ITS Information Technology Services

CAMPUS NETWORK REPORT

ACADEMIC YEAR 2007

OCTOBER 9, 2007

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1. Campus Network Report - AY2007

This report provides a brief look at metrics describing the size and performance of UTnet, the campus computer network. Included are overall reliability statistics, traffic rates, network size statistics, and data on the growth of the systems and services.

1.1. Summary

The key points of interest from this year's network report are categorized by points of interest, actions taken, and new requirements.

1.1.1. Points of Interest

- There were no campus-wide backbone outages for academic year (AY) 2007, and only 52 minutes of downtime for the commodity Internet.
- Building networks across campus received an average grade of 85.9 (B).
- There are 2,709 switches and 2,164 wireless access points on campus, and an estimated 110,000 wired ports.
- There are approximately 108,000 unique devices on the campus network at some point in a semester.
- Inbound commodity traffic increased by 53% from spring 2006, and all hosts are consuming more bandwidth.
- The wireless network is growing to match the size and complexity of the departmental wired networks.
- Total wireless connection hours increased to 4.8 million for spring 2007.

1.1.2. Actions

- One gigabit per second (1 Gbps) of commodity bandwidth was acquired for AY 2007-2008.
- Telesys was discontinued on August 31, 2007.

1.1.3. New Requirements

- All campus buildings must be routed and dually connected to UTnet at a minimum of 1 Gbps.

2. Scope of UTnet

UTnet serves The University of Texas at Austin, which has an enrollment of approximately 50,000 students as well as 3,000 faculty and 18,000 staff. The University budget for fiscal year (FY) 2006-2007 was $1.84 billion, with annual research funding that exceeds $400 million across more than 100 research units.

There are 16 colleges and schools at UT, as well as 7 museums and 17 libraries. The main and PRC campuses include several hundred buildings with a UTnet presence in most of them. UTnet also serves a number of external sites, primarily located around the city of Austin. All told, the campus network serves a combined total of roughly 200 buildings and sites.

UTnet is funded and operated in a federated model. Central staffing and operations are provided by the Information Technology Services (ITS) Networking group with an AY 2006 budget of $2.4 million. University departments provide distributed funding, operations and staffing. While support and funding is distributed, Networking co-manages 90% of the networks on campus and all of the wireless networks.

2.1. Reliability

There were no campus-wide backbone outages year-to-date. A second Network Operation Center (NOC) is under construction and expected to be completed during the 2007 winter break. This second NOC will increase backbone resilience for on-campus connectivity immediately and off-campus connectivity in the future (**Figure 1**).

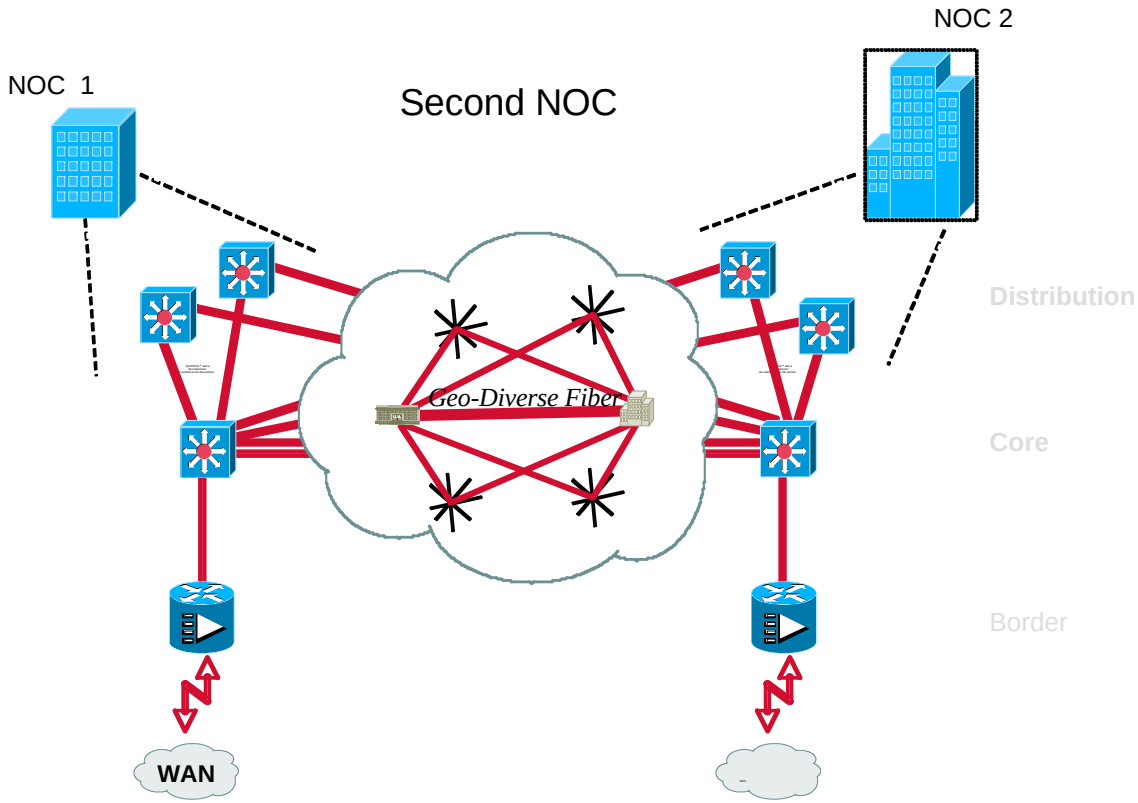

Figure 1

Commodity Internet reliability was 99.99% (52 minutes of downtime) year-to-date. Outages were evenly split between minor external ISP and internal faults. Networking has proposed and expects to receive funding for second border router to reduce outages caused by internal faults for AY 07-08. A request for additional external ISPs will also be forthcoming.

Reliability of individual building Point of Presence (*POP*) connections to the campus network is reported in the TSC outage tools (**Figure 2**). Out of 197 sites, only 3 did not meet our service goals—remote sites where we have little control over third-party carriers—and 169 sites experienced no outages. The most common cause of outages was loss of power and resulting failure to recover once power was restored (hence our recommendation for UPS systems at all sites—especially remote ones).

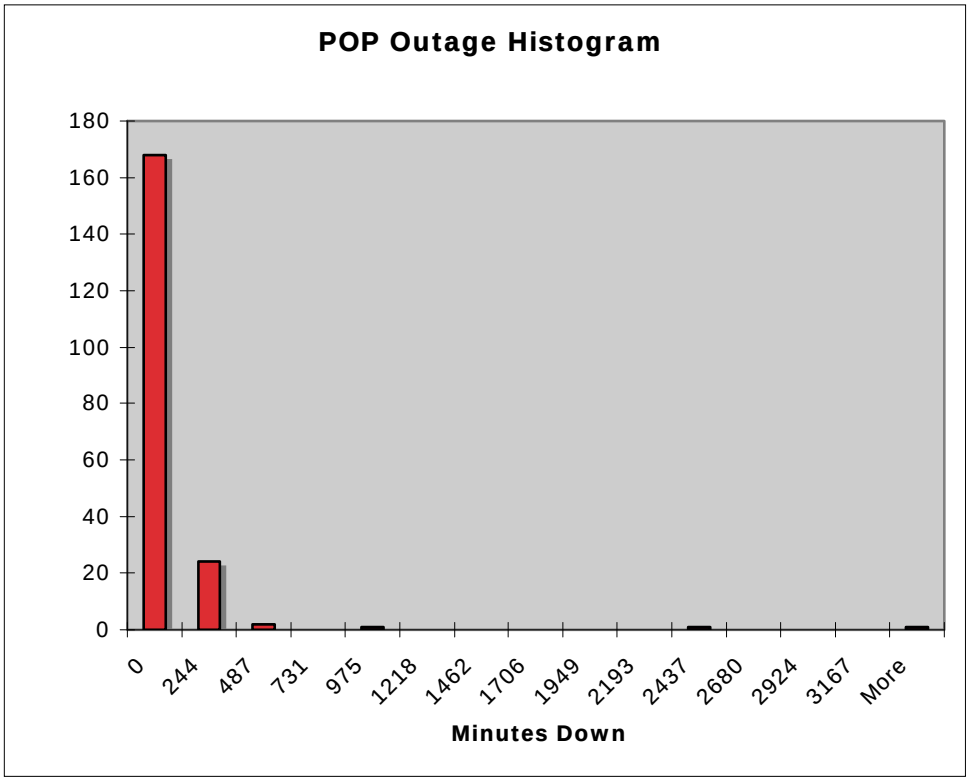

Figure 2

The Building Network Report Card registered an average grade of 85.9 (B) for building networks with at least 75 devices (up from 83.6 the previous year) (**Figure 3**). Building grades reflect the capability and supportability of the equipment comprising the buildings' networks and their configurations. The average for all buildings was only 68.2—influenced by lower device population buildings, such as small buildings on the PRC campus. Complete results are available in the TSC tools, or by request of a department head.

Internal building network reliability is not metered by Networking at this time due to complexities of federated operations, but is under study for AY 07-08.

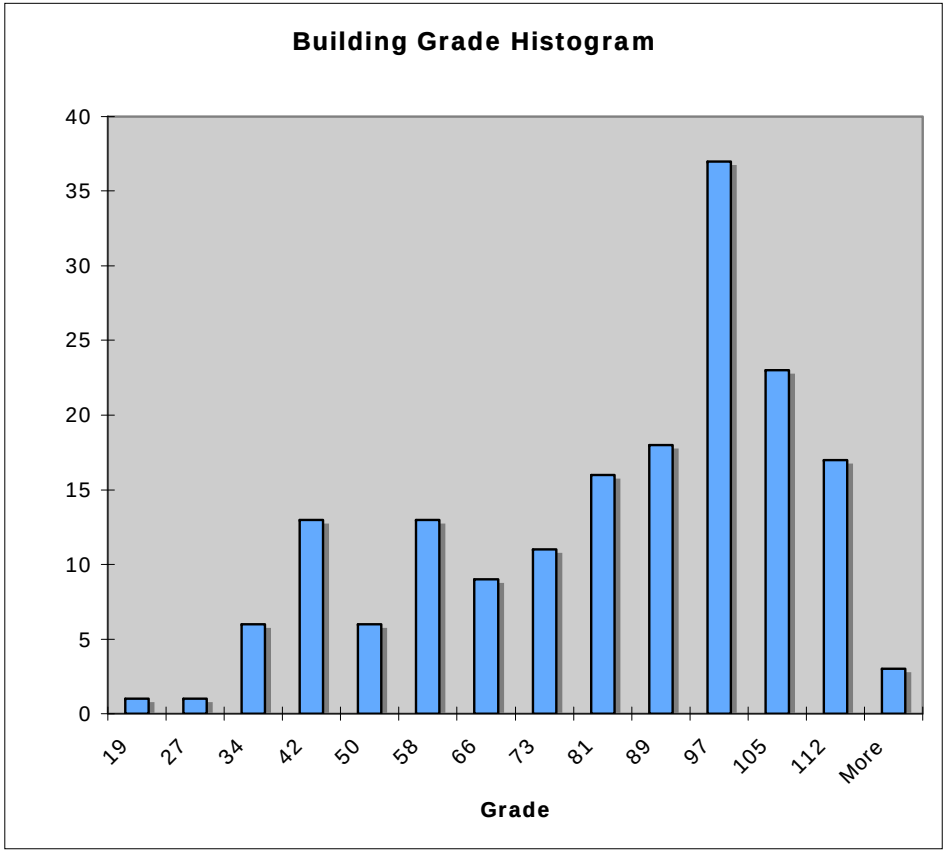

Figure 3

2.2. UTnet Backbone

All traffic between buildings and to the Internet passes through the *UTnet core* (**Figure 4**).

In FY 06-07, all core devices were upgraded with the latest dual switching engines to improve reliability. Additional 10 gigabit interconnects were also added this year.

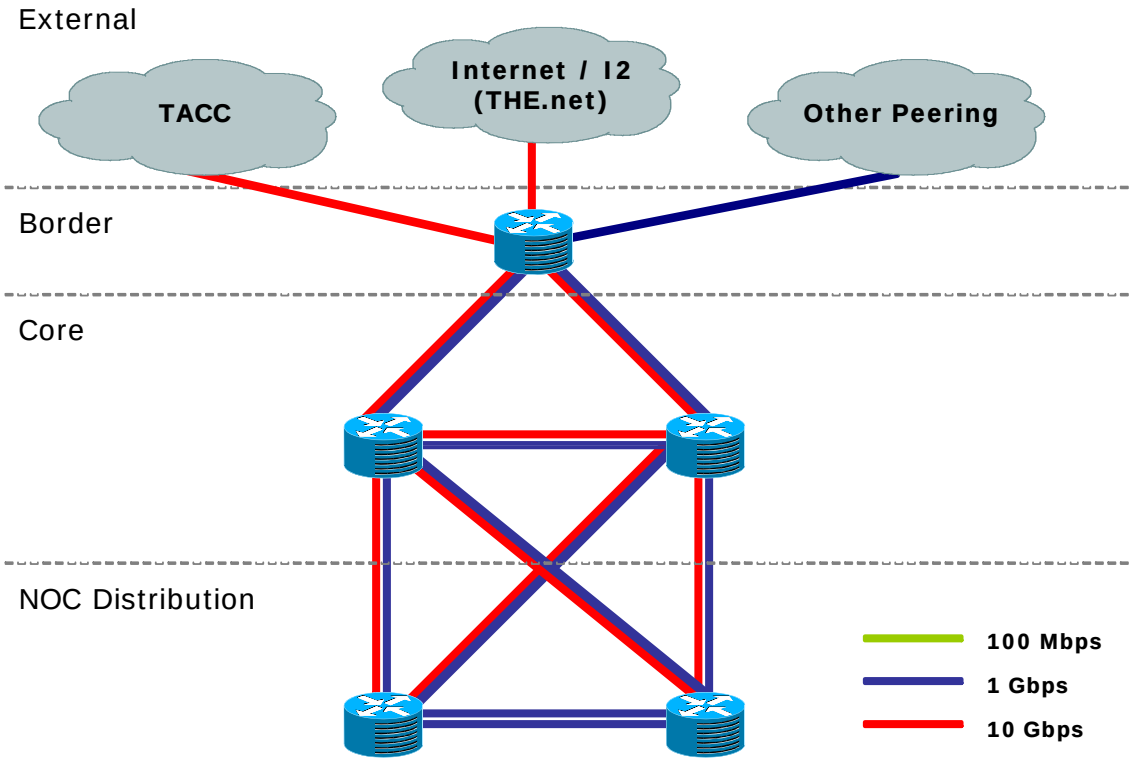

Figure 4

UTnet experienced a 14% increase in throughput in 2007 over the same time period in 2006 (**Figure 5**).

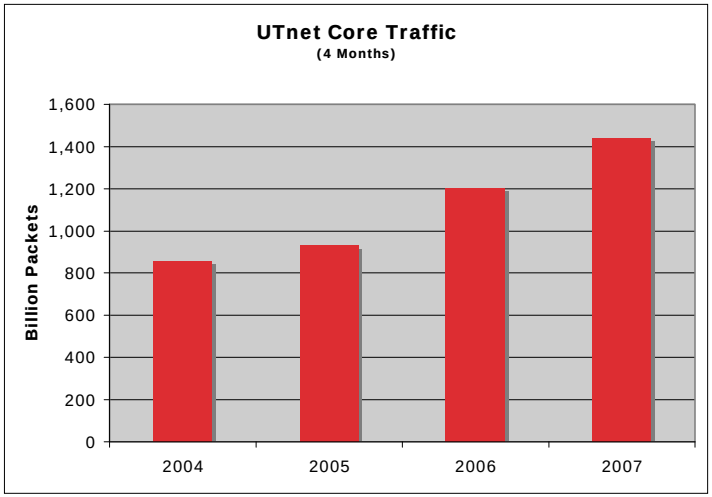

Figure 5

The number of routed subnets carried by UTnet also increased to 2,436 (**Figure 6**). Growth in subnets is being driven by allocations in RFC1918 address space (private networks not routed off campus) and Public Networks (wireless).

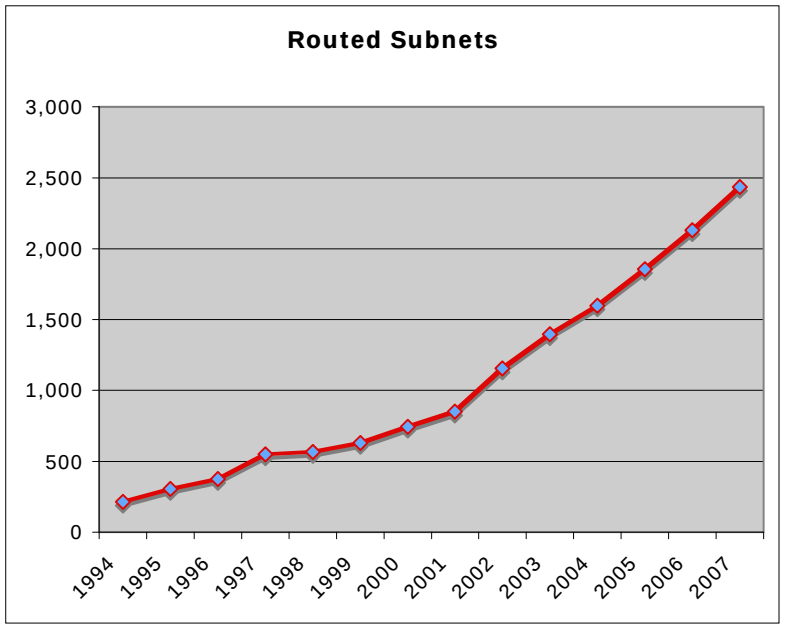

Figure 6

Networking now requires all buildings on the main and PRC campuses to be routed and dually connected to UTnet. Networking recommends that at least one connection for larger sites be 10 Gbps (**Figure 7**).

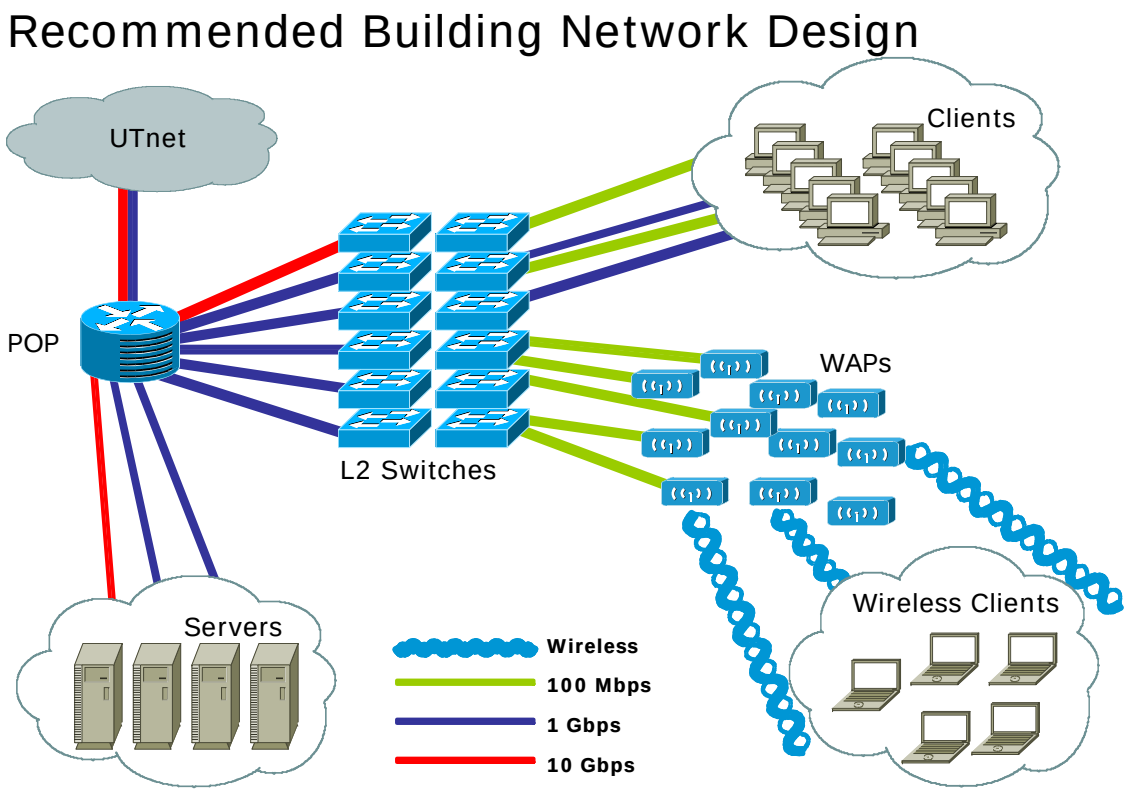

Figure 7

Current UTnet connection speeds are shown in **Figure 8**. 1 Gbps connections are the minimum required. 100 Mbps connections have been deprecated and are only allowed as an exception. Connectivity to remote sites will vary, but AT&T Opt-E-Man connections (100 Mbps) have been high performance and cost effective.

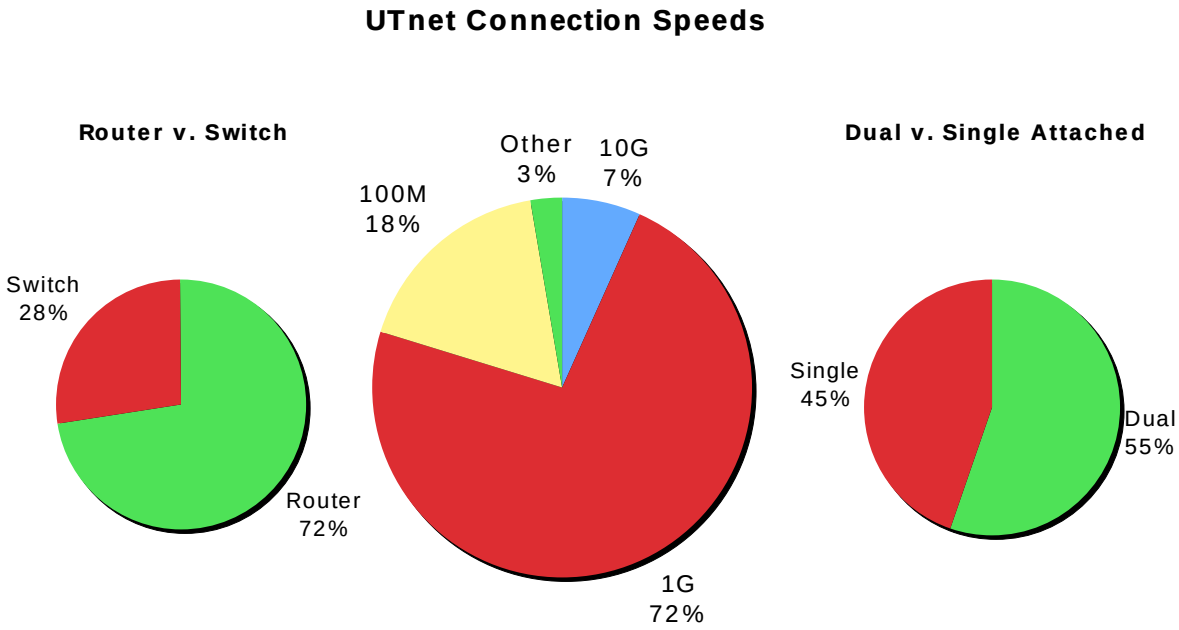

Figure 8

There are 164 UTnet sites connected at present. 106 are routers, the rest are layer 2 switches. Sites not meeting network standards tend to be smaller and less well funded departments—particularly at the PRC campus and remote locations. They have been grandfathered, but must move to current standards at their next upgrade opportunity.

An upgrade to the DWDM (dense wave division multiplexed) ring connecting the PRC campus and other sites throughout Austin was purchased this summer, and is to be installed in fall ’07. Beyond additional 10 Gbps connections to the PRC campus, it will connect the Dell Pediatric Research at the new Mueller campus, and increase the Texas Advanced Computing Center’s (TACC) external connectivity.

The importance of dually connected and routed sites will be increased with the completion of the second NOC this fall—improving on campus network survivability in the event of major failures.

The majority of networks on campus are co-managed by Networking. April 2007 edge device totals included 2,709 switches and 2,164 wireless access points (29% growth, mostly wireless devices). All running supported/patched code as of summer ’07 intersession. Monitoring and managing a network of this size, along with providing critical services like DNS, DHCP, and Public Network Access, requires over 90 servers.

The set of switches alone provides over 103,099 Ethernet ports (84,792 in 2006). We estimate there are 110,000 ports on campus after accounting for those not in the management tools or hidden by local firewalls.

Despite the advent of wireless, wired port growth continues on campus with new categories of use (for example, control systems) (**Figure 9**).

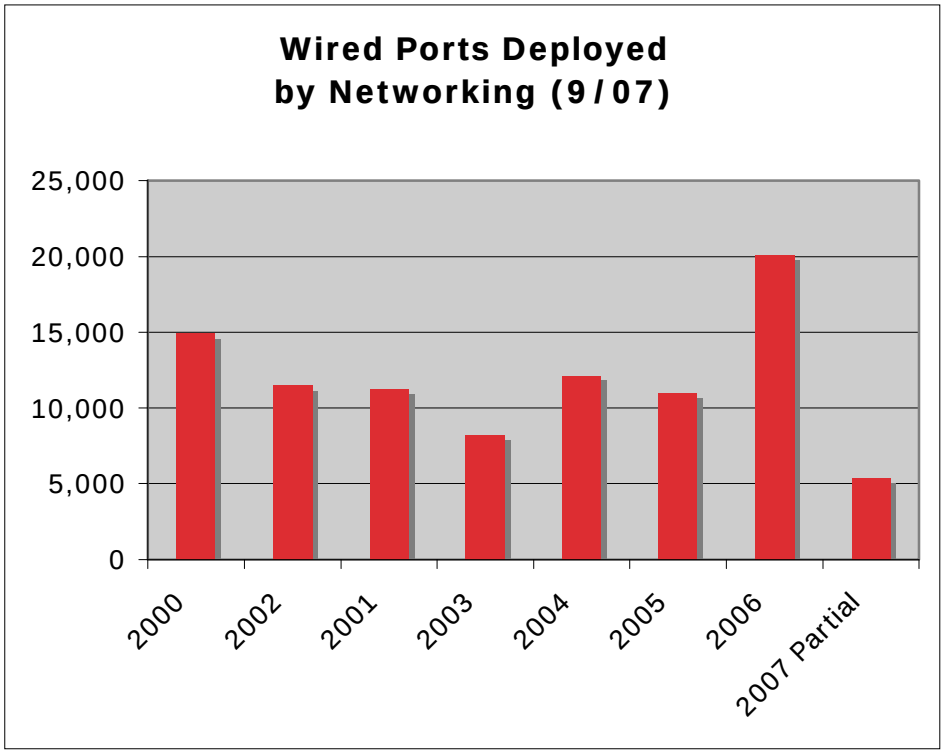

Figure 9

2.3. External Bandwidth Consumption

Busy hour inbound commodity traffic increased by 53% from Spring 2006, exceeding our purchased allocation (**Figure 10**). This was a repeat of the previous year's impressive growth (47%). Our goal is to utilize only 80% of our capacity at the 95th percentile of busy hour consumption. Instead we reached 106%. Peak excursions beyond the 95th percentile increased in both in frequency and magnitude.

Outbound commodity consumption maintained a healthy ratio to inbound—which along with the diurnal pattern indicate a mainly consumer network (i.e., not a producer of content, no rampant copyright infringement).

Busy Day Commodity Bandwidth
(3-19-07)

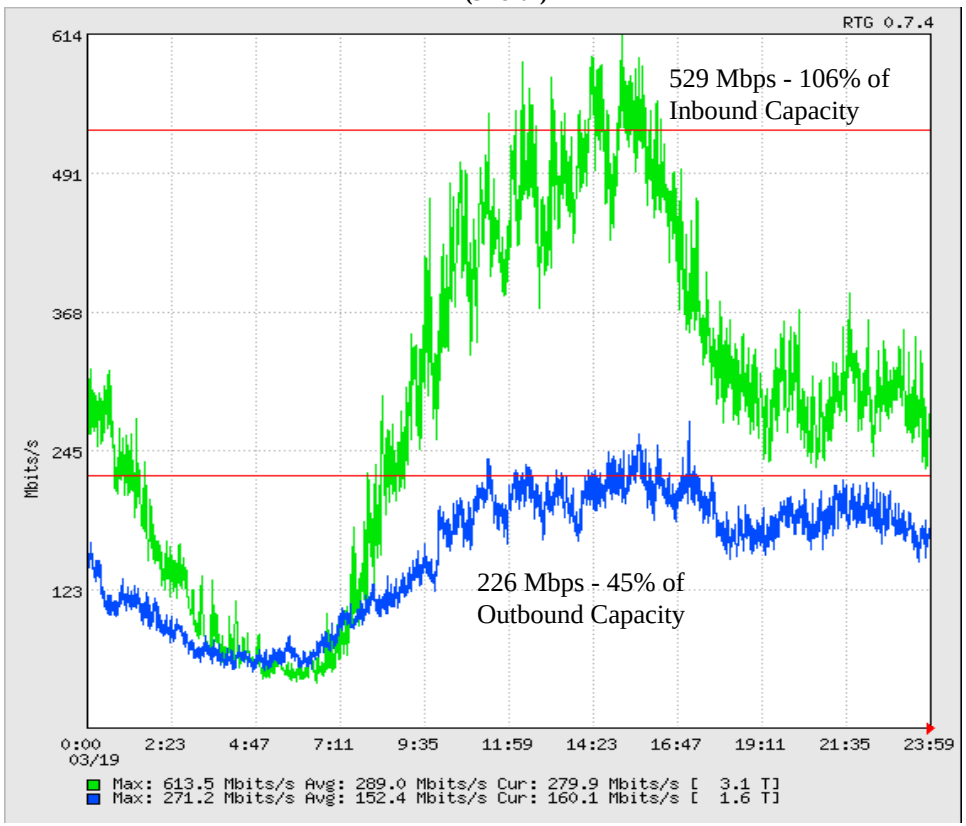

Figure 10

Long-term volumetric traffic increased by 50% inbound and 14% outbound from Spring 2006 (**Figure 11**).

Commodity Trend (2007)

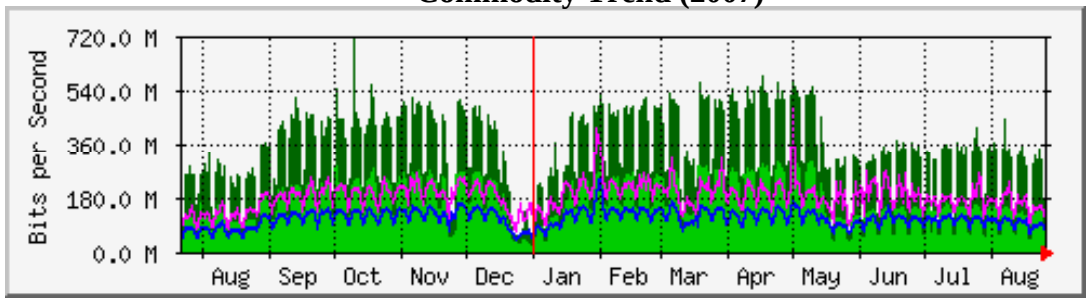

Figure 11

Per host, median consumption increased by 18% from Spring 2006 (all hosts are consuming more bandwidth) (**Figure 12**).

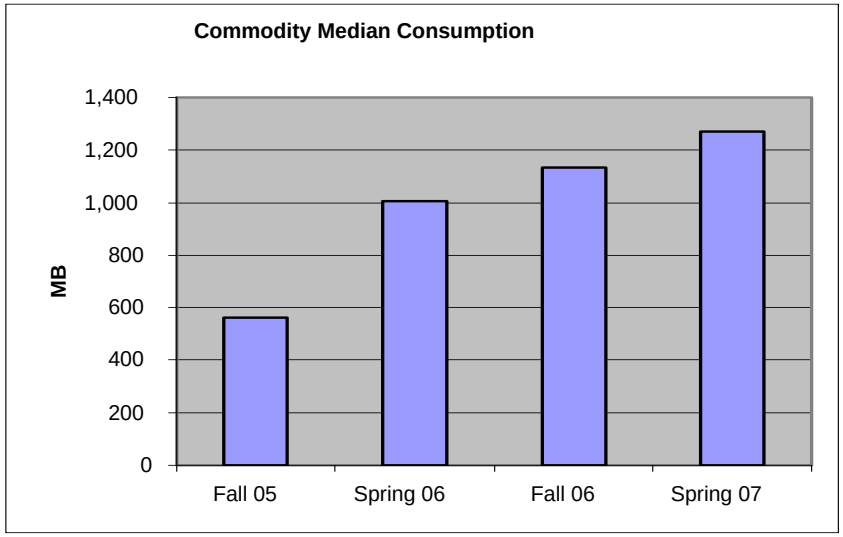

Figure 12

However, the standard deviation increased by 42%, indicating that the outliers are increasing consumption at an even greater rate (**Figure 13**).

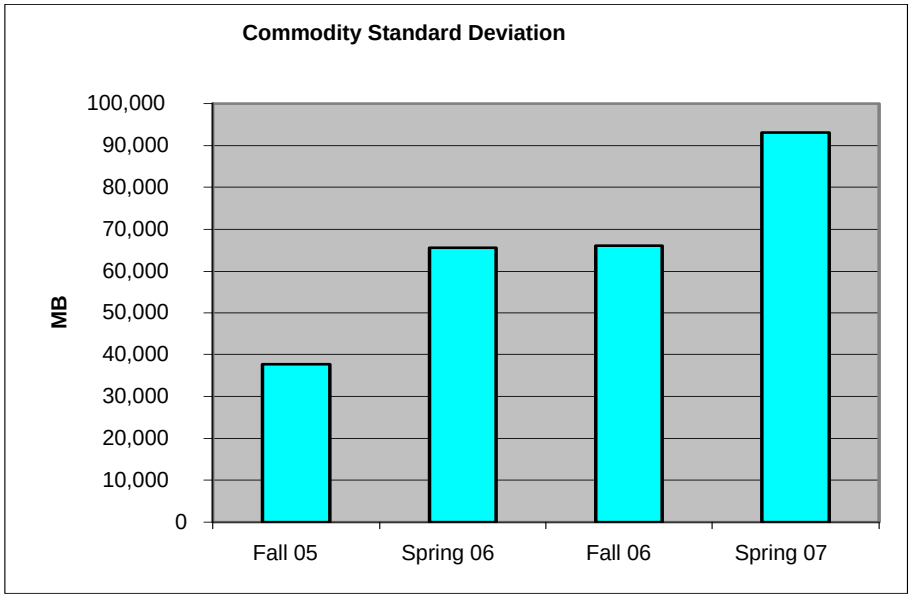

Figure 13

By class, departmental hosts still dominate commodity consumption (56%, down from 62% in Spring 2006) (**Figure 14, Figure 15 next page**). However, departmental hosts dominate commodity consumption less each year as Resnet and Public Networks (wireless) continue to grow. The distiction between Resnet and the Public Networks is failing as Resnet wired users transition to wireless usage and their consumption is counted under Public Networks.

Resnet is self-funded and pays for its commodity bandwidth—benefiting departments by providing workday excess capacity—and benefiting in the evening from excess departmental capacity. Resnet users are individually metered and subscribe/pay for tiers of service. Their allocations apply to Resnet wired and wireless networks on campus.

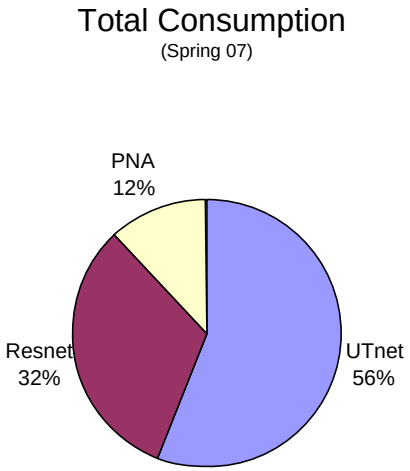

Figure 14

Public Networks represented only 12% (**Figure 14, previous page**) of all commodity bandwidth, but its consumption more than doubled from Spring 2006. Analysis revealed the growth was due to increased connect time (up 72% from Spring 2006), and not from new users (16% increase from Spring 2006) (**Figure 15**). However, a portion of this growth includes Resnet wireless users. Public Network user consumption is metered by role, and Public Network users are able to purchase additional bandwidth. In Spring 2007, less than 3% of students exceeded their default allocation of 500 MB/week (median consumption was 18 MB/week) (**Figure 16**).

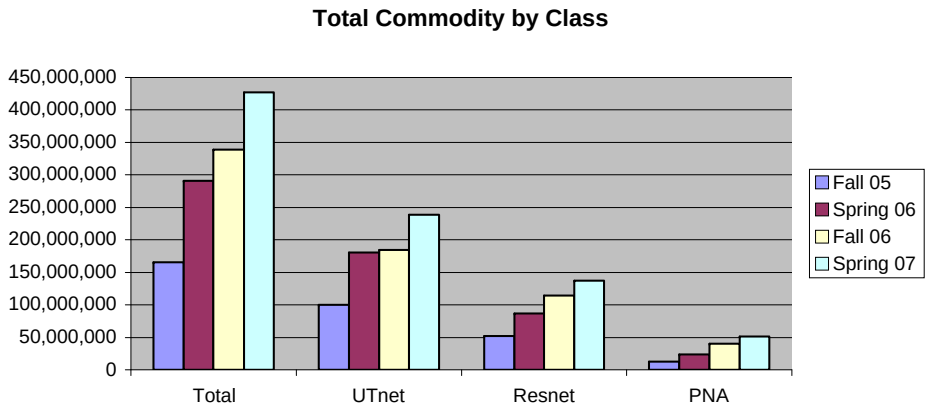

Figure 15

Public Network Consumption (Week 4-30-07)

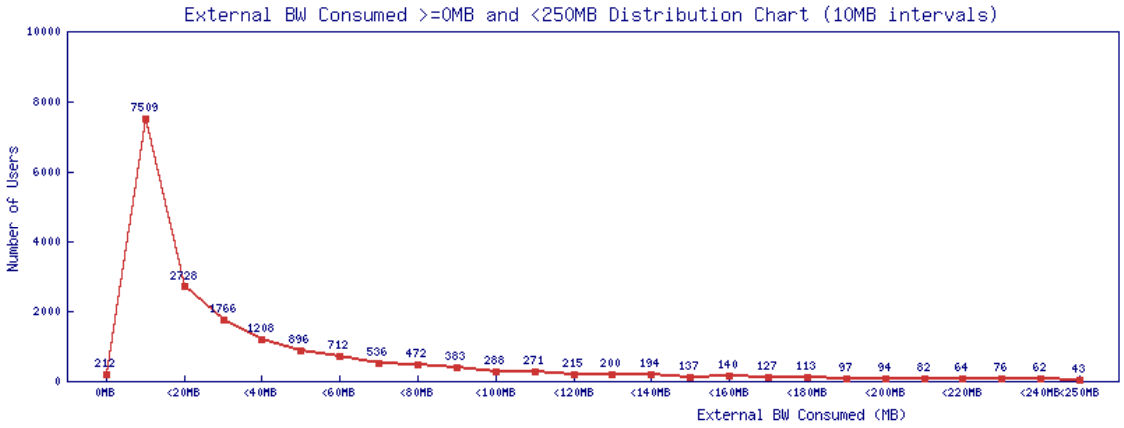

Figure 16

One gigabit per second (1 Gpbs) of commodity bandwidth was acquired for AY 2007-08 (**Figure 17**). This should suffice if trends from the past two years continue and consumption is carefully managed.

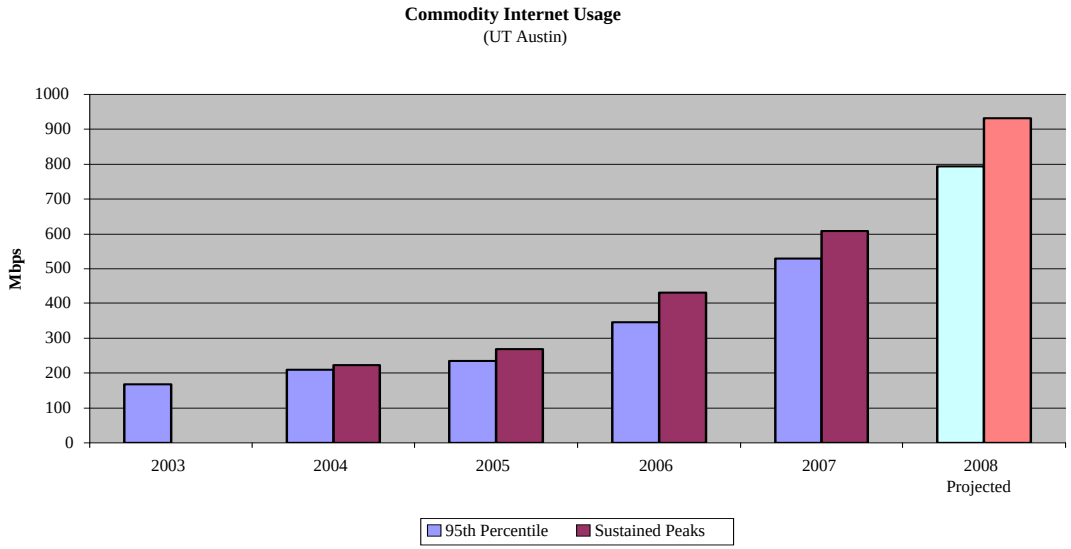

Figure 17

Research Network capabilities increased this spring. UTnet directly peers with Internet2 (I2) (**Figure 18**) and National Lambda Rail (NLR) (**Figure 19**). Both are reached through our 10 Gbps connection to the UT System network, which interconnects in Houston via LEARN (Lone Star Education and Research Network). In Houston, LEARN is connected to I2 at 1 Gbps, and NLR at 10 Gbps. Intra-state traffic with other higher education institutions is also shared across the UT System 10 Gbps connection.

NLR (2007)

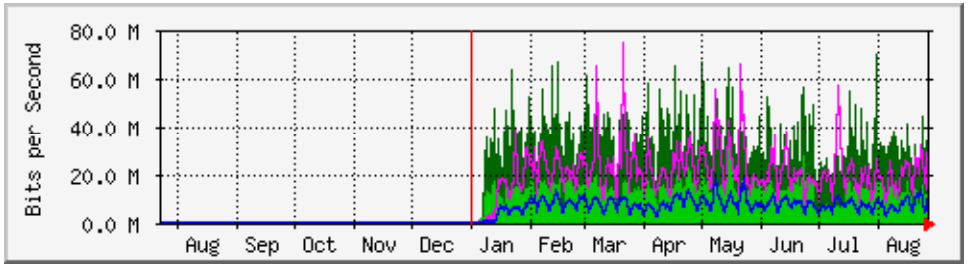

Figure 18

Internet2 (2007)

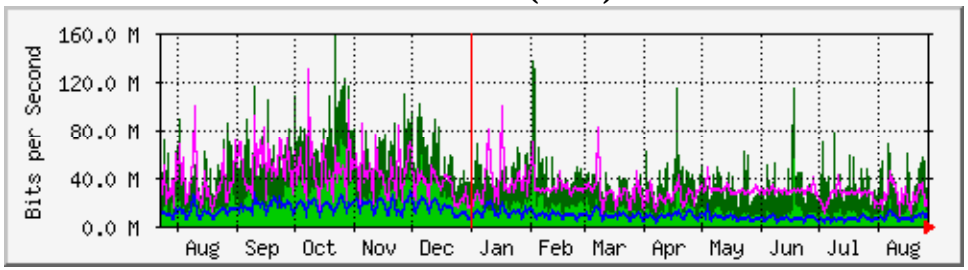

Figure 19

2.4. UTnet Population

The university is too large and diverse an organization to register all devices connected to the campus network. In order to derive actual device count we track two statistics: IP addresses (**Figure 20**) and Ethernet MAC addresses (**Figure 21**). IP addresses are required to communicate on UTnet, and an Ethernet MAC address is required to communicate on the local departmental network. Networking's management system records IP and MAC addresses that are seen in use on the campus network in various databases. Firewalls and other NAT devices interfere with our ability to track these numbers, as does overlap between our databases. IP addresses are also re-used (by design), making tracking devices even more difficult.

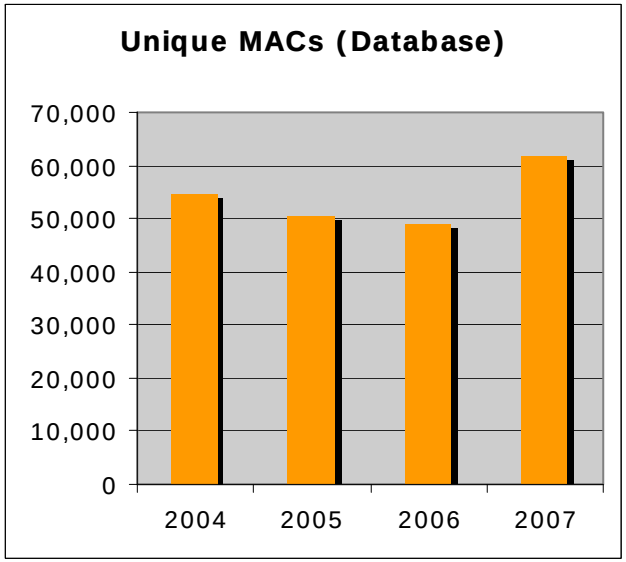

Figure 21

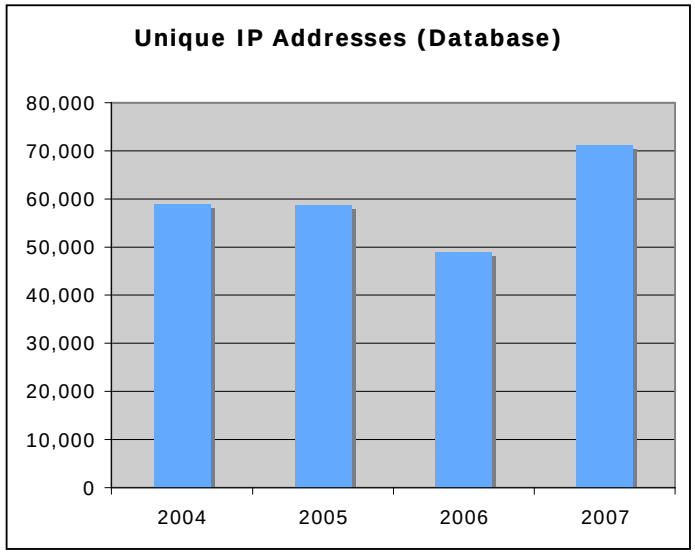

Figure 20

We estimate that there are 55,000 devices on departmental networks, 55,379 devices on the Public Networks (wireless/wired), and 8,861 devices on Resnet. Estimating for overlap, we project there are 108,000 unique devices on the campus network at some point in a semester. 80,000 of those are likely active on any given day.

Deriving the type of devices connecting is more difficult. By analyzing network signatures of devices communicating off campus, we have attempted to derive operating systems in use on campus seen in **Figure 22** (taken on 9/2007). The ITS 2006 Survey reports:

	Microsoft	Apple	Linux
Undergraduate	85%	14%	0%
Graduate	81%	14%	4%
Faculty	54%	43%	3%
Staff	75%	23%	1%

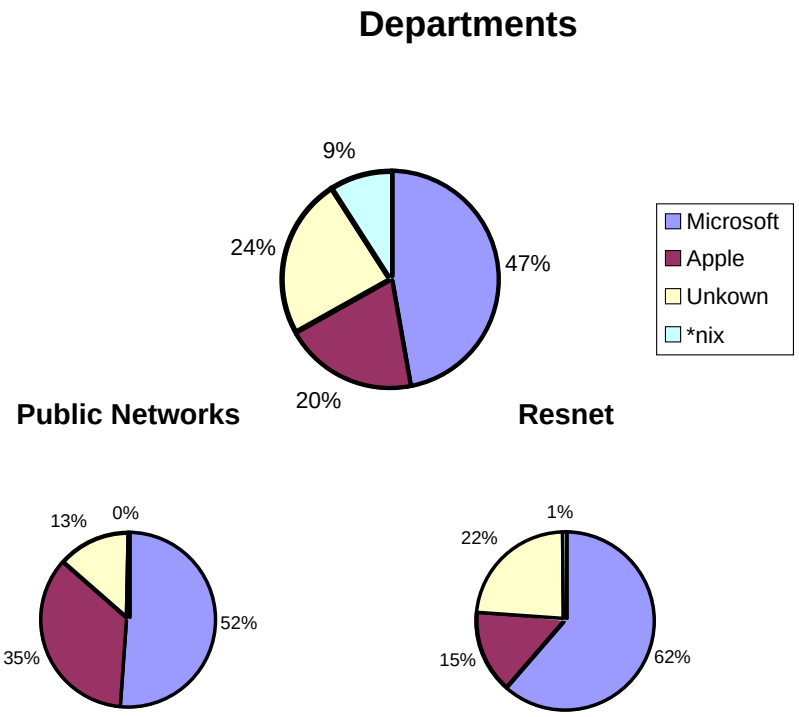

Figure 22

2.5. Wireless Networks (Public)

The 802.11 wireless system is growing to match the size and complexity of the departmental wired networks. Multiple generations of equipment have been deployed, including 2,164 access points as of April 2007 (**Figure 23**), which provide coverage to 65% of the main campuses (most populous portions). An upgrade to the central control system is being completed this fall. As part of that project, all access points have been upgraded to 802.11g.

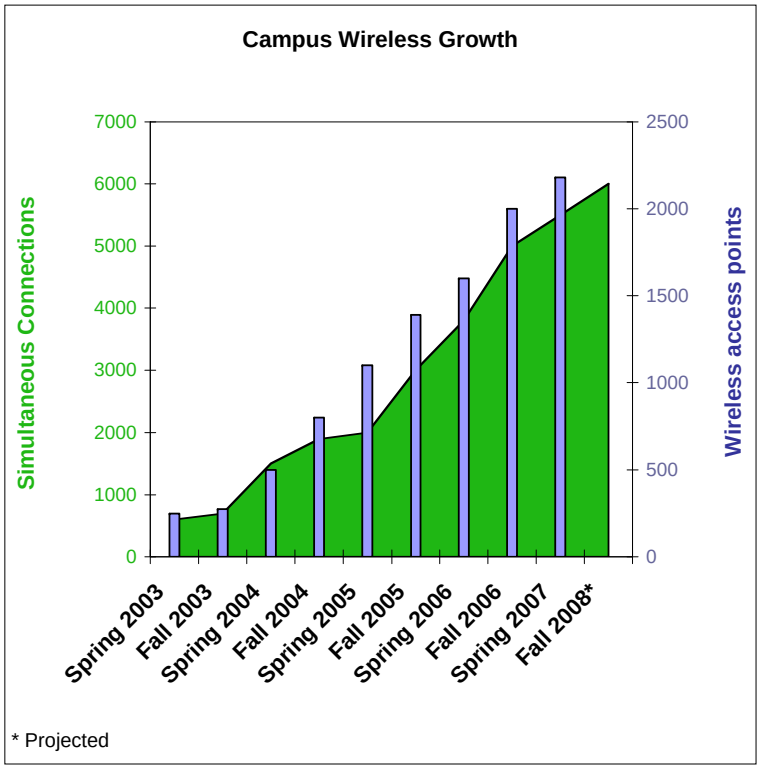

Figure 23

78% of graduates, 74% of undergraduates, 48% of faculty, and 31% of staff use the Public Networks (refer to **Figure 24**, which shows the number of unique PNA users). While user population is saturating, total connect hours increased to 4.8 million for the spring semester (71% growth). The connect time heat map is shown in **Figure 25**. See the PNA report for additional details (http://www.utexas.edu/its/about/reports/utnet/2007/PNASpring2007UsageReport.pdf)

Connect Minute Heat Map

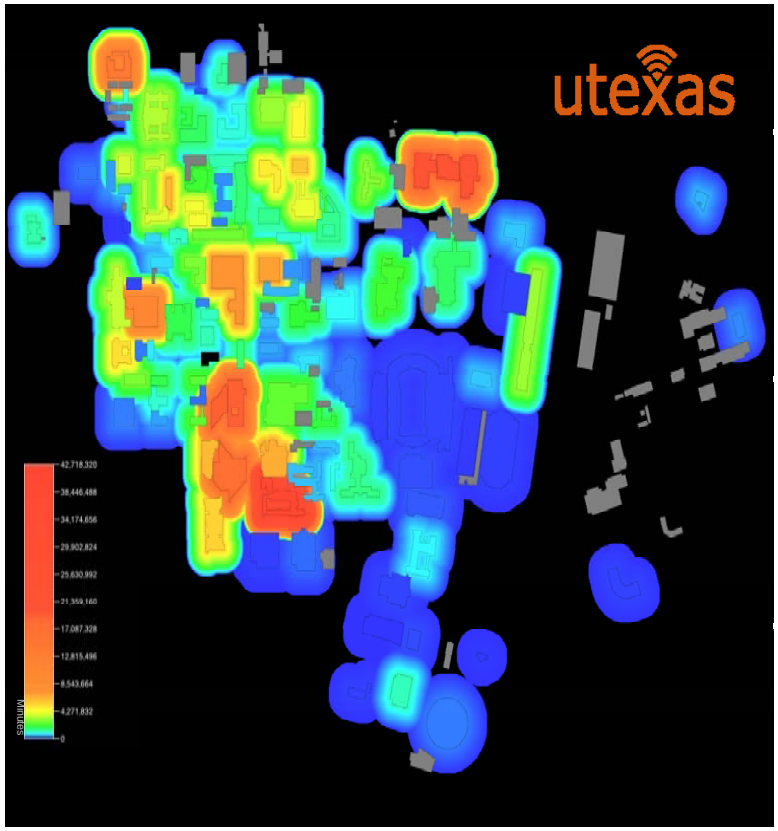

Figure 25

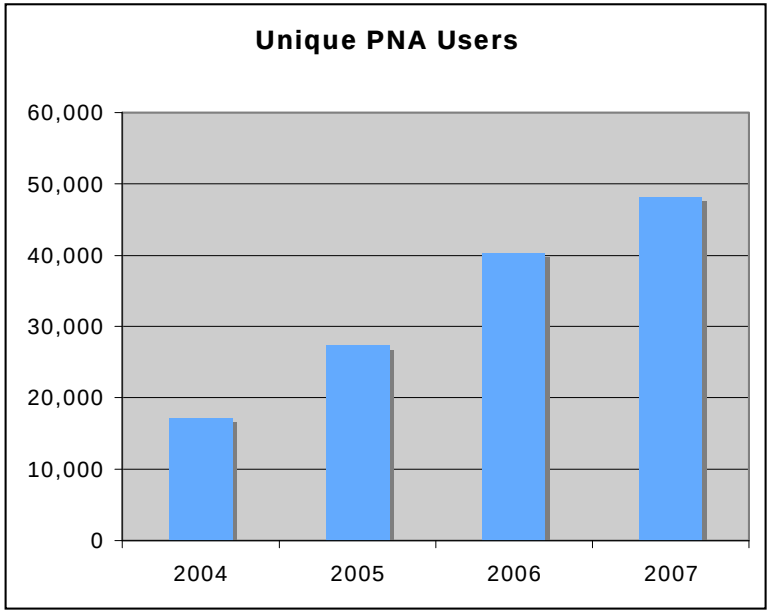

Figure 24

A cautionary note: departments have not been budgeting for regular refresh cycles of their wireless infrastructure as they have for their wired networks. Despite campus spending nearly $4 million on the wireless infrastructure, over two-thirds of the access points are discontinued and soon to lose support. Even greater expenditures can be expected as campus upgrades new wireless standards (e.g., 802.11n), which will be required to meet increasing demands for capacity and reliability.

2.6. DNS (Domain Name System)

Networking maintains a highly resilient collection of DNS servers to provide both primary and secondary hosting and caching. Some larger departments elect to be authoritative for their own domains, and also provide their own local caching (which deprives their users of centrally engineered resiliency/redundancy). However, all DNS caches are required to be configured to resolve through the campus caching system. Long term queries of campus caches average 764 per second—peaking to over 1,800 per second during busy hours (**Figure 26**).

The system is being upgraded in the fall semester to add additional resiliency through the provision of more caching servers at additional locations (related to the second NOC project).

DNS Cache Traffic (2006-2007)

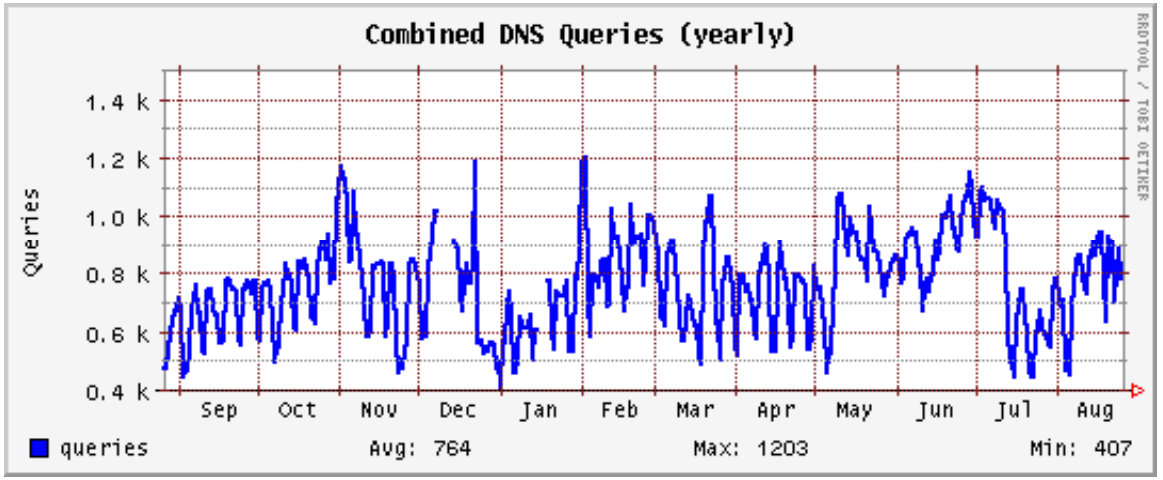

Figure 26

2.7. DHCP (Dynamic Host Configuration Protocol)

Many IP addresses on campus are dynamically assigned using DHCP from Networking's central DHCP services. These servers handle approximately 16,000 leases per day and 55,000 leases long term (**Figure 27**). There are 32,608 DHCP addresses reserved in the DNS system. Some departments utilize their own DHCP servers (which deprives their users of centrally engineered resiliency/redundancy), and are not represented in these statistics.

The system is being upgraded in the fall to add additional resiliency through the provision of servers at additional locations (related to the second NOC project).

Known DHCP Leases (2006-2007)

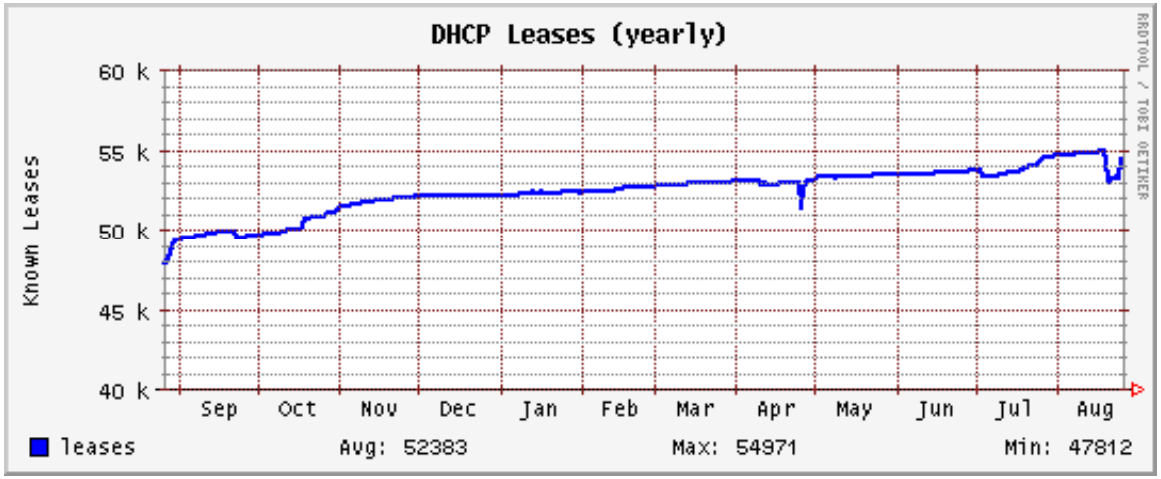

Figure 27

2.8. VPN (Virtual Private Network)

The central VPN service is currently lightly loaded. Average peak utilization has been 375 users—an order of magnitude from its design limits (**Figure 28**). However, IT staff should be cautious about requiring VPN use to access their applications due both to resource limits inherent in any centralized VPN service, and impositions on users caused by VPN software problems/constraints.

The VPN service was upgraded in June 2007 (**Figure 28** shows usage of the old system). Additional features are expected to be added in October, including SSLVPN support and special groups for the IT technical communities.

VPN Usage (2006-2007)

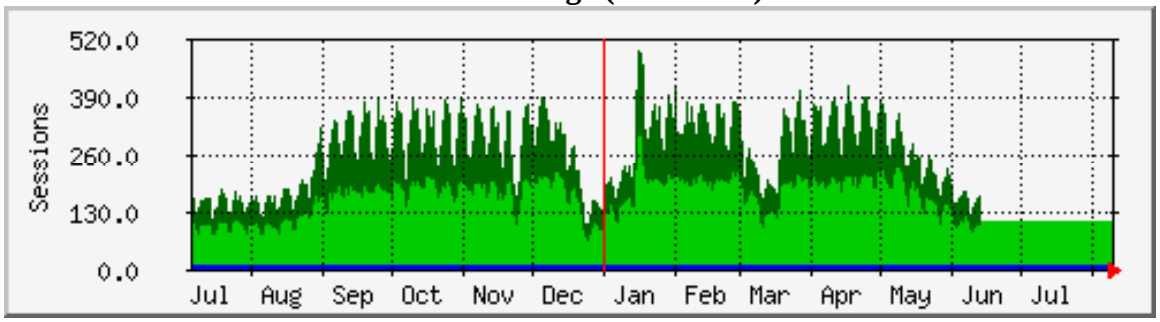

Figure 28

2.9. Telesys (dial up service)

Telesys usage continued to decline in AY 2006-07, which led to the decision to discontinue the service August 31, 2007. Revenues from the remaining subscriber base could not fund the service, and usage did not justify continuation given competitive commercial offerings (**Figure 29**).

Telesys Use (2006-2007))

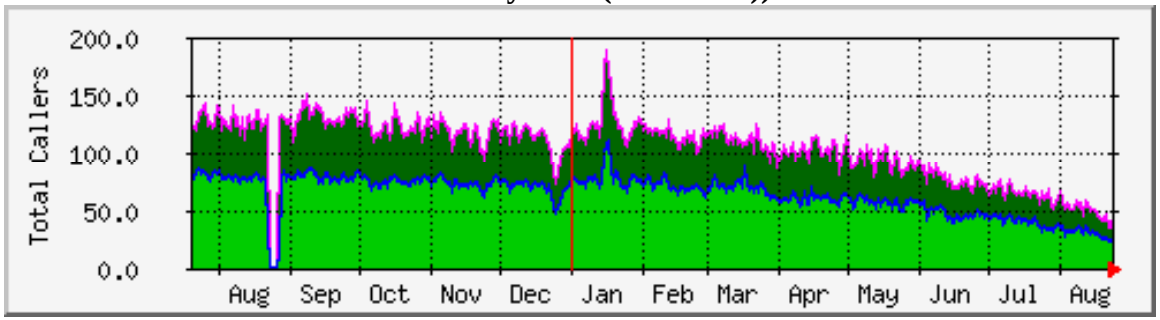

Figure 29