Telecommunications and Networking Services

A Unit of Information Technology Services

2002-2003
Annual Report
July 1, 2002 to June 30, 2003

Acknowledgments:

This report was produced by Telecommunications and Networking Services, *a unit of Information Technology Services*, The Pennsylvania State University, University Support Building 2, University Park, PA 16802

A copy is available at http://tns.its.psu.edu, under "About TNS"

Contributors:

Steve Updegrove: Senior Director
Emily Anselmi: Director, Transmission Facilities & Operations
Ron Dodson: Director, Special Projects
Jerry Krawczyk: Director, Administrative Support
Steve Schroeder: Director, Network Planning & Integration
Compiled and Edited by: ITS Marketing and Communications

Table of Contents

At a Glance... *Some of the Years' Highlights and Numbers*

Integrated Backbone (IB)

Commodity Internet Bandwidth	180 Mbps
Overall Bandwidth to Gigapop	622 Mbps
Total IB connections to date	699
IB Connections designed by TNS during 02/03	331
IB Connections installed by TNS during 02/03	131

Local Area Networks

LANs installed by TNS during 02/03	82
Total TNS-Installed & -Supported LANs	456

Peak Residence Hall Ports Activated in 02/03

UP	11,563
Non-UP	1,129
Total	15,692

Voice Mail Subscribers

Traditional Voicemail Service at UP	5,257
VoIP Unity Service at UP	672

$15.8M Program at UP	Completed November 2002
Number of Outlets	19,000
Quantity of Category 5 Cabling	Over 2,000 Miles
Total Number of Buildings re-wired	106

I. Summary

This report summarizes the achievements, activities, and ongoing projects of the Telecommunications and Networking Services (TNS) unit of Information Technology Services (ITS), for the fiscal year from July 1, 2002, through June 30, 2003. Adjustments, especially in the areas of financial management and organizational responsibility, continued to be made as a result of the creation of TNS and of the adoption of the budget for telecommunications and security that was previously established by University executives.

There were numerous accomplishments during the year. The $15.8M program funded by the Commonwealth's Department of General Services was completed during the first part of the year, as planned. New equipment was specified, selected, installed, and activated within the backbone portion of the University's network--the 5th generation of technology since the backbone's creation in the mid 1980's. A 622 Mbps (OC-12) circuit replaced two smaller 155 Mbps (OC-3) circuits to the Pittsburgh Gigapop, enabling increases to both commodity Internet and Internet2 bandwidth. The next generation of local area networking (LAN) equipment was selected from a competitive procurement, and continuing encouragement was given via Consulting and Support Services (CSS) to those still having LAN's incapable of supporting Internet2, to make the necessary upgrades.

Deployment of Voice-over-IP (Internet Protocol) technology continued, albeit at a slower pace than expected. An effort was undertaken in the latter part of the year to assess products from an alternative provider of VoIP technology for use in the building currently under construction for the College of Information Sciences and Technology (IST), and to possibly enable compression of timeframes envisioned for the technical evolution of VoIP at Penn State. After an unexpectedly difficult start of the evaluation process, testing of the product, in a still-emerging state, was underway at the end of the reporting period.

Support and leadership were provided to develop *ITS Wireless: SecureNet Assist* and ITS firewall services, and several installations of the *ITS Wireless: SecureNet* Complete service were undertaken, including at the Hetzel Union, Shields, and other buildings at University Park, and within various buildings at several other campuses. After the firewall service was redefined in mid-year, arrangements were made for new trials, in preparation for introduction of the service for Fall '03. Arrangements were also pursued to offer an "individual good" service to those organizations having Private Branch Exchange installations, in response to requests to ITS for various forms of such support.

Interactions with various partners and service providers such as ATT, Agere, Avaya, Cisco, TelCove (previously, Adelphia Business Solutions), 3Com, Verizon, and others, continued, and a new contract for outsourced labor was established with Pennsylvania Networks. Investigations were also undertaken with several of the above firms, and others, to assess availability of "dark fiber" as a future means of connection from Penn State to the Pittsburgh Gigapop. Involvement continued at a national level with groups such as Abilene, BICSI, CIC, EDUCAUSE, Internet2, the Pittsburgh Gigapop, Net@Edu, and various working groups.

Within the unit, partial responsibilities of two positions filled by departed senior personnel were realigned into a single position, and a new director was hired. A revised set of cost centers was established, enabling improved accountability to various budget items, and mechanisms put in place to address various anomalies uncovered during the transition process. Changes were made in the use of certain physical space, and to equipment configurations and locations in the Telecommunications Building.

II. Accomplishments

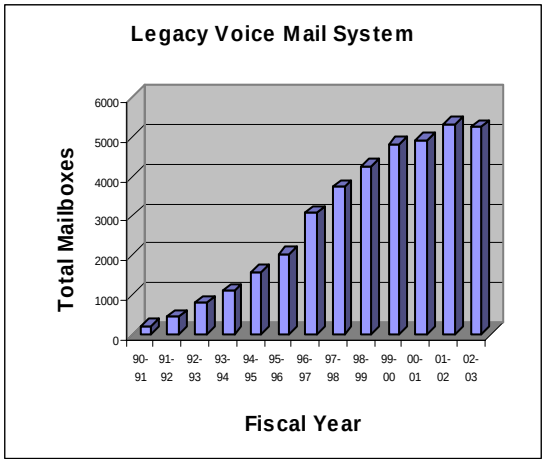
$15.8M Telecommunications Infrastructure Project Completed

The multi-year, multi-million dollar project to expand and upgrade the telecommunications infrastructure at University Park was completed in November of this reporting period, per the budget and schedule arranged with the Pennsylvania Department of General Services. With the completion of the project, several research projects are now possible and a large number of new capabilities are now available to the Penn State community. By greatly magnifying the bandwidth of Internet connections throughout the University and increasing the number of places these connections are available, the network expansion has made it possible for researchers to do such things as search digital resources more quickly and better transmit video and three-dimensional images to colleagues around the world. The seven year, $15.8 million dollar project involved the installation of 2,000 miles of telecommunications wiring and upgrading the technical capabilities in over 250 technology classrooms and 106 buildings at University Park. The project also extended high-speed Internet access to 25 additional buildings and many classroom facilities as well as accomplishing work not envisioned to be financially possible in this timeframe. The enhanced telecommunications infrastructure has widespread benefits for all of Penn State's research activities, ranging from the assessment of national watersheds, the design of cutting-edge architecture, and international collaboration, to aerospace engineering, bio-genetics and more.

Comprehensive information on the Project is available at http://tns.its.psu.edu .

Voice-over IP Technology

The University's traditional telephone communication services continue on the technological shift away from voice communications carried over a circuit (Verizon's Centrex) to having them carried over the Penn State Integrated Backbone (the Internet Protocol, or IP). As support for circuit-switched technology, such as is used by Merlin telephones, at University Park ends, telephone sets are being replaced with Voice-over-IP (VoIP) technology and IP phone sets. VoIP technology offers greater efficiency and opportunity for reducing costs for University departments and colleges, while at the same time establishing a basis for creation of innovative applications. The IP phone sets offer a full range of intelligent communication capabilities designed to take advantage of the University's network, while providing the convenience, reliability and ease-of-use expected from traditional telephones.



Unity is the name of the voice mail system used in conjunction with Voice over IP at Penn State. Unity offers Penn State VoIP subscribers all of the features of the legacy voice mail system, but at a monthly rate that is 50% less than that of the current legacy voice mail system. As a result, there has been a decrease in the subscriber base of the legacy voicemail system while at the same time the new Unity Voice Mail subscriber base has grown to a total of over 500 mailboxes.

Telecommunications Projects

At University Park Locations

TNS has been actively involved in planning, design and construction of the telecommunications distribution systems for many construction projects completed or underway at University Park locations, including:

- New Chemistry Building: design complete and construction in progress.
- Life Sciences Building: design complete and construction in progress.
- New Information Sciences and Technology (IST) Building: design complete and construction in progress.
- Pasquerilla Spiritual Center: construction completed.
- MBNA Career Services Building: completed and put into use in July 2002.

Additional Telecommunications Projects at University Park locations:

New fiber installations at:

- Dairy Administration Building
- Mushroom Research Building
- Patterson Building
- Althouse Lab

Buildings re-wired with TNS-managed infrastructure funds:

- Business Administration Building1
- Research Building East

At Non-University Park Locations

TNS has also been actively involved in planning, design and construction of the telecommunications distribution systems for many projects that have been completed or are currently underway at non-University Park locations, including:

- Berks campus: Completed the addition to the Franco Building, including re-wiring of that building. This building is considered the “Front Door” of the Berks campus, housing the office of the Registrar, finance, academic advising and other important academic departments.
- Behrend campus: Design was completed for the new Research and Economic Development Center Building. Design and installation were also completed for the re-wiring of the Tiffany, Porcupine, and Tigress residence halls. The halls were rewired with Category-5e cabling, replacing the old Type-II cabling.
- Beaver campus: Design was completed for the new Administration Building. The main switch room, which houses the voice switch, data hub and other telecommunications services for the campus, resides in the basement of the old Administration Building. The old building is slated to be demolished to make room for the new building. The design includes encapsulating this existing switch room so that when the building is demolished around it, the switch room will remain intact. A new entrance to the switch room will be provided, and ultimately a gazebo, with professional landscaping, will be built on top of it.
- McKeesport campus: The new Student Community Center was completed and put into use.

Network Reliability

TNS efforts to maintain a high level of core network reliability have resulted in an average total Integrated Backbone (IB) uptime of over 99%. Timely software upgrades, continuous support staff training, and regularly scheduled replacement of core network components with advanced technology have been important factors in keeping outages caused by equipment failures low in number and short in duration.

The implementation of alternate communication paths and redundancy for University Park routers has further increased system reliability. The Cisco 7600 routers at University Park are connected in a dual-homed star topology. The primary link to the integrated backbone for each is provided by two Gigabit Ethernet (GigE) interfaces configured as a single trunk, homed to a primary core router,

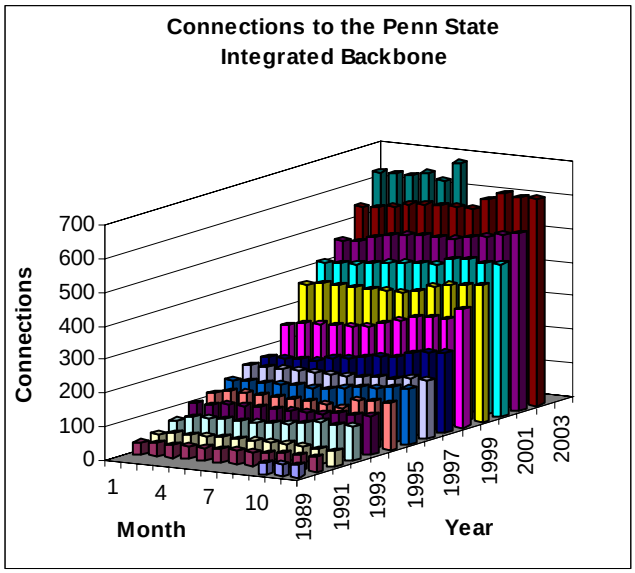
Penn State's border to Internet and Internet2 circuits. As an alternate path, each of the Cisco 7600"routers also has a single GigE interface homed to a separate, redundant, router. This connection is used in the event of a failure of the primary connection. This latter router will perform a real-time failover to serve as the core of the IB in the event of the loss of the primary core router. If a fiber outage between Penn State and the circuit vendor prevents the primary core router from functioning as the border router, the redundant router can be re-configured in a matter of minutes to route Internet1 and Internet2 traffic. This overall architecture uses the latest routing technology in an innovative fashion to further improve the core Integrated Backbone services provided by TNS.

Redundant links to other campuses continue to provide connectivity to those sites during circuit outages. These redundant links consist of 4 Integrated Services Digital Network (ISDN) Basic Rate Interface (BRI) lines, totaling 512 kbps of available bandwidth to back up the 45 Mbps (T3) circuits between each site and University Park. When a campus's router detects a loss of default route information from the T3 circuit, an ISDN call is automatically placed over the BRI connection to University Park. That call is maintained until default route information is reacquired from the T3 circuit. While this remains an economic and innovative way to provide a critical degree of redundancy among campus locations, TNS is currently researching methods to increase the bandwidth provided on these redundant links, which continue to fill a critical role during power outages and other disruptions affecting service to the sites.

III. Network Enhancements

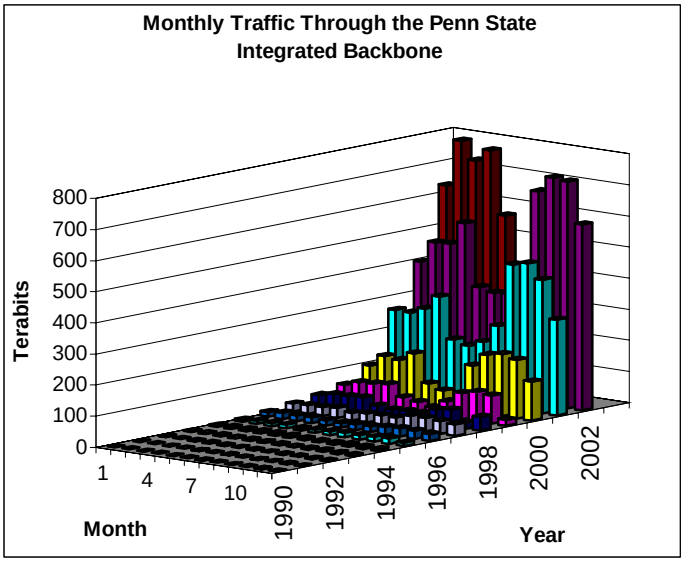
Integrated Backbone (IB) Services

The Integrated Backbone (IB) is the IP network that enables the efficient transmission of voice, video and data between students, faculty and staff–not only within University Park–but to 22 other Penn State campus locations across the state, and to the Internet. The IB supports interconnectivity of over 450 Local Area Networks at Penn State, as well as providing access to Penn State computer resources and information available via the Internet. During this reporting period, 331 IB connections were designed, and 131 IB connections were activated, bringing the total number of IB connections to almost 700.



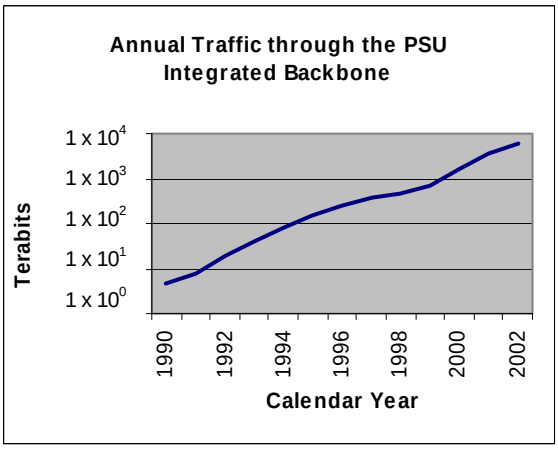
Due to the continued exponential growth of traffic carried on the University's network, an upgrade of the IB - to its 5th technological generation - was completed during this reporting year. The upgrade enables greater amounts of traffic to be transmitted at faster rates while also improving the quality of the data to a level that had before this time been impossible. Utilization of Penn State's computer networks exhibit growth in rate-and-quantity areas that is exponential in nature, requiring upgrades across the system approximately every three years simply to keep pace with demand.

Internet Router Upgrades



Routers are highly intelligent devices, which serve as an interface connection between two networks to ensure end-to-end reliability of data transfer. The last upgrade of the IB, which utilized the then state-of the-industry Cisco 7500 and Cisco 7200 IB router platforms, was completed in fiscal year 99/00. The Cisco routers served well at that time but it was projected that they would not be able to accommodate expected future demand for increased bandwidth-improved transmission quality. Projects were begun in the 4th quarter of 1999 that resulted in the selection of hardware that would meet today's bandwidth expectations, culminating in the two-year project to upgrade all of the IB routers on the Penn State network completed this year. This recent iteration utilizes Cisco 7600 routers at University Park, and at Harrisburg.

A new generation of Internet router, the Juniper M-10 series, was installed at the Altoona campus. This installation required numerous changes to automated scripts that routinely back up the router configurations as well as manage various aspects of the residence hall networks. The Juniper M-10 router offers increased performance, support for new Gigabit Ethernet ports, and higher port density than the Cisco 7206s they replaced. With the success of the Altoona installation, additional Juniper M-10 routers were installed at other campus locations. In total, 21 Juniper M-10 routers are now part of the Penn State Integrated Backbone.



High-Speed Wireless Networking Access Opportunities

ITS' coordinated development of a high-speed wireless networking service during fiscal year 01/02 has created a wireless network model that can be utilized at any of Penn State's campus locations. The service, given the name *ITS Wireless: SecureNet Complete* during this reporting period, offers authentication and user accountability to ensure that data transfers are safe, using the ITS Virtual Private Network (VPN). *SecureNet Complete* creates *new* wireless networking areas within buildings. This service is designed, implemented and maintained by ITS. A second service was developed during this period to complement *SecureNet Complete*. The new service, known as *SecureNet Assist* offers an easy and secure method for interconnecting *existing* wireless LANs to the Penn State wireless network using the same state-of-the-art VPN, in order to assure overall security integrity. Existing local wireless networks that want to use the ITS VPN server must comply with specific criteria to ensure the overall security expected by users of ITS services.

Following the announcement of *ITS Wireless: SecureNet Complete*, RF[1] designs were completed for a number of facilities including Dickinson's Tricket Hall, portions of Harrisburg's Olmstead Building and Eastgate Center, McKeesport's Frable Building, the Library at the Worthington-Scranton campus, and at Cedar, Keller, Chambers, and Shields buildings at the University Park campus.

At the end of the reporting period, the high-speed wireless access service was also made available within the Hetzel Union Building (HUB) on the University Park campus. The service will make it convenient for Penn State computer users at the HUB to wirelessly access the network, and to use e-mail and Web browsing applications as well as digital research tools such as the Library Information Access System (LIAS).

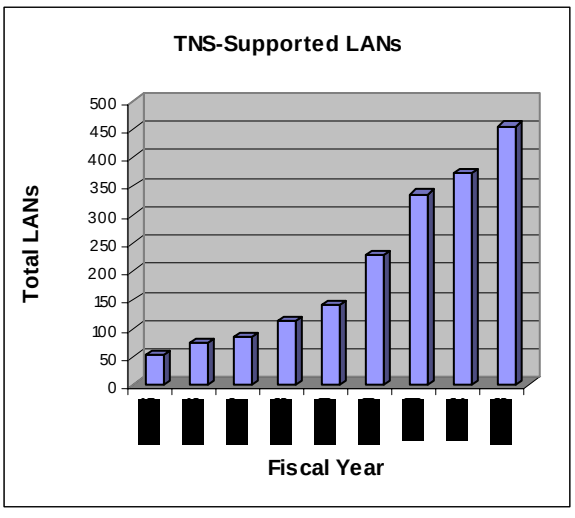
Stemming from an effort to identify existing wireless system installations in buildings at Penn State as part of the wireless system design process, TNS created a wireless registration information database for general use as a tool to enable any Penn State person to locate areas having ITS wireless services, or other wireless services which are registered. The registration process is voluntary and utilizes an on-line application form that is completed by the Technical, Security, or Administrative contact of the building in which the wireless network is located. The wireless registration records information about the location and technical aspects of the wireless local area network, including coverage area, IP addresses, access point(s), and other information necessary to enable its use by others. The application also records contact information for those requiring assistance within each building where service is registered. Approximately a dozen entries were registered as of the end of the period.

Disaster Recovery/Preparedness

A variety of activities was undertaken in the general context of disaster recovery/preparedness. These ranged from working with those involved with the connection to the Pittsburgh Gigapop (to complete a physically separate cable entry to a critical facility there), to undertaking an initiative to install additional fiber pathways in certain locations at UP, to introducing an integrated backbone redundancy service, to reviewing and making plans to improve the robustness of telecommunications and networking services within and between campuses. Numerous meetings with those in other Penn State and outside organizations were attended, review and comments were provided to a variety of associated documents, and appropriate actions were taken to improve resiliency of services both offered and used, to various potentially disruptive situations.

Local Area Network (LAN) Services

During this reporting period, 82 LANs were installed, bringing the total number of TNS-designed, installed and supported LANs to 456. Each TNS-supported LAN is serviced through an IB connection.

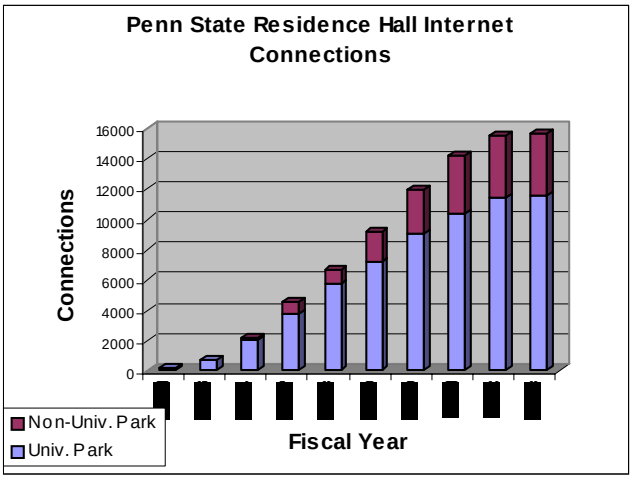


[1] Radio Frequency: Radio Waves that propagate in free space with guides or wires. Used in wireless devices.

IV. Student-Focused Issues

Residence Hall Internet Services

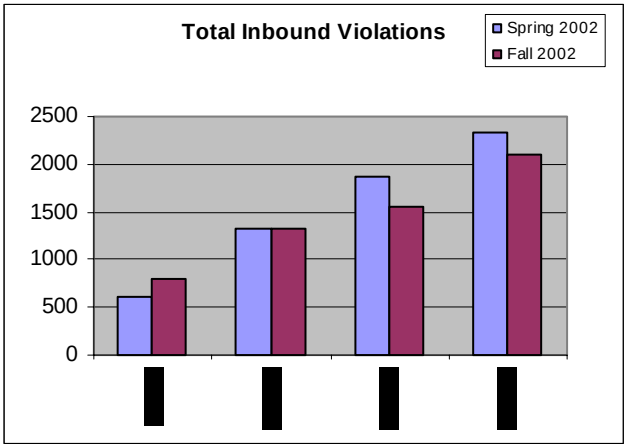
Over 15,000 students who lived in Penn State "traditional" residence halls during this reporting year, and had their own computer, activated the Internet connection port(s) available in their room. This represents 98% of those in University Park residence halls, and 93% percent of those in residence halls at Non-University Park campuses, exclusive of Penn College.

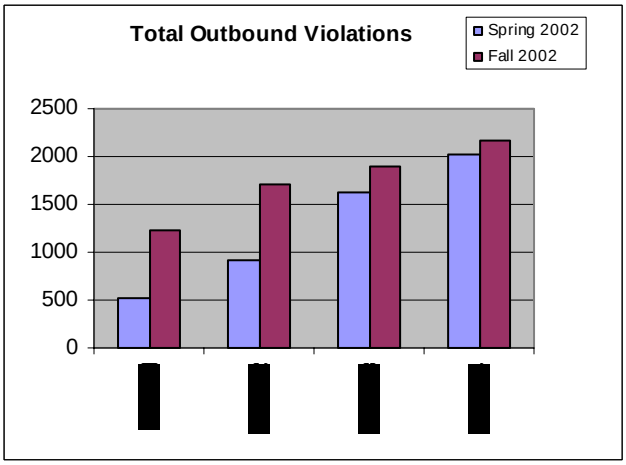


The residence hall students use 10 Mbps, or 100 Mbps, Ethernet connections to communicate over the Penn State network and with the Internet. A transition is underway to offer only the faster, 100 Mbps connections, by Fall 2004.

Bandwidth Monitoring

The residence hall population makes up approximately 12% of the total population at Penn State. That 12% was found to be regularly consuming almost 65% of the "shared" bandwidth for all of Penn State. As a result, in order to restore the fraction of University resources to a more commensurate level, bandwidth limitations were imposed upon overall use of the Internet by residence hall students and upon individual consumption of bandwidth by those students occupying residence hall rooms. The total upload and download traffic for each residence hall student with a registered Ethernet connection is measured in order to determine if a student is operating within the bandwidth limitation cap of 1.5 GBytes/week, as set by the University.

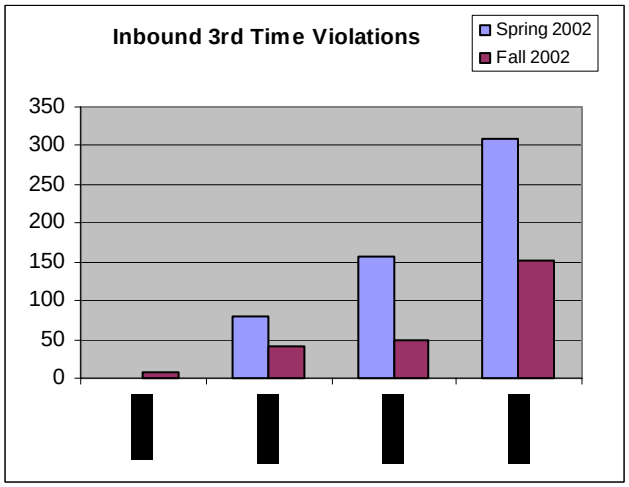


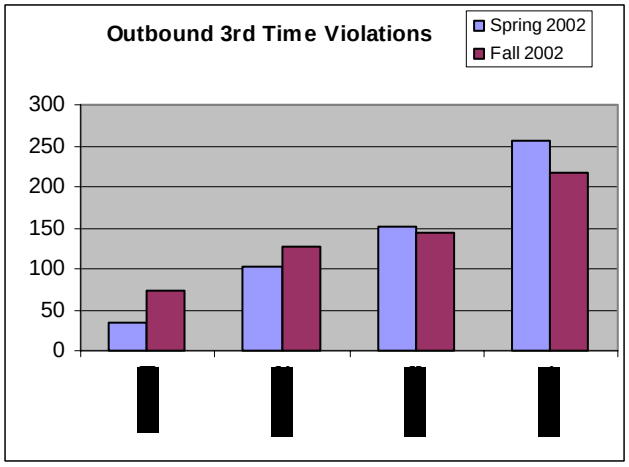


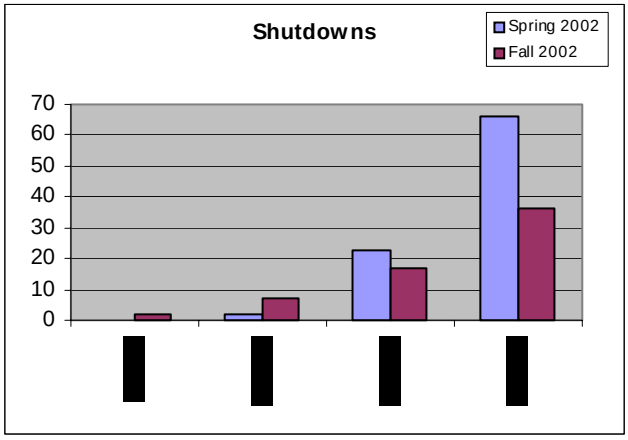
An automated monitoring program runs every 8 hours to compare a student's bandwidth totals with that individual's bandwidth limit. When a student's consumption is between 60% and 99% of the weekly 1.5 GB limit, a *warning email* is sent. However, if a student should go over the limit before the process is first run for the week, a warning notice is not sent. In that case,

or in the more likely case of a warning not being heeded, and the limit exceeded later in the week, a *violation* results, and the student's connection speed is changed to that of a "shared 56 Kbps" limit for the remainder of that week. This is also the process for a second week's offense. In the case of a third week's offense, the speed is set to remain at the reduced 56 Kbps speed for that student, for the remainder of the semester. If a student manages to exceed the 1.5 GByte/week limit for a 4th time in one semester, the student's residence hall connection is shut down for the remainder of that semester. Residence Life accommodates appeals for those students who wish to challenge that action being taken.

Since the restrictions and monitoring were implemented, the residence hall demand on bandwidth has been reduced and percentage of bandwidth consumed has been restored to a more reasonable level. These restrictions have turned out to be extremely successful.







V. New Initiatives

Firewall Service

An ITS Firewall Service is being developed to provide University networks with cost-effective, practical, real-world protection from external attacks and internal abuses. This new service will be made available to all TNS-maintained University backbones, including those with customer maintained LANs. Specifically, the service offers centralized LAN protection, rapid response for coordinated network or Internet attacks, customizable rules governing inbound and outbound traffic and continuous TNS maintenance for departmental LANs. Two different types of services, Basic Firewall and Custom Firewall, will be offered. Both types of services define the rules for filtering inbound and outbound communications.

IPv6 Trial

A limited-scope engineering trial of the next version of Internet Protocol, known as IPv6 was introduced during fiscal year 01/02. The trial was still ongoing during this reporting period and it was found that Penn State has enough IPv6 addresses to put a 64 bit subnet in every room. A 64 bit subnet has 2^{64} addresses.

IPv6 will enable Penn State to accommodate the anticipated growth in the number of registered computers on the Internet (IP addresses) and will also help pave the way for future service enhancements available via Penn State's Integrated Backbone, such as "Quality of Service" and "Anycast." These services will enable students, faculty and staff to conduct real-time communications and applications over Penn State's network by allowing multimedia traffic (such as voice and video) to coexist with traditional data traffic on the same network. In addition to greatly expanding the number of Penn State's Internet addresses, IPv6 will also provide enhanced features such as flexibility, extensibility, and new security features. The goals of the trial include furthering Penn State's knowledge of IPv6 and providing IPv6-based connectivity with other institutions, as preparation for the Protocol's broader deployment. Other goals are to provide an opportunity for Penn State staff members to work with IPv6 while keeping the University up to date with the development of Internet2's next generation network. The trial, which is limited to 20 participants, is designed to maintain the "trust model" adopted by the University and applied to the Integrated Backbone. Encouragement continued to be given to others to join the few organizations engaged thus far in the trial.

VI. CQI

Timely Notification of Telecommunications Work and Deadlines

One of the best practices developed by TNS during the past few years has been to request timely notification of telecommunications work that is needed by Penn State organizations during the summer months. Again this reporting period, notices of deadlines are posted to the Telecommunication's listserv well in advance for work to be billed during a fiscal year and for work that is to be completed during the summer months. Timely notifications provide a tremendous overall benefit for the University community by enabling contacts to complete Telecommunications Service Requisitions (TSR) prior to the deadlines so that TNS can schedule work in an orderly fashion. This eliminates much of the disruptions stemming from high-priority, last-minute requests. The practice also minimizes the amount of extra-cost overtime needed to accommodate these efforts, leading to overall savings to the University, as well as to individual departments.

VII. University Relations

TNS Participation in IT DAY 2003

ITS held its inaugural IT DAY Expo at the HUB Ballroom on October 16th from 10 a.m. to 3 p.m. Over 30 exhibits including displays and demonstrations on current IT technology, products, services and newly emerging technologies were showcased. Wireless Networking, University Infrastructure and Voice over IP technology were represented by TNS. In addition, TNS was responsible for designing and temporarily installing the wireless networking access points needed to provide connections for each ITS display table.