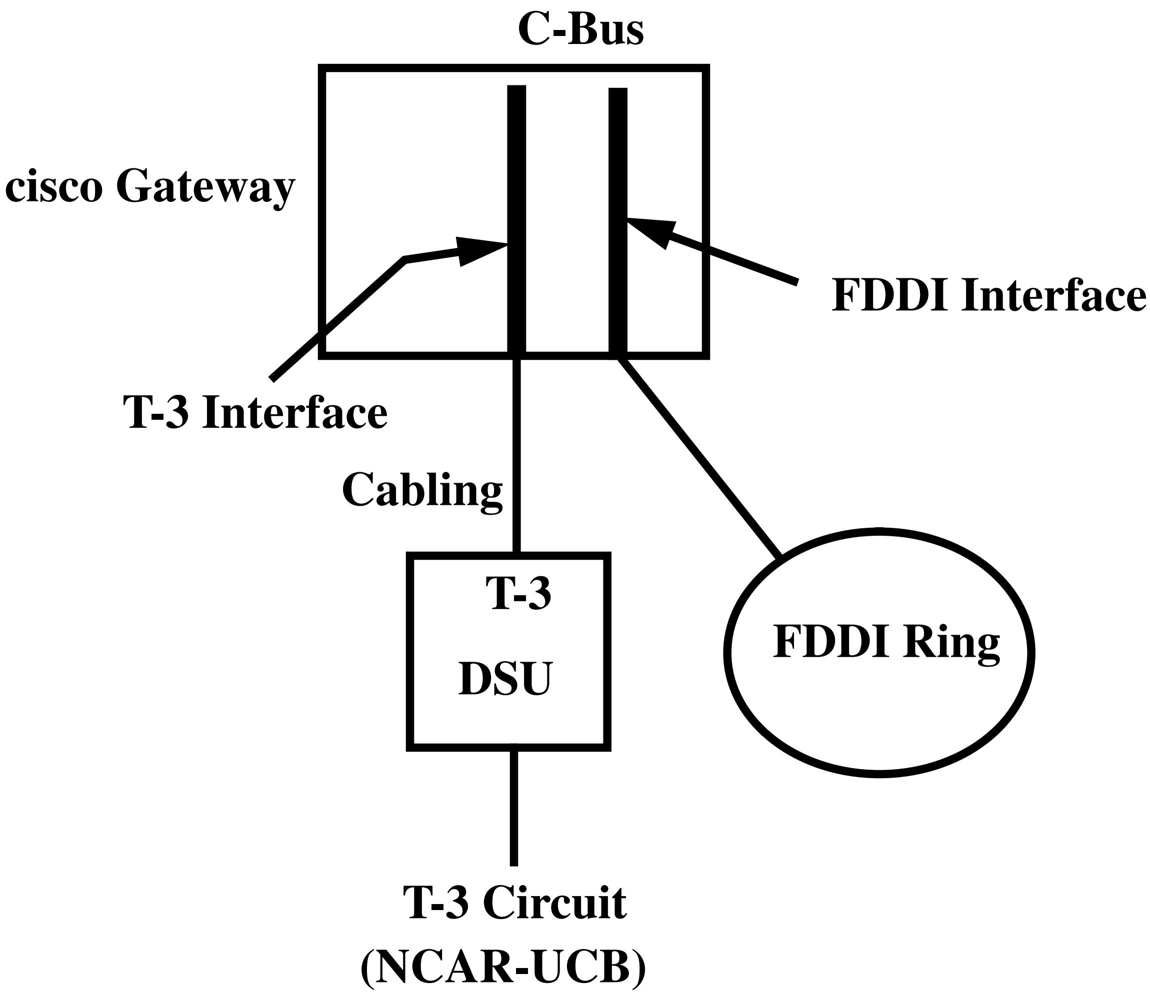


Figure 2 Hardware Configuration

(Identical at Both Ends)

5. BIOGRAPHICAL INFORMATION

5.1 Dr. Pat Burns

In 1978, Dr. Pat Burns received a Ph.D. in Mechanical Engineering from the University of California at Berkeley. His Ph.D. research involved large-scale computation on a CDC 7600 -- the only supercomputer in existence at that time. In August of 1978, Dr. Burns joined the faculty of the Department of Mechanical Engineering at Colorado State University as an Assistant Professor. Since that time, Dr. Burns has continued his efforts in research with a heavy computational emphasis. He spent the years of 1980 and 1981 in the Methods Development Group at the Lawrence Livermore National Laboratory (LLNL), where he developed large-scale codes for general purpose use by the Laboratory. During the 1988/89 academic year, he was on sabbatical leave at the Supercomputing Research Center. Currently, he is a full professor in the Department of Mechanical Engineering at Colorado State University.

Dr. Burns has substantial management experience, having served from 1984 through 1986 as the Chairman of the Engineering Science Major at Colorado State University. From May of 1986 to August of 1988, he served as Coordinator of Supercomputing for Colorado State University. He has over the years managed many research contracts, including at present being the Principal Investigator for the Westnet Networking contract from the NSF.

5.2 Dr. Ken Klingenstein

Kenneth Klingenstein is Director of Computing and Network Services at the University of Colorado at Boulder. He also serves in a number of regional and national networking positions, including Chair of the Technical Advisory Committee for the Colorado State Computing Network, Chair of the Steering Committee for Westnet (a NSF funded regional network), and a member of the Executive Board of FARNet. He has served on NSF and OTA advisory panels on networking, was a participant and commissioned author for Harvard University workshops on Information Infrastructures and Networks, and has recently been nominated to the Federal Networking Council Advisory Committee.

Dr. Klingenstein has consulted for a number of computer companies, including DEC and HP, and has advised state and local government agencies on topics in computing and networking. He has been a lecturer for both Educom and CAUSE on the topic of strategic planning and managing campus networks.

Dr. Klingenstein received his Ph. D. in Applied Mathematics from the University of California at Berkeley. He has published in the fields of formal language theory, networking and distributed computing environments. Among his awards are NSF and Rockefeller Fellowships and recognitions for campus leadership. He is currently a faculty member in the Computer Science Department at the University of Colorado and teaches courses in computer networks.

Appendix A

ITU Electronic Distribution Project

The International Telecommunications Union is an independent international body affiliated with the United Nations. The ITU is responsible for setting standards used in telephone, telegraph, and radio systems worldwide. In the area of computer networks, the ITU sponsors the Consultative Committee for International Telephone and Telegraph (CCITT) which publishes recommendations in many key areas, including the X.400 electronic mail, X.500 international directories, X.25 packet-switched networks, and the Integrated Services Digital Network (ISDN).

CCITT standards, as with most computer standards, have been only available on paper and at a very high cost. A complete set of these key standards can cost as much as $10,000. While the revenue stream has been important to the ITU, they feel that the high cost and inaccessibility of standards information may decrease the relevance and importance of the group. These concerns have led Dr. Pekka Tarjanne, the Secretary-General of the ITU, to authorize an experiment for free distribution of the standards over the Internet.

Carl Malamud has been asked to coordinate this experiment and has in turn asked the University of Colorado if it would serve as one of the electronic distribution sites for this important project. The CCITT standards will be made available as ASCII text and PostScript using SMTP-based electronic mail and the File Transfer Protocol (Anonymous FTP) as distribution mechanisms.

This project is a radical departure in the way the ITU conducts its business, and may force other groups such as the International Organization for Standardization to change their distribution mechanisms. The project hopes to have standards prepared for on-line distribution by October for an announcement at Interop. The participation of the University of Colorado would of course be made part of the announcement to the press at the conference

Appendix B

CVL (Computer Visualization Laboratory) - Colorado State University

The CVL (Computer Visualization Laboratory) at Colorado State University is an outgrowth of the Cyber 205 support staff (the Cyber 205 was decommissioned in the summer of 1989). A central facility, funded by the Vice President for Research, it is available to all at the University. The staff of four operate and maintain diverse high-resolution visualization platforms to produce personal, peer, and presentation graphics.

Among the graphics platforms are: two Silicon Graphics workstations, six Sun workstations, three high-end Macintosh workstations, and an extremely sophisticated video animation system for producing dynamic computer-generated videotapes. It is not the primary intent of the facility to provide graphics hardware for the University (although those without workstations do use the facility for this purpose); rather it is to provide the infrastructure for such visualization including software, expertise, user assistance and tools.

The staff maintain a variety of software tools, including: (1) NCSA's - Height-Color-Visualizer, Iso-SurfaceVisualizer, Layout, Image, PalEdit, Imagetool, DataSlice, X-Image and X-DataSlice, (2) NCAR's - NCAR Graphics, (3) Precision Visuals - Point and Click, (4) PSC's - gplot and P3D, (5) OSC's - apE, (6) Wavefront Technologies, Inc. - The Data Visualizer and The Advanced Visualizer.

A number of dynamic videotapes have resulted from their efforts, which have been included in proposals, and shown at professional conferences. Among the many visualizations are: the dynamic growth of ice crystals subjected to a temperature gradient, temperature and motion from a room air diffuser, photon trajectories through a daylit room, the visualization of the spin of molecules at liquid helium temperatures, experimental wind tunnel data on buildings, and groundwater flow (including motion of pollutants).

Appendix C

Circuit Price Quotation

from

US West Communications