Network Funding Models: Cornell University, University of California at San Diego, and University of Wisconsin–Madison

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ECAR Case Study 1, 2005
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Preface

The EDUCAUSE Center for Applied Research (ECAR) produces research to promote effective decisions regarding the selection, development, deployment, management, socialization, and use of information technologies in higher education. ECAR research includes

- research bulletins—short summary analyses of key IT issues;
- research studies—in-depth applied research on complex and consequential technologies and practices;
- case studies—institution-specific reports designed to exemplify important themes, trends, and experiences in the management of IT investments and activities; and
- roadmaps—designed to help senior executives quickly grasp the core of important technology issues.

From its most recent research, ECAR published a comprehensive gathering of information on IT networking in higher education in Information Technology Networking in Higher Education: Campus Commodity and Competitive Differentiator. The study uses a multifaceted research methodology to collect and analyze quantitative and qualitative data from approximately 545 senior IT and network administrators.

Literature Review

The study began with a review of the relevant literature on effective IT networking practices and future directions in order to define the study’s major themes and create a working set of hypotheses to be tested.

Online Survey

We invited higher education institutions in the United States and Canada that are members of EDUCAUSE (1,477) to participate in an online survey. Senior IT leaders, most of them chief information officers (CIOs) or networking administrators, from 488 institutions responded to the survey. Another 29 institutions that are not EDUCAUSE members asked to be included, generating a total of 517 institutions responding.

Interviews

We conducted telephone interviews to further explore some of the key findings derived in the quantitative research. In support of the study’s core analytical chapters, we interviewed 19 individuals representing 13 different institutions. We also interviewed 12 higher education networking leaders about their view of networking’s future over the upcoming 5- to 10-year time frame. Finally, we sent e-mail follow-up queries to selected online survey respondents for clarification.
and further description of some topics. We received responses from 21 individuals.

Case Studies
Three in-depth case studies complement the core study. In addition to this case study, we conducted one on voice over Internet protocol (VoIP) at the State University of New York College at Courtland and one on student uses of mobile computing at three postsecondary institutions in The Netherlands. We assume readers of this case study will also read the primary study, which provides a general context for the individual case study findings.

Network Funding Models
Over the past two decades, colleges and universities have fully embraced networking as essential to their research and teaching mission as well as to their business processes. To this end, campuses are increasingly committed to ensuring that their network infrastructure is high quality—reliable, secure, adaptable, scalable, and fault tolerant. In fact, the ECAR networking survey found that respondents overwhelmingly agree that their leadership perceives the campus network to be
- more important than it was three years ago (94 percent),
- an essential resource (98 percent),
- a critical infrastructure (89 percent), and
- a strategic resource (81 percent).

The network is finally claiming its status as a utility like such other long-term utilities as water, gas, and electricity. These older entrenched utilities have been around long enough to have well-established funding models. The data communications network, however, as the most recent utility to appear, has not brought with it a standard funding model. As a higher education community, we’ve often piggybacked on telephone revenues to fund a good portion of the network, or tried to capture some revenue based on network connections. But we haven’t generally established stable funding models that fully support a high-end production network for the whole campus, with adequate renewal and replacement programs. In fact, the ECAR survey showed that only about 10 percent of respondents who indicated that they are moving toward converged services had changed their funding model to reflect the nature of converged networks and services.

This multipart case study examines three different approaches to building a sustainable network funding model. In the belief that a case illuminating the most complex instance of a problem will illuminate most other instances, the cases include three complex research universities:
- Cornell University,
- the University of California at San Diego (UCSD), and
- the University of Wisconsin at Madison (UW–Madison).

ECAR is extremely grateful for these institutions’ willingness to share their time, ideas, and experiences with respect to network funding. We especially thank R. David Vernon and Scott Sheavly of Cornell University, Steve Relyea and Elazar Harel of UCSD, and Jack Duwe of UW–Madison.

Cornell University
Cornell University is a privately endowed university as well as the public land-grant institution of New York State. It is a member of the Ivy League and a partner of the State University of New York. Cornell, which has annual revenues of approximately $1.9 billion, has 14 colleges and schools: seven undergraduate units and four graduate and professional units in Ithaca, two medical graduate and professional units in New York City, and one in Doha, Qatar. Total campus student enrollment is 20,334.

The Cornell Campus Area Network (CAN) supports the university’s mission to be “the
best research university in the country for undergraduate students” and an institution “where any person can find instruction in any study.” Today, this is a Gigabit Ethernet–based campus backbone, supplemented by wireless access and monitored 24 x 7 by the network operation center (NOC). Cornell is highly decentralized, and the Cornell Information Technology (CIT) organization assumes responsibility for the campus network all the way to the building wall jacks.

Historically, Cornell's campus network was funded by a monthly “port only” charge to campus users. However, this charge didn't recover costs fairly. The underlying assumptions were that there would be one user for each network connection and that each port would use the same amount of CIT network services. As it turned out, these assumptions were inaccurate. Increasing use of “hublet” devices in departments to connect additional resources to a single billed port made it clear that departments were installing hublets, and also wireless systems, simply to avoid legitimate network fees. This complicated cost recovery, undermined the notion of fairness, and resulted in compromised network design. Other problems included user perceptions that voice and data were too expensive, a lack of understanding about how prices were derived, and difficulty in determining optimal funding levels for the fast-growing data network.

Cornell therefore decided to radically change their network funding model and create a rate structure in keeping with the Cornell philosophy that reliable funding requires that
- service providers highlight a service's true cost to the campus;
- service providers convince consumers of the service’s value; and
- charges be deployed in ways that make it possible for service consumers to make rational decisions about how much of the service they purchase.

The new model has three service components—the local area network, the campus area network, and the wide area network—each with a different cost recovery method. The model was implemented in July 2003, and all fee components are set at a level that allows Cornell to maintain the necessary infrastructure, service, and support for the high-end data networking the institution requires.

**Principles and Goals**

Several important principles and goals guided development of the new network funding model:
- A model that matches “cost to cost caus- er,” assigning the true cost of the service delivered to the unit incurring the cost.
- A model that doesn’t either bundle all costs into a single fee or obscure individual services’ true costs and value.
- A model that provides a fair and equitable rate structure for all users.
- A model in line with commercial service providers’ market rates.
- A model that considers best practices of higher education network funding models.
- A rate structure that supports a unified campus network architecture, competitive in features and performance with peer institutions.
- A model that ensures affordable access to basic services for all and also provides premium services to allow world-class research and education.

**Organization and Process**

In 1999, Cornell took the first steps in creating the new network funding model by explicitly defining all campus network services and determining their actual costs. This process involved an enormous amount of work over approximately two years. It involved a detailed review of all direct costs (down to the invoice level in some cases), all indirect
costs, and the allocation of these costs to voice and data network services. As part of this process, CIT also revised its accounting system to include 15 new expense categories that accurately map to the new funding model’s three service components. With this accounting system change, expenses are now automatically collected into the proper accounting expense categories required to determine networking services’ costs.

In 2001, Cornell took another critical step in the model development process—the creation of a CIT paper, the IT Architecture Initiative. This document provided background information about the current Cornell network and its costs, and it discussed the current rate structure and its problems. It further outlined alternative cost models and their associated strengths and weaknesses. This paper specifically reviewed cost recovery alternatives based on number of campus ports, number of IP addresses, number of machine access control (MAC) addresses, and total head count.

At this point, Polley McClure, vice president, information technologies, formed a university-wide network cost recovery task force charged with recommending an effective billing structure for network services. Task force members included key participants from both the administrative and academic communities. The committee spent six months examining the results of the network services cost analysis, looking at rate structure options, and considering their impact on campus departments. Most crucial, however, was the task force’s consultation with key campus constituents—the faculty senate, student assemblies, campus IT directors, the faculty advisory board on IT, the executive budget group, and the executive cost committee—and ensuring their eventual support. The task force’s work resulted in a hybrid approach for charging for network services, with three primary service components each using a different cost recovery method:

- a monthly port fee for the local area network (LAN) “edge,”
- an infrastructure allocation for the campus area network (CAN), and
- a monthly usage fee for the wide area network (WAN).

As part of this process, Cornell benchmarked local ISP rates, researched peers’ benchmarks, and conducted their own research. They used focus groups to solicit feedback from 38 administrators representing some of the top 300 academic and administrative WAN users. Findings suggested that under the new billing model, the data volume transferred by the large users would likely decrease by about 70 percent. Student input indicated that their consumption would drop by about 75 percent. This analysis was critical to predicting the cash flows the model would generate.

Cornell implemented the new model campus-wide in July 2003. For several months previous, CIT provided “shadow bills” so that departments could see what their charges would be, gain familiarity with the billing process, and begin actively managing their WAN usage without being charged. This proved extremely helpful in making the actual implementation go smoothly. Further, the task force provided a cushion for departments that would incur a large initial expense as a result of the new model: these departments were able to request a one-time budget allocation through the normal campus budget process to help with the transition. Only a few actually requested this one-time allocation.

With the new model now in place, general rate changes are done annually through the established campus rate approval committee and process. Each fall, the committee reviews rates for implementation the following fiscal year in July. At some point, if CIT wishes to make significant changes to the model itself, a task force will again convene to carry out the model modification process, recommendations, and consultation.
The New Funding Model

The Cornell network funding model is a three-tiered model, with a separate cost recovery method for each of the three basic network services—the LAN, the CAN, and the WAN. The sidebar “Cornell Network Cost Recovery” summarizes this model.

- A per-port fee recovers $2.1 million for the LAN. Each data port installed and maintained by CIT incurs a $6.50 monthly fee. Cornell refers to this as the “edge” service, and it includes only the actual switching equipment in the building closet that connects to the end-user wall jack and the staff required to support this equipment.
- An IT infrastructure allocation recovers $5.0 million for the CAN. This funding is used to maintain and upgrade the Cornell backbone wiring, building wiring, and related equipment; the NOC; publicly available ports across campus; and all campus-maintained wireless access (the RedRover system). These costs are recovered at the vice president or dean level through the existing campus allocation method; they apply to those units that are “tubs on their own bottoms.” The campus allocation method already allocates a cost to these units for general services such as payroll, central IT, and general administration. The CAN’s cost was added to this allocated expense.
- A network traffic usage fee recovers $1.4 million for the WAN. Each active IP address incurs a small fee of $3.00 per month, which entitles that address’s user to 2 gigabytes of traffic. Only traffic that crosses the border between Cornell and the rest of the Internet is measured (regardless of traffic type). Cornell-to-Cornell traffic incurs no cost. Users who exceed this threshold (about 6 percent of staff and faculty and 25 percent of students) pay an additional incremental cost of $0.002 per megabyte above the base level.

Cornell Network Cost Recovery

What services are included in the $6.50 monthly per-port fee?
- The actual switching equipment in the building closet that connects to the end-user wall jack and the staff required to support this equipment (the actual wiring is included in the infrastructure allocation).

What services are included in the infrastructure allocation?
- Backbone: Access to Cornell backbone (campus area network).
- Public ports: Ports in open classrooms and public locations not specifically associated with any one department or unit.
- RedRover: Campus-supported wireless access infrastructure.
- NOC: 24 x 7 monitoring and problem resolution.
- Security

What services are included in the $3 monthly usage fee?
- 2 gigabytes per IP address per month of traffic entering or leaving Cornell’s network to or from the Internet or Internet2.
- Additional traffic is billed at the rate of $0.002 for each additional megabyte.
- There is no fee for an IP address if the monthly usage is less than 4 megabytes.
- An external connection to the Internet.

What services are not included in these fees?
- Installations, moves, or changes for data and voice lines.
- Telephone instruments and computers.
- Remote network access (dial-in data services via EZ-remote).
- Analog voice telephone line ($22 monthly).
- Digital voice telephone line ($35 to $50 monthly, depending on equipment).
- Local and long-distance toll calls.
- Voicemail.
- Special-use rooms and computer labs.

The residence halls network (ResNet) recovery mechanism for the CAN infrastructure allocation differs somewhat from that of the
main campus. Student housing fees are as follows:

- For undergraduates in residence halls, the CAN infrastructure allocation, port charge, and IP fee are assigned to the Campus Life organization, which keeps ResNet fees as part of the room rate. The room rate also covers up to 2 gigabytes of WAN usage per month, with the campus surcharge for excess traffic of $0.002 per megabyte.

- For students in graduate housing, fraternities and sororities, and other off-campus housing units, the CAN infrastructure cost and port charges are included in a $23.70-per-month charge. This charge also includes 2 gigabytes of WAN usage per month, with the campus surcharge for excess traffic of $0.002 per megabyte.

CIT’s Network and Communication Services Division (NCS) has also made tools available for users and departments to monitor their network usage: one software tool generates traffic alerts and another provides real-time IP usage monitoring. NCS also provides references to information on preventing usage abuse, as well as a “terms and conditions” document clarifying user and administration responsibilities. The network user-based billing (NUBB) system can also be used to monitor bandwidth, as it accumulates usage every evening and can be viewed online the next day. Extensive information about the campus network cost recovery method—history, guiding principles, rates, planned network enhancements, frequently asked questions—is available on the Web.  

Cornell has also set up a process for users and departments to request an investigation of charges or credit to their IP(s). This is especially important for students as they learn to manage their network usage. For example, one student requested a credit, saying, “In August I was billed $400 for my careless use of Kazaa, so I have now disabled the super-node and limited my sharing to one person at a time. It would be greatly appreciated if you could give me relief for my ignorance in bandwidth and give me a credit for August.”

The WAN usage costs associated with a faculty contract or grant can also be determined from the data on the NUBB bill. The bill reports traffic usage by IP address, allowing faculty members to review their traffic and accurately allocate costs to their contracts and grants. Further, CIT staff are available to help faculty estimate bandwidth usage costs as they prepare grant proposals.

Because Cornell is highly decentralized, keeping the model flexible is very important. The fee structure can be implemented and recovered at the college, department, program, or individual level. For example, departments may choose to receive bills for each IP address or a single bill for a group of IP addresses. This gives academic units the option to continue to subsidize some programs or to require all faculty members to cover their own costs. In fact, since the model’s implementation, departments have chosen a mix of these options.

The current rate structure for the LAN is a small fee ($6.50 per month) that covers only staff and hardware costs related to the switching equipment in the closet that connects to the user wall jack. Purchase of this “edge” service is not required, and therefore departments may choose to install and maintain their own switching equipment, avoiding the $6.50 monthly fee. However, most departments are choosing to buy the service and have CIT install and maintain the LAN edge. The larger CIT organization’s economies of scale translate into better equipment for less cost than most departments can arrange on their own. R. David Vernon, director of network and communication services, notes that “departments find that they cannot assume responsibility for the edge as cost-effectively as CIT, and it is no longer profitable for them to create hublets
to avoid such small port charges.”

Results of WAN usage for student bandwidth consumption have been in line with Cornell predictions: student bandwidth consumption is down by about two-thirds since implementation of the funding model. Vernon comments that “students are now socialized to watch their machines, and in fact, our student user population is better behaved in this regard than our nonstudent user population.” Staff and faculty usage, however, didn’t decrease significantly, indicating that the fee did not inhibit WAN usage for teaching, research, and business.

Cost recovery of voice communications has been based on true costs since July 2001, allowing the campus to reduce the cost of analog phone charges from $35 to $22 per line. Renegotiated vendor contracts have also reduced domestic long-distance rates from an average of $0.15 per minute to $0.07 per minute, and international long-distance rates were reduced from an average of $1.00 per minute to $0.055 per minute. Further, Cornell plans to deploy VoIP as appropriate, and the new funding model will not inhibit that deployment.

Future Directions

Because the new funding model was recently implemented in July 2003 and has been very successful, no significant changes are currently envisioned. There are some developments, however, that bear watching, as they may impact the model in the future. For example, Cornell will be using acquired fiber to connect to major metropolitan areas. Once this happens, commodity Internet costs will drop significantly and user rates will reflect that cost reduction. If the rate structure’s WAN component should become free, there would be no need for this component of the model. This, however, would eliminate the benefits that have resulted from the WAN usage charge, including user stewardship of network usage and improved security.

Another example is the campus wireless program, RedRover, which is presently included in the model’s infrastructure allocation component. At Cornell, wireless is supplemental to the wired network infrastructure and cannot be used as a primary connection. However, the university has created an incentive for building the wireless infrastructure. Departments that wish to install wireless can capitalize the one-time installation cost and transfer control to CIT (essentially integrating it into RedRover). This eliminates the monthly WAN usage fee for their wireless, because it is now a part of RedRover and included in the infrastructure allocation. At some point wireless usage might need to be billed directly to users through the NUBB WAN billing process instead.

Lessons Learned

Cornell’s experience with the new network funding model has been positive to date and has resulted in several lessons learned for schools and centers as well as for the campus as a whole.

- Implementing a new funding model is a significant change management exercise. It is critical that all key constituents—administrative and academic—be meaningfully involved in the full process. This includes not just campus leadership but also those who will be responsible for administering the rate structure in schools and departments. Vernon says that “it was essential for us to have the support of the entire campus before we flipped the switch.”

- The model reinforces stewardship and responsible use of network resources. Users are actively managing bandwidth consumption, and bandwidth usage is more predictable and consistent as a result. And overall, bandwidth consumption has been drastically reduced. Scott Sheavly, assistant
director of finance, notes that “before the model was implemented, the campus was facing exponential increases in bandwidth demand and was planning to add two new OC3s. This expansion has not been necessary.” Further, Cornell does not use or need packet switching; use is governed by economics.

- The new funding model has had unprecedented value with respect to network security. Indeed, users are now paying much more attention to security, and Vernon believes the model has been “the single most effective tool for improving network and client security at Cornell.” Sheavy adds that “worms and viruses infecting network computers were behind some of the high-volume WAN use on campus. This has been greatly reduced as students, staff, and faculty monitor and manage their traffic usage.”

- The model requires that the CIT be open and honest about the true costs of network services. Vernon sees that “all of this is a way of honestly reflecting the true costs to the people that consume these resources. How those costs are allocated is up to the university, and Cornell decided to allocate these costs back to the user.”

Vernon summarizes the Cornell experience by saying that “the new rate structure has been a great success. The majority of users now pay less because they are no longer subsidizing a few big users. This is a fair approach. We definitely chose a road less traveled, but the improvement in network security and the appropriate control and rational consumption of an expensive resource are enormous benefits.”

**University of California at San Diego**

UCSD, part of the 10-campus University of California System, is ranked as one of the nation’s top institutions for higher education and research. It has annual revenues of $1.9 billion (more than 25 percent of this from the federal government for research and 14 percent from the State of California for education). The university has 15 schools and divisions and a total campus enrollment of 23,045.

In the late 1990s, UCSD initiated a campus network initiative called the Next Generation Network (NGN). NGN’s stated goal is to provide and maintain a sustainable state-of-the-art network, including electronics, wiring and other technologies, faster data connections and increased Internet bandwidth, enhanced security, and expanded help desk services. Actual work on the NGN began in 1999, and the first iteration of network upgrades is essentially complete. UCSD uses a four-year upgrade cycle for the backbone and a six-year upgrade cycle for building equipment.

To make the NGN possible, UCSD needed to address their network funding problems. At the time, expensive telephone charges and rates were subsidizing the data network. There were also some small (and inconsistently applied) charges per IP address, which created disincentives for usage and compromised good design, for example by hiding IP addresses behind routers. This overall funding structure did not capture anywhere near enough money to allow a sustainable state-of-the-art network with adequate renewal and replacement of network equipment.

UCSD concluded that their use of voice telecommunications charges to fund the data network was badly flawed. The days of the independent phones appeared to be numbered, and although VoIP was far from prime time, it was definitely coming. Strategies such as inflating long-distance rates to subsidize data networking were also doomed to failure as people began migrating to mobile smart devices, combination PDA phones, and the like. Taking a careful look at the emerging trends, Steve Relyea, vice chancellor for
business affairs, says, “We felt it was time to overhaul the whole thing. We needed to ensure stable funding that would support a high-end production network for the whole campus, as well as support cutting-edge research with high bandwidth.”

The campus began work on a new model in 1998 and actually implemented the model in July 2001. They took a radical approach, not only eliminating all voice subsidies but also creating one charge per user that combined data, voice, and video services. UCSD took the position that more and more people would see the network as a digital pipe with a mixture of “everything” and wanted to align their funding model accordingly. There is an increasing blur between costs and services for voice over IP and data over IP, and it gets increasingly complicated to separate costs. For example, VoIP costs money to put redundancy and backup power in the data network backbone and wiring closets, but this increased redundancy also benefits all data services on the network. Other services such as Instant Messaging, voicemail to e-mail, and e-mail to voicemail are also problematic in this regard. CIO Elazar Harel says, “We wanted to be able to make decisions based on what services and technologies made sense, and not be constrained by a charging scheme. Since we put it all in one charge, then even our Ericsson switch—which becomes a VoIP system with its next release—is just another component. We are free to move forward with Ericsson, or change our approach entirely, without a negative impact on the charging structure.”

Principles and Goals

Several important principles and goals guided development of the NGN funding model:

♦ A model that would work well over time, not something that needed to be changed often.
♦ A model that would make sense to users and minimize administrative work in departments.
♦ A model that wouldn’t use voice telephone charges and rates to subsidize the network.
♦ A model that would further UCSD’s competitive position compared with other top R1 universities in its ability to recruit and keep the best students, faculty, and staff.
♦ A model that would encourage use of the network and further the UCSD goal of eventually providing all official communications via the network.
♦ A model developed with leadership from and full involvement of the academic constituents.
♦ A model that would ensure a sustainable high-end network for the entire campus. Previously, there were “haves” and “have nots,” and evening this out would give everyone a high quality of network service and infrastructure.

Organization and Process

The NGN project results from years of planning and extensive consultation with the academic senate, departmental administrators, executive management, campus external auditors, and many others. It is now jointly operated and managed by the central Academic Computing Services (ACS) and Administrative Computing & Telecommunications (ACT) departments. Because the change was radical, it had to involve everyone, especially the academic senate and their faculty committees on budget and information technology. High-level interaction with the faculty was essential because the project raised complex issues concerning contracts and grants that could potentially impact faculty. Relyea gives an example: “A faculty member with a dozen researchers on a grant that had two ports and one phone for them to share was affected more by a per-person charge than a faculty member with the same number of researchers
where each one already had their own port and phone.”

Relyea also feels strongly that “the key was our partnership with David Miller, the senior vice chancellor of academic affairs—the top academic position on campus. We formed a ‘tag team,’ and he was as involved as I was in bringing about the new model. The project had to be led by the academic side of the house.” They had to make it clear to all constituencies that the NGN and its funding model would benefit everyone and would open up services to people who didn’t have them before. The model was developed over the two- to three-year time frame to let departments adjust to and plan for these significant changes and to educate the overall campus about the new model. Harel notes that “as we changed from one model to another, some people were going to win; others were going to lose. The people who were previously subsidizing the network were happy; the people who were previously not paying anything were unhappy.”

Once the model was in operation, the “tag team” of Relyea and Miller established and now co-chair an NGN advisory committee composed of academic senate representatives and campus administrators to oversee the network and the funding model. This committee reviews strategic directions, appropriate policies, implementation priorities, and actively participates in any funding model or rate changes.

The process to determine the NGN’s cost was data intensive and iterative. Sheryl Gerbracht, the ACT department’s financial manager, worked with campus technology and financial staff to determine the design and costs of a sustainable infrastructure. They spent hundreds of hours developing scenario after scenario on the basis of varying technical designs and criteria. They also carefully analyzed how these funding model alternatives would impact specific faculty and disciplines, to avert any surprises and ensure any impact would be known in advance and planned for.

Compromises were necessary all along the way. For the team’s original NGN design, the cost would have been about $120 per person per month. This was neither financially nor politically feasible, so the team kept working back assumptions and making compromises. For example, instead of a three-year useful life for backbone equipment, the campus settled on a four-year useful life. Another point of compromise involved very high-end faculty needs. Relyea observes that “we could easily get to $250 per person if we built in support for very high-end faculty needs. We decided that these extreme needs would not be included and had to be funded separately. NGN was to support everyone with a high-end, but production, network.”

The New Funding Model

The UCSD network funding model has two sources of annual funding:

- $6.5 million generated from a $60 monthly tax on each full-time employee designated as a “communication user” and
- $4.0 million allocated from the chancellor’s and vice chancellors’ budgets.

UCSD is now in the fourth year of its new five-year network funding model. The model specified that it would cost approximately $10.5 million annually for managing the entire NGN: voice, video, and data. This NGN design and funding ensured that the existing hodgepodge of routers, bridges, and other equipment could be systematically replaced following a logical, thought-out program. In addition, UCSD could now invest in security, redundancy, fault tolerance, and other technologies that are important but weren’t previously funded. The networking group could also migrate to new and emerging technologies such as VoIP and wireless without negative financial impact. In the past, network equipment and wiring were distributed,
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some departments owning much, others very little. With the new model, central campus IT claimed ownership and responsibility for the electronics and wiring in all the buildings all the way to the wall plate.

The NGN bases its funding model on the concept of a “communication user”—a UCSD employee who uses a telephone and/or a computer as part of his or her daily work. Whether to levy the flat monthly charge of $60 for each campus employee who qualifies as a communication user is determined by an individual’s payroll title. Although this includes most job titles, some exceptions are made for jobs such as gardeners, who don’t use a computer or phone. Further, the per-communications-user charge is proportional to the percentage of time employed. A person employed at only 25 percent of the full-time equivalent (FTE) level will be charged $15 per month instead of the full $60. Lower rates were also created for off-campus users, medical center personnel, postdoctoral researchers, and others. A campus-wide committee carefully evaluated every single job title and determined whether the majority of its constituents did or did not qualify as communication users.

The flat monthly charge of $60 per employee includes all building wires and wireless, a help desk, and all basic voice and data services, as detailed in the sidebar “The UCSD ‘Communication User’ Monthly Fee.” The real cost to cover all voice and data networking for the university would be about $100 per communication user per month. However, since this charge was not financially viable for campus departments, the monthly charge was reduced to $60 and the rest was subsidized by the chancellor and vice chancellors. UCSD agreed not to change this charging structure for five years, to help departments plan ahead and let the central IT networking group implement the NGN within a known budget and without affecting network users financially.

The UCSD “Communication User” Monthly Fee

What services are included in the communication user monthly fee?

- **Voice services**: Basic voice service (digital or analog telephone line), customer service, feature packages for phones, line repairs, and technical support.

- **Data services**: Switched Ethernet data service, on- and off-campus network access, e-mail services, DHCP service, line repairs, and technical support.

- **Wiring**: Fiber optic cables between buildings and Category 5 (or better) cables inside buildings.

- **Wireless**: Wireless data network access in selected public areas and classrooms.

- **Help desk**: Staffed 24 x 7 by first-level support personnel to resolve simple technical questions and route medium or complex problems to appropriate personnel for fast resolution.

What services are not included in the communication user monthly fee?

- Data and voice line installations, moves, and changes.

- Telephone and computer instruments.

- Remote network access (dial-in data services).

- Local and long-distance toll calls (toll calls).

- Voicemail.

- Experimental networks and exceptionally high-bandwidth needs.

- Special-use rooms and computer labs.

Charges per full-time communication user are assessed monthly as follows:

- On campus: $60.

- Medical center: $12.

- Public computer labs: $16.50.

- Off campus: $23.

UCSD decided to use the communication user as a basis for charging not as a precise reflection of individual use but rather as a fair mechanism for aggregating and averaging communications charges over departments. UCSD is moving toward providing all official communications via the network, and employ-
ees are encouraged to use this network and be given access whenever possible and appropriate to conduct university business. Harel notes that “users can have as many phone lines and computers as they need, since we want to encourage use of the network. At the beginning we were concerned about potential abuse, but our worries did not materialize.”

As part of the initial NGN implementation, UCSD continued to charge for toll calls but substantially reduced rates. Long-distance charges were dropped by about 40 percent in 2001 and again in July 2004 because of favorable negotiations and market conditions. This was possible because long-distance calls no longer have to subsidize the data network. Also, the campus previously had a long menu of possible phone features, such as call forwarding and caller ID, each with a small extra cost per month. Now these features are simply made available to everyone as part of the monthly charge per person.

Much work was required to determine how the communication user charge would be applied to university contracts and grants. Faculty grants are charged only when the faculty are paid from grant funds, and then by the percentage of their salary on that grant. Postdoctoral researchers and fellows are charged at one-third the communication user rate, multiplied by the percentage of time on the grant. Further, grants are not charged for graduate students or undergraduate students. The overall effect of the new model on contracts and grants is positive, with the net average impact being a decrease in charges. Some grants that had previously not been paying phone-related charges saw a modest increase, but many saw a decrease in total charges, thanks to reduced phone toll charges.

The funding model also provides a rebate program for departments that want to purchase and install NGN-approved distribution electronics sooner than their building is scheduled for its normal upgrade during each six-year upgrade cycle. They are given rebates based on the equipment’s depreciated value using the six-year useful life, and they receive these rebates as an annual fund transfer, not affecting the assessment of communication user fees. This program provides an incentive for departments to upgrade to new standards early.

Another goal was to greatly simplify campus departments’ administrative work with regard to their billing for voice communications and data networking. The actual billing of the $60 monthly fee shows every month on the general ledger, along with other employee costs such as university-paid benefits charged to departments. This makes the accounting very simple, and it is handled automatically as employees come and go and change their percentage of time worked. Relyea observes that “administrative staff quickly get used to this and like it. They don’t think about it any more than they think about employee charges for dental insurance. Instead, they care more about network services.” Full information about the funding model, rates, and processes is publicly available on a UCSD Web site.

**Future Directions**

UCSD is well into the process of planning for the next five-year model, to be implemented July 1, 2006. In fact, the NGN advisory committee finalizes the updated model and rates in February 2005. Long lead times are necessary because of the effect on research contracts and grants. A faculty member submitting a grant proposal needs to know what the charges will be as far as a year in advance.

The modeling and scenario creation process used to set up the original model is again being used for this next iteration. It is taking into consideration new and emerging technologies, strategic campus directions such as wireless, and major campus growth that has resulted in many new buildings. Rates for existing services such as voicemail and long-
distance charges are also being reviewed. For example, Relyea says, “Long-distance calls are becoming very cheap. We have to watch for the threshold where it costs more to track and administer long-distance calls than the cost of the calls themselves. Then, it would no longer make sense to charge for them.”

Looking carefully at the past five years’ experience with the original model concepts is also important. For example, the original goal was to gradually, over time, reduce the subsidy from the chancellor and vice chancellors and increase the $60 charge for each communication user. Plans such as these are also being discussed and evaluated.

Lessons Learned

We identified several key lessons learned on the basis of UCSD’s experience with its funding model over the past several years.

♦ Building a new funding model takes time. Relyea says that “even though we knew it would take a long time, it took longer than any of us thought. If you have a big, complex university and want the model to stick, it will take two or more years to run through all the possible models and scenarios and carry out the necessary broad communications with all constituents.” He recommends that everyone be ready for a lot of hard work and consultation. Or, as Harel says, “It is a long and painful process—and it’s worth it.”

♦ The issue of faculty contracts and grants can prove extremely challenging, depending on how an individual institution handles voice communications and data networking in overhead rate agreements. UCSD does not have these expenses included in the overhead agreements, so it was a major undertaking to determine how contracts and grants would be charged directly. This is a huge issue, as faculty are used to being charged for telephones but not for data networks. Harel thinks that “if we did not have to deal with the issue of directly charging contracts and grants, the whole implementation would have been much easier.”

♦ Involving the university’s external auditors in addition to internal auditors is very useful. In the last six months of model development, as it was nearing approval, UCSD had the external auditors review the model and provide a written report endorsing it. This was especially useful in regard to the policies for charging contracts and grants.

Relyea sums up their experience: “This is a great way to go. We had been struggling for so long. Now, our NGN funding model is robust, most of our problems are gone, and people are happy. Once it’s set up and running, it’s on autopilot. It is nice not to have to constantly worry about the network.”

University of Wisconsin–Madison

Nationally, UW–Madison currently ranks second among public universities and third among all universities for research expenditures. It has 20 schools and divisions, an annual budget of approximately $1.8 billion, and a total campus enrollment of 41,588 students.

UW–Madison’s current data network initiative, called the 21st Century Network, is designed to support the campus community’s
growing needs. The upgraded network will be fully redundant, more secure, and faster, and it will allow high-quality services such as video streaming, graphics, and animation—and “be ready for tomorrow.” The backbone spans 3 supernodes, 12 nodes, and approximately 180 radial buildings. Communication speeds are 10 Gbps between supernodes and a minimum of 1 Gbps between nodes, radials, and telecommunications rooms. The Division of Information Technology (DoIT), under the leadership of CIO Annie Stunden, is responsible for this network implementation and for the overall management of the 21st Century Network.

As part of the 21st Century Network initiative, the university decided to review and change its network funding model. The goal was to establish a stable funding model for maintaining a state-of-the-art network, which didn’t exist prior to this effort. Despite occasional one-time infusions of year-end monies and some cross-subsidies from voice communications revenues, the network was seriously underfunded and had become badly out of date. Deputy CIO Jack Duwe comments that “historically, network upgrades were funded on budget dust.”

To develop an appropriate funding model, UW–Madison contracted with a nationally respected consultant in this area, Western Telecommunications Consultants (WTC). WTC worked with UW–Madison staff and financial records to determine the current actual costs of all of UW–Madison’s network and telephony services. They then helped restructure the cost model so that only the costs for providing a specific service are included in the charges for that service. WTC analyzed costs of both voice communications and data networking and created alternative funding models for evaluation. The university also interviewed peer institutions about their network funding practices, models, and experiences.

**Principles and Goals**

Several important principles and goals guided development of the 21st Century Network funding model:

- A model that took advantage of peer institutions’ best practices.
- A model that eliminated all cross-subsidies and based charges on cost only.
- A model that funded all ongoing infrastructure costs of a state-of-the-art network, including technology upgrades, security, extensive redundancy and backup power, and so on.
- An extensive consultation process with campus executives and faculty governance committees.
- A model in which the billing process doesn’t negatively influence network design and scope. The previous charging scheme, for example, charged users per network connection to a building. This resulted in departments running their own cables between buildings to avoid network costs, which compromised network design.

**Organization and Process**

Creating the 21st Century Network funding model heavily involved several key constituents. First, DoIT worked with WTC consultants to carry out the extensive and data-intensive background work needed to understand the institution’s voice and data networking costs. WTC used its proprietary methodology and UW–Madison numbers to create alternative funding models for evaluation. This work began in late summer 2002, and the finished cost study and model options were ready for further work and review by the information technology committee by early winter.

The information technology committee—the campus IT governance committee established in accordance with university general practices for faculty and student governance—is an ongoing committee that over-
sees all of IT, including campus networking. It is an advisory committee whose guidance is important and generally taken by the campus. This group reviewed all background materials, evaluated alternative funding models, and recommended a solution that they felt would be best for UW–Madison. In early spring 2003, the deans council became involved and met several times to review, discuss, and eventually support the chosen model.

In July 2003, UW–Madison implemented the new model and rates, which are locked in for an initial period of five years, through mid-2008. The model and rates incorporated technology forecasts and needs for the upcoming five years. This gives local departments the ability to plan and also provides the IT organization with a known budget—one that is stable and will not go up. The IT organization is charged to do an excellent job within this constraint.

DoIT also worked extensively with other technical staff on campus throughout the project. Formal and informal organizations such as Tech Partners, the Campus Technical Issues Group (CTIG), and the network technical task force provided advice on technical network decisions and directions. While not involved in funding models and decisions, these committees provided forums for education and discussion of the new funding model. Computer science faculty were also consulted throughout the process.

The New Funding Model

The new funding model for the 21st Century Network comprises several annual funding sources (numbers are approximate):

- $4.0 million from a charge of $30 per month per full-time equivalent (FTE) employee to all campus organizations;
- $3.7 million from the campus, usually from indirect cost revenue from federal grants;
- $750,000 from student technology fees for network-related services to students, such as computer labs; and
- $1.9 million, which was already part of the base budget allocated to the network.

The university also received a substantial gift from John Morgridge, chairman of the board of Cisco Systems. John Morgridge and his wife are both UW–Madison alumni and have been lifelong benefactors of the university. The gift provided matching funding for Cisco network electronics: for every two items of Cisco equipment purchased at the usual discount, Morgridge provided funds to purchase one more. Duwe expresses the campus’s gratitude when he says, “It is hard to imagine how we would have done this project without the help of this gift.”

Much of the funding is being used to renovate the network physical plant. This involves replacing all remaining Category 3 copper, adding optical fiber where necessary, and replacing all switches, routers, and other electronics. Rooms containing main distribution frames (MDFs) and intermediate distribution frames (IDFs) in each building, now often shared with janitorial services and used for storage of chemicals and other supplies, must also be brought up to standards for space, power, air conditioning, technology, and security. As UW–Madison has approximately 800 IDFs, this poses both a physical and a cultural challenge. A complete and detailed implementation project schedule for the network upgrade is kept online and available to the campus. While not fixed in stone, this schedule provides the best current planning for implementation. It has turned out to be popular and a good way to keep campus departments informed.

The $30 monthly fee is a new charge based on full-time equivalent (FTE) faculty and staff and is described in the sidebar “The UW–Madison Full-Time Equivalent (FTE) Monthly Fee.” Each college and major division is charged $30 a month for each FTE who uses the data network for daily work activities. Although this includes most employees, there
are some exceptions, among them temporary employees (such as student employees), teaching and research assistants, and personnel categories who are not network users, such as janitorial staff, dietary workers, and specific other groups. These exclusions are discussed with each dean and his or her key administrative staff in each college. In some cases the change in cost to colleges was a substantial increase; in other cases it was a minor increase.

For telephone services (local, cell, and long distance), UW–Madison contracts with vendors and allocates these costs back to end users (approximately $6 million). All voice telecommunications cross-subsidies were eliminated. Not only is the full cost of telephone and long distance now recovered, but UW–Madison was also able to lower voice costs significantly. A Centrex line now costs only about $18.50, and cell phones cost $5.46 per month plus a per-minute charge. The reduction in phone charges for the 2003–2004 fiscal year exceeded $1.1 million campus-wide.

Although VoIP is not yet common on campus, the new network and funding model provides the infrastructure to move to VoIP when it proves economical. When customers discontinue their traditional voice line and move to VoIP service, they will need to pay for their VoIP handset and for the VoIP phone number (as they do now with Centrex). And since the Centrex revenues are no longer subsidizing the campus network, the loss of traditional voice revenue will not negatively impact the data network.

UW–Madison is dismantling the old video system, which runs on coax cable. This service will migrate to the campus IP network. There was previously no charge for this service, nor will there be once it moves to the new infrastructure. The central IT organization also covers the cost of wireless access points to all campus buildings, including common areas, conference rooms, classrooms, and computer labs. Student technology fees generate approximately $750,000 annually for network services specific to students. University housing has 4,000 rooms and pays all housing-associated network costs, as it is a self-supporting unit.

Because the network has become a key part of the campus infrastructure and is critical to research, teaching, and administration, the new campus network is being implemented

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The UW–Madison Full-Time Equivalent (FTE) Monthly Fee

**What services are included in the monthly fee?**

- **Network services**: 10-, 100-, or 1,000-Mbps Ethernet, access to the Internet and Internet2, participation in National LambdaRail and other research network initiatives, network engineering services, network maintenance, and 24 x 7 network operations center (NOC) monitoring service.
- **Wiring**: Outside plant fiber optic cabling between buildings and Category 5 (or better) cables inside buildings; telecommunications room remodeling and renovation.
- **Wireless**: Wireless network access in all campus buildings.
- **Security**: Antivirus site licenses, firewalls, event mitigation.
- **Help desk**: 24 x 7 first-level support personnel to resolve simple technical questions and route medium or complex problems to the 24 x 7 NOC for fast resolution.

**What services are not included in the monthly fee?**

- Centrex telephone line (cost per line including local calls is about $18.50 per month).
- Long-distance toll calls.
- Telephone and computer instruments.
- Voicemail.
- Cell phones (typical cost is $5.46 plus $0.10 per minute).
- Experimental networks and exceptionally high-bandwidth needs.
- Special-use rooms.

**Charges per full-time equivalent (FTE) staff and faculty:**

- $30 per month, assessed annually.
with specific standards and with much more coordinated management than existed previously. The DoIT Network Services Group is responsible for implementing all of its components. Network switches and routers in the buildings are included in the network charge, and departments will no longer be responsible for purchasing or installing them. However, three different network management options are available to the campus community:

- central management, where DoIT is responsible for network implementation, operation, and problem resolution to the faceplate;
- collaborative management, where the department’s authorized agent and DoIT staff share responsibility for day-to-day operational management of the gear, while DoIT maintains responsibility for router software revisions, upgrades, and problem resolution; and
- delegated management, where the department takes full responsibility for operation and problem resolution of the department network.

Most campus units are choosing the collaborative management option, recommended by DoIT. Although there is no cost reduction to the department, this option gives departments the flexibility to move connections around and make other changes themselves. In fact, DoIT provides a software package to support their local network management effort. Some departments, such as computer science, prefer the delegated management model, and those departments that have little network expertise may choose the central management option.

Future Directions

Since the five-year commitment for the new network funding model started in July 2003, UW–Madison doesn’t plan to modify either the model or the actual rates during this time. Instead, the focus will be on completing the enormous amount of work necessary to bring the 21st Century Network into full reality. This work is expected to be ongoing through 2008.

However, for the first five years, the funding model actively supports technological evolution and upgrading of the network. The campus can also actively move toward converged networking and services, especially VoIP and video-related services, without negative financial impact. Further, this five-year commitment allows time to gain experience with the funding model and be ready to make changes and improvements during the model’s next iteration in 2008.

Lessons Learned

UW–Madison pointed to several lessons learned on the basis of their process to date in creating a new network funding model.

- Stunden’s leadership on both the 21st Century Network project and the related network funding model was absolutely critical. Without her enthusiastic advocacy, neither would have happened.
- Using the WTC consulting firm proved extremely successful at UW–Madison. The detailed work done up front to fully understand the historical and projected costs was essential to the funding model’s success. Duwe says that “they spent many months here with our staff, going through records, time sheets, doing very thorough cost analysis. They have a methodology, and our numbers were used in their model to create realistic funding alternatives that we could consider.”
- The full involvement and backing of the university’s executive level is essential. Duwe states that the campus could not have proceeded to develop a new network funding model without the strong support of the chancellor, provost, and vice chancellor for administration and finance. Their understanding of the network’s criticality
was crucial at every step. The deans also had a pivotal role. Duwe comments that “this was difficult for them, as it involved big costs and shifts in responsibility. They had to make tough decisions, and their support was essential to the success of the model.”

* Also critical was the deep involvement of the information technology committee faculty governance committee. They were at the center of the model development and decision-making processes: they evaluated alternative models, reviewed several drafts of the chosen model, and looked at cost data in a fair amount of detail—perhaps more than they wanted. Their process of review, advice, counsel and, eventually, full support, was key to success.

Duwe summarizes by saying, “There is solid recognition that the network provides a key campus infrastructure capability—a capability that we have all come to depend on for our day-to-day activities of teaching, learning, research, and administration. And now we have the stable funding that will allow us to maintain a state-of-the-art network infrastructure at the University of Wisconsin–Madison.”

**Conclusion**

Our three case study institutions chose different approaches to achieving a common goal—creating a stable funding model that would support a sustainable state-of-the-art production voice communications and data networking infrastructure for the campus. Although there were differences in implementations—charging per user, port, or usage; combining voice and data charges or keeping them separate; using an outside consultant or using internal staff—we found agreement on several critical success factors.

* A funding model for a sustainable campus network must be based on actual costs, and any subsidies of voice revenues to support the data network must be eliminated.

* The task of accurately determining the network’s technical design and associated costs is essential to creating a sustainable network funding model that is appropriate for the institution. It is data intensive and takes a great deal of time and effort, but it cannot be given short shrift if the effort is to succeed. It is the underpinning for everything that follows.

* It is important to understand the inherent limitations and ramifications of different funding models. For example, traditional port/IP/MAC-count-based billing systems encourage departments’ ad hoc deployment of network hardware that in turn compromises network design and threatens required income streams and future advanced network services. On the other hand, a head-count-based billing system may be perceived as a central “tax” on departments for a service they may argue they do not use or that does not provide enough value to justify the tax, and such a billing system may encourage excessive consumption.

* Creating an effective participation and governance process and taking the time to ensure extensive and meaningful involvement of the campus administrative and academic constituents is crucial. This process will be tailored to fit within an institution’s culture and politics, but it is essential. Creating a sustainable funding model is a huge change, affecting everyone financially.

* Funding models and cost recovery systems operate within a cultural context and therefore should be changed carefully, infrequently, systemically, and publicly. In all cases described, efforts to change models and systems derived from principles that reflected the institutions’ goals, values, beliefs, and aspirations. Establishing and validating such principles early in the process of reformulating a funding model is likely a critical determinant of success.
Endnotes

2. See <http://www.cit.cornell.edu/oit/Arch-Init/netbilling>.
5. See <http://ns.doit.wisc.edu/21CN/PublicView.htm>.