Spring 2007

ACUTA Journal of Telecommunications in Higher Education

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Published by The Association for Communications Technology Professionals in Higher Education

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**ACUTA's Core Purpose** is to support higher education communications technology professionals in contributing to the achievement of the strategic mission of their institutions.

**ACUTA's Core Values are:**

- Encouraging and facilitating networking and the sharing of resources
- Exhibiting respect for the expression of individual opinions and solutions
- Fulfilling a commitment to professional development and growth
- Advancing the value of communications technologies in higher education
- Encouraging volunteerism and individual contribution of members
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Five years is a long time in our industry. Did any of us in 2002 anticipate the rapid growth of the Internet (and its protocol) and the effect it would have on our daily lives, both in and out of the office? In the past five years, Providence College has had to more than triple its commodity Internet bandwidth requirements just to keep pace with demand and deploy tools to both manage that bandwidth and successfully fight the viruses that come with such explosive growth. But we have succeeded in spite of these challenges, and the years from 2002 through 2006 are now behind us.

Before we can understand the network technology requirements for the campus of 2012, we must first realize that the pace of technology growth between 2007 and 2012 may indeed accelerate at an even faster rate than in the previous five years. The emergence of video applications alone on our IP networks will have a tremendous effect on bandwidth requirements and will bring new and unique security threats as yet unknown.

In “Focusing on Video Demands” in the winter 2006 ACUTA Journal, author Paul Korzeniowski described how “teachers are introducing video content into their coursework. Professors now click on a link and download a short five- to ten-minute video presentation as part of their lectures. In addition, many are incorporating longer-playing items such as short documentaries and even full-length films into the classroom.” Imagine these professors’ surprise if it takes half the class time or more to download that video.

At an ASAE meeting almost two years ago, someone asked how we could know what students will want from a four-year college in the next several years. After many attendees (including me) shrugged their shoulders, Glen Tecker, president of Tecker and Associates, a strategic planning firm, advised, “Observe how any present-day middle-school student learns and functions then go from there.” From that point on, attendees began an intense discussion based on their own children's habits and came up with some truly incredible ideas.

That is only half the story. The other half is that we must keep our senior management apprised of our educated guesses. It is critical that they understand that there is considerable cost to remaining competitive among peer institutions. Being unprepared to meet student expectations will have far-reaching consequences.

Case in point: In 1999 Providence College built two large apartment buildings and took great pride that we delivered more than 60 channels of cable television to their living rooms. To our surprise, many residents showed up with their own televisions. Finding only one outlet in the apartment living rooms and having multiple televisions available, they immediately purchased splitters, significant lengths of coaxial cable, and rolls of duct tape. They then proceeded to connect and tape the coaxial cable to the floors, walls, ceilings, air ducts, or anything that would serve as a pathway to their respective bedrooms because they were used to
coaxial cable to the floors, walls, ceilings, air ducts, or anything that would serve as a pathway to their respective bedrooms because they were used to watching cable television in their bedrooms at home.

Recognizing our omission, we sought pricing to retrofit these apartment buildings to accommodate student expectations, but found it was cost prohibitive and could not be funded. As a result, the beginning of every new school year brings a reminder of our oversight. We must annually warn the residents that this practice presents a safety hazard, and when conducting inspections during semester break, we take appropriate action against those who did not heed the warning. Needless to say, when it came time to design the next apartment building, all the bedrooms, in addition to the living rooms, were engineered for cable television.

Our members have indicated in multiple ways that they look to ACUTA to help provide insight into what they can expect:

• In the 2006 Member Needs Assessment, respondents were asked to list which issues would be critical to their institutions. The second-highest issue named was “meeting expectations of students of the future.”

• At the 2005 Strategic Leadership Forum, one of the specific comments was, “Having Bill [Clebsch, Stanford University] and Phil [Beidelman, WTC] together was excellent and a similar projection should be held each year or two.” The title of their presentation was “Planning for the Technology of 2020.”

• At the 2006 Annual Conference, a focus group composed of institutional members and corporate affiliates was gathered to gain insight into their perceptions of ACUTA. In the priorities section, we were told, “Bring relevance by reporting on the state of the industry as it will be in the future.”

We may not have a crystal ball that will let us gaze into the future. But there is no mistaking that the rumbling noise in the distance comes from an insatiable hunger for bandwidth.
CHEMA, the Council of Higher Education Management Associations, is an organization of approximately 30 nonprofit associations representing professionals engaged in the administrative functions of higher education. ACUTA’s president, president-elect, and executive director participate regularly in CHEMA, and we have found it to be a valuable forum for information sharing and collaboration.

In recent years, there has been growing scrutiny of higher education from policy-makers at the federal and state levels. In addition, factors such as technological innovation, tight budgets, global issues, and the evolving student demographics have become significant forces for change.

In this dynamic environment, 22 CHEMA member associations, including ACUTA, decided to sponsor an unprecedented examination of the future of higher education from the administrative professional’s point of view. Our goal was threefold: examine how administrative functional managers and association leaders anticipate how higher education will change in the next 10 years; identify change drivers; and understand the degree to which institutions are prepared to manage change.

We engaged the EDUCAUSE Center for Applied Research (ECAR) to design and carry out the study, under the direction of a steering committee of CHEMA executives. ECAR chose Philip J. Goldstein, one of its research fellows, as the principal investigator and author of the report.

Members of the ACUTA Board of Directors participated in this study by completing a written survey and lengthy telephone interviews.

I would like to share some of the key results of the study with you, as I think they fit well with the theme of “Campus 2012: Imagine That!” This information is from “The Future of Higher Education: A View from CHEMA,” by Philip Goldstein, published in August 2006. For those interested in more depth and detail, the full report is available on the ACUTA website at http://www.acuta.org/doc.cfm?Docnum=1619. We also have printed copies available from the ACUTA office (request by e-mail to jsemer@acuta.org).

• Respondents generally agreed that higher education will change dramatically in the next 10 years, but those from public institutions were more likely to agree with this statement than those from private schools. Many participants believe that public institutions are more sensitive to changes in funding, demographics, and regional economics. Others anticipate growing privatization of public institutions.

• On average, respondents believe that higher education will face more competition and be under pressure to reduce tuition and improve the quality of education.

• Financial constraints are expected to be a significant factor defining the future of higher education. There was strong agreement that institutions will not have sufficient financial resources to meet their future strategic objectives (both for the institution as a whole and for individual functional areas).

• Respondents agree to some extent, but not strongly, that their functional areas will change dramatically, face more competition, and be expected to reduce costs. They agree more strongly that they will achieve improvements in their quality of service.
The following were identified as the top three change drivers: financial constraints, technological change, and changing student demographics.

- The following were perceived as the top three threats to the future success of higher education: resistance to change, lack of resources, and the increased cost of an education.
- Fiscal challenges were a continuing theme, including reduced funding, increasing costs of operating the institution, pressure for cost containment, and a permanent shift from public to private funding sources for public institutions.
- Dramatic changes in student demographics, including greater ethnic diversity and an increasingly older and more-mobile student body (resulting in increased demand for 24/7 services) are perceived as significant factors.
- Three forms of increased competition were identified by the respondents: (1) among traditional institutions, (2) with new entrants such as global competitors and for-profits, and (3) between internal campus services and external providers. Auxiliary services were the most likely to feel pressure from external competition, while infrastructure providers felt almost none. ACUTA members may fall in either or both categories, depending upon the business model at their institutions.
- Technology's impact as a change driver is second only to finances. Technology is perceived as transforming higher education at all levels, including teaching and learning, communication, and access to information. It is also seen as a method to increase productivity and control costs. While participants believe that the physical university will not become obsolete, they do feel that the need for students to be physically present on campus will diminish, and that campus services should be planned accordingly. (To me, this was one of the most significant results of this study.)
- The integration of technology into operations is also perceived as requiring more management time and attention, increasing expectations for rapid response, and quickening the pace of administration. Some respondents felt this was a threat to the thoughtfulness, deliberation, and collaboration that are inherent in the culture of higher education.
- The respondents are optimistic overall about the future of higher education, but less confident in their own institution. Fewer than half of the participants felt that their institution was well-positioned to deal with future change. In contrast, they were quite confident and optimistic about their own functional department's ability to capitalize on change.
- Finally, participants identified many strengths that will enable higher education to succeed in the future. The ability to innovate, a strong sense of mission, and the capabilities of institutions' executive leadership were the top three.

I hope that you will give some thought, both individually and with your colleagues, to the change drivers that were identified by your peers on a wide cross section of campuses. Consider how these issues might apply to your functional area and to your institution as a whole. Are you positioned as a department and as a campus to make the most of change and emerge successfully from the next decade? ACUTA is committed to helping you in this process, through access to information, peer networking, and scanning the future for significant developments in both technology and education.

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Strategic Planning in the College and University Ecosystem

James S. Cross, Ph.D.
Longwood University

In today's competitive era, rising expectations, escalating user demands, tight budgets, soaring security concerns, and creating value are key stakes for college and university administrators. Closely linked to these issues is communications technology, including the Internet, which grows more pervasive day-by-day. The widespread use of new technologies and the open environment that has arisen exposes many perils and pitfalls in this strategic resource and emphasizes the importance of strategic planning in the telecom environment.

"Smart" and "good" aren't enough anymore. New strategies, innovative management methods, creative products, and services reengineering are required for success as CIOs and their teams manage an expensive strategic resource and service portfolio. The research opportunities are phenomenal. The ability to develop end-to-end multiservice portfolios and test beds, capture real-world implications of network convergence, model usage patterns, and simulate economic implications of innovative applications and virtual education communities offers limitless possibilities.

Many critical time-dependent factors—known and unknown—must be taken into consideration in the education community network ecosystem of the future.

Successful strategies must be aligned closely with the wireless market, as more and more calls will involve wireless devices. As Internet services become increasingly less distinct, users will expect a family of converged services with a similar look and feel. Without a plan, implementing expensive technologies will result in missed opportunities, wasteful redundancies, and significant fiscal irresponsibility.

The Evolving Campus

The proliferation of telecommunications networks at the university is transforming the education community ecosystem. For example, the central administrative function, once supported by a large mainframe, has been replaced by networks of personal computers, servers, websites, and expert systems. The teaching and learning process, once characterized by lecture halls and books, is now being redefined by electronic links between student and instructor. The library, once a source of pride for which prestige was measured by the number of printed volumes, is being transformed into a seamless web of electronic resources with access shared by all scholars. Even research, whose hallmark is the secluded professor, is growing into an electronic community of collaborating individuals more aligned to an academic discipline than an academic campus.

The goal is to creatively exploit the potential of a campus's most important resource—its people. Technology does not, in and of itself, innovate; people do.

The vision now is to empower people and increase productivity by exploiting the capabilities and potentials of a wide array of information-processing technologies, such as high-performance processing systems, networks with speeds of billions of bits per
second, multi-megabit bandwidth on demand, terabyte databases, and personal communications systems.

The strategy is to provide faculty, staff, researchers, and students with access not only to their own personal information, but also to the seamless web of heterogeneous computing resources anywhere on their own campus or other campuses, or at businesses and governmental agencies. Although many of our faculty and staff can intuitively envision the value of an information-age campus, the complexities of making the transition from the traditional office and textbook/teacher-centered classroom to the high-tech array of multimedia and knowledge navigation tools is disconcerting to many.

Yet, realization of the information-age education community ecosystem is critical for multiple reasons. It will enable us to accomplish the following:
- Communicate and work effectively in the future.
- Meet the needs of a diverse constituency.
- Overcome time, distance, and location constraints.
- Support class, unit, and competency-based degree programs.
- Provide access to a wide array of scholars and subject matter experts.
- Simulate complex real-world situations.
- Empower the human mind to reach new levels of creativity.
- Make the once impossible, possible.

Special times, Special Challenges

The challenge will be to keep up with rapidly changing technology and make sense of it. Gone are the days of merely automating the backroom functions. Creative application of the technology will mean assessing its impact on the curricula, faculty, staff,
Key Definitions

Strategic
In the dictionary, the word strategy has to do with war and deception of an enemy. In nonprofit management, strategy has to do with responding to a dynamic and often hostile environment in pursuit of a public service mission. Thinking strategically thus means being informed and consciously responsive to this dynamic environment.

Planning
Planning is intentionally setting goals, choosing a desired future, and developing an approach to achieving those goals.

Strategy
Strategies are the set of intuitive and educated best-guess actions that will enable the organization to achieve results. The process entails examining the critical issues, as well as the organization’s strengths and skills/expertise that can be employed to address the critical issues.

Decision Making
Decision making is a set of actions or positions taken to achieve some desired goal. The decision ultimately is no more, and no less, than a set of actions about what to do, how to do it, and why to do it.

Long-Range Plan
Long-range plan is a series of decisions and actions for accomplishing a goal or set of goals over a period of several years in a relatively stable environment. The time period varies from organization to organization. For most nonprofit organizations, a 3–5 year time frame is appropriate, taking into consideration the pace of change relating to technology, politics, economy, internal realities, and marketplace conditions.

Inclusive Process
Inclusive process means that stakeholders in the organization participate in the planning process in an appropriate way. This does not mean that everyone must come to a joint consensus. It does mean that these interested individuals have a chance to be heard by the decision makers.

...
another right choice as the need demands. Colleagues may well ask, “What are the perils and pitfalls involved in migrating to this new education community ecosystem? How should we proceed? What are the risks? Where do we start? What are the key issues in strategically planning for this new education community ecosystem?” These are questions best raised and answered in the planning process.

What Is Strategic Planning?
Strategic planning may be broadly defined as a disciplined effort to guide decisions and actions that shape the direction of an organization, with a focus on future goals and objectives (Bryson, 1995). It is a complex, thought-provoking, challenging, messy, and sometimes controversial process, because some decisions and actions are more important than others in achieving desired results. It is a creative process with lots of unknowns, and the insights gained today might very well alter the decisions made yesterday.

Strategic planning is a management tool to help an organization focus its energy and resources to ensure that members of the organization are working toward the same goals. The process is strategic because it involves developing strategy and exploring alternatives on the best way to respond to the circumstances of the organization’s desired outcomes.

Strategic means being clear about the organization’s objectives, being aware of the organization’s resources, and incorporating both in responding to a dynamic environment. The process involves setting goals, choosing a desired future, developing strategy for achieving those goals, testing assumptions, gathering information, and anticipating a changing, unpredictable future environment. The plan is ultimately a set of decisions, actions, and assumptions about how to proceed toward a desired set of goals and objectives. Although the objective is to anticipate possible pitfalls in the future, strategy development focuses on the factors to consider in responding to the pitfalls if they should occur.
Strategic Planning Versus Long-Range Planning

Although many use these terms interchangeably, long-range planning generally means the development of a plan for accomplishing a goal or set of goals over a time period (usually several years) in a relatively stable environment. The current knowledge about future conditions is sufficiently reliable to ensure the plan's reliability over the duration of plan.

On the other hand, strategic planning assumes that an organization must be responsive to a dynamic, changing environment in unpredictable ways. Strategic planning stresses the importance of making decisions that will ensure an organization's ability to successfully respond to unpredictables in the environment. More precisely, it means:

- Developing assumptions about an unpredictable future;
- Assessing the environment with a definite purpose in mind;
- Determining the potential forces that may affect or impede the fulfillment of goals;
- Creatively developing effective responses to those forces;
- Being attentive to the "big picture" to keep an organization relevant;
- Being flexible in order to adapt to changing circumstances.

Strategic planning is fundamentally about decisions and actions. Although it involves anticipating the future environment and making specific conjectures and assumptions about the future, the decisions are made in the present. That means staying abreast of changes in the environment in order to make the best decisions at any given point. Ultimately, it involves determining the most important issues and factors to consider in making some future decision.

Elements of a Strategic Plan

A strategic plan is a comprehensive view and strategy of where an organization is headed: vision, mission, assumptions, strategies, and action approaches to achieve targeted results in a dynamic environment. Specifically it attempts to answer:

- Where are we now?
- Where do we want to go?
- How will we get there?
- What are the challenges?
- How will we assess results?
- How will independent actions and decisions be molded into an organizationwide game plan?

The task is to create a picture of an organization's future, decide what future business position to stake out, and provide long-term direction and a strong identity.

Links to More Information

More details about strategic planning, including some sample plans, can be found through these sources:

- Strategic Planning (in nonprofit or for-profit organizations): www.mapnp.org/library/plan_dec/str_plan/str_plan.htm
- Strategic Planning, Strategic Plan, Business Strategy, Strategic: ... www.planware.org/strategy.htm
- Idealist FAQ: www.nonprofits.org/npofaq/03/22.html
- Writing a Strategic Plan: www.cwc.org/market/mkt4.htm
- Strategic Planning: www.allianceonline.org/FAQ/strategic_planning
- Strategic Planning Don'ts (and Dos): www.cio.com/archive/060102/donts.html
- Strategic Planning Template: www.lbb.state.tx.us/Strategic_Plans/Documents.htm
- Planning for Results—A Strategic Planning Process: www.win.org/library/library_office/reports/stratplan/
Missions Versus Strategic Visions

A strategic plan concerns an organization's future direction, including the following:
- Direction it will pursue
- Market it intends to stake out
- Capabilities it will have
- Customers it will serve
- Yardsticks to track performance

The plan should push the organization to be inventive, creative, and focused. It should prevent coasting and complacency if targets require stretch. It involves deciding how to respond to

- Unpredictable and changing environments
- Best-of-class provider
- Shifting socioeconomic conditions
- Growth needs over the long term
- Reactions of stakeholders
- New technologies
- Evolving customer preferences
- Political and regulatory changes
- New windows of opportunity
- The crisis of the moment

Strategic planning is the application of strategic and critical thinking to the decisions and actions involved in leading an organization in a dynamic and unpredictable environment. The assumption is that the organization desires to be responsive to a dynamic, changing environment that is often unpredictable. Thus, the emphasis is on understanding how the environment may change, is changing, and will change in the future.

The Draft and Review Process

Writing a strategic plan is done most efficiently by one or two individuals, not by a whole group. The task should be delegated to a staff member or a consultant who has been an integral part of the planning process. The critical factor is that it accurately documents the decisions made and has the support of those responsible for carrying it out.

It should be decided in advance who may review and respond to the draft plan; who will decide which suggested revisions to accept; and who approves the final plan. Ideally, the big picture, ideas, decisions, and strategies have been debated and consensus resolved, so that revisions are minimal.

Standard Format for a Strategic Plan

Generally, a strategic plan is a document that summarizes, in about 10 to 12 pages of written text, why an organization exists, what it is trying to accomplish, and how it will go about achieving its goals. Its "audience" is the stakeholders who want to know the most important ideas, issues, and priorities of the organization. It is a document that should offer edification and guidance. The final document should include a table of contents that points to the following sections commonly included in a strategic plan:

- Introduction by the president. A cover letter from the president that introduces the plan to readers. The letter gives a "stamp of approval" to the plan.
- Executive summary. A one- to two-page section that highlights the mission, vision, goals, and objectives; the process followed to develop the plan; and a thank you to participants involved in the process.
- Mission and vision statements. These statements introduce and define themselves.
- Organization profile and history. A one- to two-page summary of the organization's profile, history, key events, triumphs, and changes over time.
- Critical issues and strategies. This section succinctly states the critical issues and strategic thinking behind the plan.
- Goals and objectives. The goals and objectives are the heart of the strategic plan; what the organization intends to "do" over the next few years.
- Appendices. This section should provide needed documentation to enhance readers' understanding of the plan.

Conclusion

Technology and industry trends are heading toward greater autonomy and control at the edge, but we will see a gradual transition away from carrier-provisioned services. It is against this kind of background that strategic planning can play a critical role in helping to lay a foundation for the development of advanced campus services to meet unique needs.

James S. Cross, Ph.D., is dean of the School of Business and Economics at Longwood University. A past president of ACUTA, he is a member of the Journal Editorial Review Board and a frequent contributor to the journal himself. Contact Jim at crossjs@longwood.edu.

Editor's Note: In the summer issue of the ACUTA Journal, Dr. Cross will examine some strategic plans submitted by various campuses or available online.
Curt Harler
Contributing Editor

Outlook 2012: Chickens or Eggs?

Do the products and services that vendors offer drive the campus strategic plan, or do the needs of the campus determine the direction product manufacturers and service providers take? We live in a world where technology is increasingly pervasive. Is the student consumer one more force to be reckoned with as we try to envision the technology landscape of the campus in 2012? Just where will campuses be in five years? It is a chicken-or-egg conundrum—one that is not only fun to consider but also imperative to resolve if telecom and IT directors are to survive.

Expect marked change in campus telephony and services in the next five years. It is anyone’s guess what the situation will be by 2012—but 2012 is only a few planning cycles away.

“Students will require commercial-level or greater services,” says Rick Cunningham, vice president for strategic markets with PAETEC Communications. “This will be a challenge for IT and telecom directors. Students will expect things that are available in the general marketplace to be supported by their school and there will be so many services and technologies that IT will be required to support.”

Whatever the answer to the chicken-or-egg question, there is no doubt that the chicken will cross the road...as well as wander around campus: mobility will be king.

Mishez Avari, director of education for AT&T out of Chicago, agrees that services will be student-driven and that wireless, along with VoIP, will be technology keys.

“Students are dictating, more and more, the technology that campuses must interface with,” she says. “It used to be the school dictated what the student got to use. Now, you have to focus on what the student wants and expects,” she adds.

“First and foremost, CIOs will be looking at wireless,” says Dennis Elwell. He is not only national director with Verizon Business’s government and education solutions, but he is also on the faculty of Virginia Commonwealth University. So he sees the question from both sides.

At a recent Verizon-sponsored Higher Education CIO Summit, wireless was a top concern. Elwell says schools have to prepare for local wireless – inside buildings, between dorms, and reaching beyond campus to serve mobile faculty members and administrators.

“We’ll see the use of advanced PDAs in the academic environment,” he continues. “Not just tablets or PCs, but units that combine the PDA, phone, and an iPoD-like academic device.
They are working with 802.11n, which promises huge bandwidth and distance leaps over today's 802.11 standards and UWB, ultra-wideband transmission.

There is no doubt users will demand ability to extend desktop IM functionality to mobile devices. According to a report by researchers at the Radicati Group, Inc. (Palo Alto, CA, www.radicati.com), widespread use of mobile devices and a gradual movement toward unified communications will bring the IM and mobile markets closer together. They see no halt in the trend for carriers, IM vendors, and device manufacturers to continue to add mobile IM functionality to their services.

"Administrators really need to look at who the students are who will be coming to campus and their expectations of the college," says Guy Clinch, director of global solutions for education at Avaya (Ipswich, MA, www.avaya.com). He says students of tomorrow will be extremely electronics literate and will have high expectations that their campus will be the same.

"Institutions need to adapt themselves to those expectations," he says. Students expect colleges to be temples of technology and expect the goodies they had at home to be available on campus. Devices they use for fun or communication must be part of the campus IT plan. "IM and texting are the lingua franca of the upcoming generation. They expect multitext communications," Clinch says.

Avaya is layering applications on devices students will carry. Speech access to information—from e-mail to video clips—will be voice activated. It will be typical for an e-mail to have a WAV (audio) file response to a TXT (text) message. Access to calendaring and other personal productivity tools will drive a sense of community via electronics that establish the virtual community.

Colleges will take the concept of social networks like MySpace to the campus quad, allowing a device user to contact anyone interested in a Hacky Sack game and inviting them, electronically, to play. These "blast conferences," which will ping all users within, say, 1,000 feet with an invitation to join the game, will create virtual flash mobs for many uses. Some students may even use them to set up study groups.

All manner of next-generation networking will be commonplace as traffic increases on Internet2. Users will demand better-performing on-ramps, better connection, flexible peering, and an infrastructure open to more people with better quality of service than the commodity Internet of today.

High-speed packet access (HSPA) network deployments will represent 60 percent of infrastructure revenue in 2012, according to a new report from Telecom Trends International, Inc. (Falls Church, VA, www.telecomtrends.net). WCDMA (wireless CDMA) is the fastest-growing technology, giving WCDMA networks unprecedented economies of scale and helping to lower equipment costs, predicts Naqi Jaffrey, president and chief analyst of Telecom Trends. He expects HSPA, an enhancement to WCDMA, to increase both data rates and network capacity and, by 2012, HSPA to become the de facto global standard.

EDGE networks will become more spectrally efficient with the transition to EDGE Evolution, beginning in 2007. EDGE Evolution will add voice and data capacity, increasing data rates up to three times as compared with today's EDGE networks. EDGE Evolution will garner over 20 percent of infrastructure revenue by 2012, Jaffrey says.

Elwell says wireless will extend to a "community network," with service extending the campus network into town to serve faculty after hours, off-campus residents, medical centers, research parks, and even townies. "They need the same performance off-campus as on," Elwell says. "It has to come from a ubiquitous, seamless network."

Look for dual-mode handsets to allow interoperability between HSPA and EDGE Evolution networks, allowing for global, seamless roaming. This will give both technologies tremendous impetus. As a result, spending on CDMA2000 family of technologies will gradually decline, relegating it to a niche status. Jaffrey says telecom directors should expect their mobile operators with CDMA2000 networks to begin switching to HSPA or EDGE Evolution within the next seven years.

Expect to find more WiFi hotspots on campus. WiFi and WiMAX infrastructure will jump, according to TIA's Telecommunications Market Review and Forecast, a report by the Telecommunications Industry Association (TIA). The WiFi equipment market is increasing at a fast pace and will continue to grow as hotspots proliferate. An emerging WiMAX equipment market will also contribute to growth in the coming years. TIA says it expects revenue from spending on wireless capital expenditures on WiFi and
WiMAX to climb to $29.3 billion by 2008, a 7.1 percent compound annual gain.

"With the WiFi and WiMAX markets expanding rapidly, we will begin to see more demand for mobile broadband and broadband connectivity. Major carriers such as SBC, Verizon, and Sprint have already announced deals to expand the number of hotspots and to broaden their networks," says TIA president Matthew J. Flanigan. "It is likely that both of these markets will stimulate the overall broadband market to the benefit of all technologies."

WiFi, which includes wireless standards 802.11i, 802.11a, 802.11b and 802.11g, represents a small but quickly growing component of wireless communications services. Spending on Wi-Fi services is expected to climb at a 99.9 percent compound annual growth rate (CAGR) to $335 million by 2008. Although experiencing healthy growth on a percentage basis, aggregate revenue is expected to remain relatively low, because most WiFi services are either offered free as a promotion or bundled with other services. Consequently, according to the report, WiFi is not expected to become a significant source of service revenue by itself. Rather, it is expected to stimulate other revenue by attracting business and by growing the equipment market.

Verizon's Elwell agrees. The consensus of CIOs at the Summit was that schools need to give serious consideration to infrastructure. "That includes rebuilding and new buildings and providing wireless, fiber, and WiMAX between buildings," he says.

The number of WiFi hotspots in the United States increased more than six-fold from 2002 to 2004, from 3,400 to 21,500. The number of hotspots in the United States is expected to increase to 64,200 in 2008, growing at a 31.5 CAGR.

WiMAX is emerging as a last-mile broadband wireless Internet access solution. WiMAX provides wireless services in the metropolitan area network (MAN), just as WiFi provides wireless in LANs. WiMAX can make broadband service available in regions where it is currently not feasible, particularly in rural communities. When certified products become available, the market will expand. Costs should be less than for WiFi because WiMAX is a standards-based technology. WiMAX is potentially disruptive, Flanigan notes, in that it could compete with other high-speed fixed solutions, including DSL and cable modems, as well as high-speed mobile solutions like 3G.

**IP Will Remain Hot**

After years of hype, says a report by IDC (Framingham, MA, www.idc.com) analysts Mark Winther and William Stofega, Internet protocol-based telephony (IPT) has made the shift from an emerging technology to a viable business solution. "IPT is finally poised to overtake and replace the reliable but aging circuit-switched phone network," they say.

IDC says the old saw about IPT paying for itself in toll bypass savings is passé. Rather, today it is about added features and functionalities, improved processes and performance. "Forward-thinking organizations are seeing enhanced telecommunication infrastructure and services as a competitive advantage, aligning infrastructure needs with business strategy and vision," IDC continues.

Most campuses will continue to be saddled with a legacy mix of PBXs, key systems, and desktop phones, often from a variety of vendors. (See related statistics in Table 1.) Voice services are a mix of private trunk lines, POTS, ISDN, Internet, data networks, and perhaps some Centrex thrown in to scramble the picture. Worse, IDC notes, contracts and bills come from multiple phone companies, maintenance firms, and equipment suppliers. IDC sees an opportunity to use IPT to eliminate redundant infrastructure and manage all voice and data communications via a single.

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<th>Table 1. Telecom service spending by category (U.S. $ in millions) — Education, 2005–2010</th>
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Source: In-Stat, 9/06
Thanks to all the companies that support ACUTA as Corporate Affiliates!

Year after year, our Corporate Affiliates provide meaningful support to the association and its members as they contribute valuable information in sessions, in our publications, and on the listserv; provide personal attention and excellent customer service; and participate in our events by presenting, exhibiting, sponsoring, and attending. As you have need of various products and services, we hope you will always include ACUTA Corporate Affiliates in your RFI/RFP solicitations.

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Information current as of 2/16/07

ACUTA Journal of Communications Technology in Higher Education Spring 2007
Internet network, with a single provider. The same solution will be deployed in every room, office, and branch campus—a solution that can be administered and managed remotely from a Web-based interface by in-house staff.

These Web-based phone systems will be easier to configure, especially at midsized operations. IPT allows centralized administration of multisite facilities, with upgrades and new features added at a central site without having to send a technician to each campus.

IDC points to a variety of personalized services available via IPT that will drive adoption. Visual voicemail (allowing voicemail to be handled like e-mail, with voice messages viewed and heard in priority according to caller ID or time stamp), Web-based call management, find me/follow me services using a Web portal, and full integration with desktop software (whatever the Outlook or Notes of 2012 happens to be called).

“Students will demand more mobility,” Cunningham says. To that end, his firm is developing IP and VoIP solutions that will enable some of this convergence and more efficient use of bandwidth.

“The continued demand for bandwidth will be insatiable,” Cunningham continues. “You’ll never be able to provide enough. If you build it, they will use it.”

IDC recommends a stepped approach to build-out, by which an IPT system is turned up with basic functionality with features added over time. That would be in tune with economic realities, too.

Avari sees VoIP as another campus super-player, along with wireless. While she acknowledges that rollout to date has been modest, she sees it continuing to expand with increasing speed.

Another growth area, she says, is e-learning. The student body is changing from 18-year-olds who come to school and live in a dorm to adults who are married with jobs and cannot conveniently commute to a campus. “This is not just MBA students, but students seeking their bachelor’s degree,” Avari says.

**Superchicken**

One technology that will boost speeds is superconductivity, which will be commercialized by 2012. Ultra-high-speed Internet switches are on the near horizon. They will carry Internet traffic to a much higher level of density and complexity, leading to an information highway that is much faster than what we currently have, says Elie K. Track, Ph.D., senior partner at HYPRES Inc. (Elmsford, NY, www.hypres.com) a developer of superconducting microelectronics technology. These switches would involve the use of superconducting technology to process optical signals in interconnecting circuits, leading to 100 TBps routers.

Add to that high-capacity power lines that use cables made out of superconductors to efficiently carry electricity to areas without power infrastructure. These innovative cables carry three to five times more current than traditional power lines of the same size. Such a system was demonstrated in New York State in 2006, and Track says she expects more comprehensive demonstrations and implementations in 2007.

Track also talked about a wireless digital receiver, using superconducting electronics, outside of the laboratory. This breakthrough will ultimately lead to significantly improved wireless communication systems—in speed, accuracy, and data capacity.

**Are You an Egg or a Chicken?**

All of this technological advancement will put more pressure on identity management. Secure identity will be a key consideration, whether it is student IDs, faculty records, bursars’ office reports, computer access, bookstore purchases, or dining privileges.

Look for much of the responsibility for that security to fall to the people who, today, are keepers of many of the password–using technologies on campus.

Integration of systems, management of systems, and responsibility for security of systems all promise to be big headaches.

Disaster recovery and business continuity are related concerns. Avari says recent disasters like hurricanes Rita and Katrina pointed out that a data center on campus, no matter how strong, is subject to outage if a regional disaster hits. It is important to diversify a college’s data center at locations around the world.

AT&T has won several awards, including Frost & Sullivan’s 2006 Education Market Leadership award and the Campus Technology 2006 Innovator Award, for programs that help schools prepare for current and future needs.

**Security**

David Lambert, CIO at Georgetown, told the Verizon Summit that he spends over 50 percent of his time on security and privacy issues.

UCLA’s security breach at the end of 2006 was just such a large and widely discussed incident.
Elwell says that CIOs are quite concerned about alert or event notification. “Colleges are coming to grips with the fact that they have an obligation to protect the community—whether it is crime, medical alerts, weather warnings, or hazardous materials.”

He says schools have to be prepared to blast text messages, e-mail alerts, and voicemail to a variety of outlets. It has to be done over all forms of transmission media, whether landlines or wireless. It has to be able to blanket hundreds of thousands of people in a near-instant.

Add physical security on top of that. Many schools are assessing IP video surveillance equipment to protect students and staff. Schools have important locations to protect and monitor, ranging from stadiums to dorms, to areas where students normally congregate, to laboratories that are increasingly the target of activists.

Clinch says one key consideration in designing networks is keeping an eye on safety, security, and privacy. Another is looking to open-standards–based equipment.

Avaya will include monitoring equipment in its system that “sees” anyone on the network anywhere who dials 911. It allows authorized campus authorities to listen in on the 911 conversation, enabling campus safety, school administration, and resident assistants to respond promptly and knowledgeably to a situation.

Privacy will be a concern, as well, Clinch says, and encryption of all conversations—not just those made on high-end systems—will become standard.

Fiber Diet

Look for our network chicken of tomorrow to have a high-fiber diet. Worldwide optical network hardware revenue increased 4 percent between the second and third quarter of 2006, reaching $3.1 billion in 3Q06, according to Infonetics Research’s latest Optical Network Hardware report. The market is forecast to grow at a 9 percent clip and will reach $11.8 billion in 2009, according to Michael Howard, principal analyst and co-founder of Infonetics Research (Campbell, CA, www.infonetics.com).

“The optical hardware market has stabilized, with a likely pattern of slow growth in WDM and a slow decline in SONET/SDH after 2007. The overall market will continue steady growth, driven by the ever-increasing bandwidth use by consumers and businesses for video applications, mobile traffic, broadband, and IPTV,” he predicts.

He sees continued strong growth in IP traffic. Growth, often anecdotally cited by carriers as increasing 50 to 100 percent each year, will be led at the carrier end by broadband and IP VPN traffic. “Service providers are experienc-
IT Trends on Campus: 2012

Imagine the 2012 ACUTA Conference: Attendees attest that stress levels have hit new highs as IT deliverers are pinched between skyrocketing user demands and prices that have risen faster than revenues. Outsourcing networking looks like a “no brainer” to accountants, but technology professionals know that a campus sacrifices future progress and budgetary control when it contracts for services.

The best alternative requires being technologically astute yourself, partnering with neighboring institutions, and using associations, such as ACUTA.

Imagining a typical 2012 university network situation brings to mind scenarios involving a patchwork of expanding technological choices. There will be increasing pressure to operate and compete beyond the campus's physical borders. We will have financial challenges to do more with less and will need to deal with security threats without a visible change in services. We will feel pressure to satisfy specifications of regulatory requirements like HIPAA, FERPA, or CALEA. There will be pressure to change technology. And resistance to change could be crippling and disheartening.

There will be new disruptive technologies. They may come as a large-scale enabler of information access, processing, and manipulation. They may be services-based, as PCs and personal software were in the 1980s, or as the Web, laptops, and PDAs were in the 1990s.

Where should our institutions position themselves? With the financial pressure on business operations, IT must assess what technology mix fits. All institutions of higher learning have a primary mission: teaching. Some are research intensive, others outreach oriented. All have students, faculty, and staff with rising IT expectations and needs. No matter the size of one's rainy day funds or institutional endowments, only a limited number of “mink holes” (rat holes that feel good) can be explored without consequences to the health of the institution. Common sense dictates that we first consider the mission and goals of our particular institution/community. This assessment is further strengthened by a periodic

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Short-Term Challenges

Understanding the technology landscape and being flexible can keep your plans from derailing. Some challenges in the immediate future are:

- Security attacks from within and outside the network.
- Migration to Microsoft Vista.
- An economic slowdown will impact budgets for private and public institutions, retarding upgrades, and reducing staff and service offerings. Revisit “must have” versus “nice to have” services.
- Regulatory actions will mandate redirection of communications investments.
- Rethinking the in-source versus outsource decision when weighing attractive service offerings. These service offerings may delay deployment of a more robust service platform. An example would be a traditional service provider offering an attractive, low-cost, functionally adequate IMS platform for IP communications.
investigation of the needs and input from the university's main stakeholders: students, faculty, and staff. Consider, too, benchmark data from peer institutions.

Every campus should take an unbiased look at where it is investing, replicating, and duplicating IT-related services. Before retiring any sacred cows to make the funds available for needed upgrades, remember that sacred cows may be ingrained in the campus culture. Be careful!

Identifying Trends

Trends can be divided into many different categories, but for simplicity, we'll consider them in three primary types of media transport: voice, video, and the all-inclusive nondescript data.

1. Trends in voice transport: Service on top of the IP network

The use of the traditional PSTN loses ground to VoIP services, and even the copper lines are reclaimed for limited DSL traffic. The new landline installs drop, and dedicated copper backhaul to the central office is relegated to users requiring five-nines for safety or who mandate it in SLAs. Is five-nines overkill? Cell phones confirm that most users can tolerate and be satisfied with technology in the 0.93–0.95 reliability range.

VoIP, with the SIP IP communications platform, has become a public offering from commercial carriers. H.323 is drifting to the backburner. Like H.320, it will survive until legacy equipment is replaced. Yet, video telephony is an exception. It is still too complicated and unreliable for the added value it offers. Video phones will be a relative novelty in 2012, but the new infrastructure put into the campus then must support desktop and cell-based (or other untethered) video-level quality of service.

Cellular is the new mainstay for voice transport. Consider how much cellular bandwidth will be voice, given the growth in text messaging and video and data streaming. New technologies, such as gigabit wireless, are emerging.

Unified messaging and "find me/follow me" will be required. Emerging offerings incorporate a location or attribute balanced with a privacy flag for discriminating users.

Spam is waiting in the wings, often masked as advertising.

Everyone wants complete coverage and penetration of radio frequency (RF) inside buildings and to fill holes in areas surrounding the campus. Cellular coverage is the battle cry of the campus cybercitizen (broadband RF coverage expands to all usable wireless transport frequencies).

2. Trends in data transport:

The data network is the next primary utility joining the ranks of electric power, water, and sewer and the dying legacy of the telephone sector.

Ethernet will dominate network protocols. How many desktop PCs existing with ATM cards in them?
Trends in End-User Services

- We will see ownership of two personal IT devices (or component systems) at a minimum—one, a large display, spacious keyboard, robust speaker system; the other, a small, mobile, power-conserving, multi-radio (cellular, WiFi) PDA-like device. Personal area networks will grow, bringing more leakage, interference, security, and routing problems.

- Hardware communication devices will virtualize into soft devices. It is happening today with blade server farms, virtualization in SANS, and so on.

- Look for nominally central (but technically distributed) computational services, ranging from single-seat virtual laboratories, provisioning of classroom-sized computational services on demand, and research and teaching cluster-based computing services.

- Research-intensive campuses will deal with petascale resources (computational, storage and applications), or at least with outputs from those. Internal networks to specialized labs and external links must handle sustained 10 Gbps streams. Data storage demands will be huge.

Single-mode fiber will share the spotlight with untethered communications for data transport. The only fly in the ointment is power. In 2012, we'll still need power sockets in meeting rooms or airport terminals.

Or maybe not. Some are re-looking at Nikola Tesla's wireless power.

10 Gig links will be commonplace in network cores, and 100 Gig links will migrate (as the standard is finalized) from the data center to data center links, onto the institution core, and to the computational backplanes.

Campuses with CAT6 copper to the desktop are okay for the next 20 years, so long as there is "light" to the nearest campus closet. It is unlikely that desktop-tethered devices will routinely need more than 1 GBps connections.

The continued decrease of "network neutrality" will invigorate the increased deployment of additional physical pipes (mainly fiber) and the increased use and creation of multiple logical pipes (such as MPLS or separate optical paths).

Security and spam will be treated with a serious and integrated approach by 2012. In 2012 we will see much more sophisticated spam attacks and security issues.

IPv4 will dominate through 2008. By 2012, accumulated pressure from the federal government and companies like Microsoft will push products that have higher utilization of IPv6.

Seamless interoperability of applications with both IPv4 and IPv6 protocol stacks will be a challenge, particularly when looking at end-to-end communications for client-server operations.

Almost everything will be digital. The need to mine data will create a thirst for dense, cheap storage and large data throughput links.

A true "grid" will emerge: University clients will not only expect utility-like network access, they will want utility-like access to any applications and storage they require.

Virtualization of resources will be the norm. End-to-end performance will be the overriding criterion of the ability of a campus to serve customers.

Service-oriented architectures and IT-based services will be the norm. Data transport will have to operate with high reliability.

3. Trends in video transport:
- Video, like telephony, will become another service on the IP network.
- Digital rights management (DRM) will be a challenge for product developers and systems integrators. Content owners will ratchet up DRM requirements well beyond what is done in the audio arena.
- By 2012, legacy CATV systems will be phased out on most campuses. Total cost of ownership (TCO) analysis will mandate the replacement of the cable plant with a digital, and then IPTV-based service.
- Need for network proxy services like Akamai will increase, as will use of multicast.

Interactive video component streams will press SLAs harder for deterministic, low-latency service offerings in the converging data networks. This will add pressure for higher-powered network processors, more intelligent buffering schema, smarter network designs, and protocol enhancements.

Where Do We Start?

What do these trends and predictions say about campuses' imminent choices?

Campus IT leadership should communicate with all stakeholders,
Imagine your institution in 2012. New technologies, new obstacles, new regulations... You need a trusted communications provider to lead your IT/Telecom organization to future success.

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Higher_Education@paetec.com
www.paetec.com
What's Working Now that Won't Last?

- MAC (moves, adds, and changes) methods for phone service will be replaced with user-web interfaces for instant changes.
- Ability to charge for telephony service will be replaced by charges for the network and value-added services.
- Voicemail will be all but extinct. The dominant message-forwarding mechanism will be IM and unified messaging.
- Network neutrality outside the campus. Replacements will be national or international networks owned by consortiums.
- The old Internet. The new Internet or Internets will have the same service challenges as legacy national monopolies. There will be stratified service levels at higher costs. A network-neutral service will be a best effort.
- Network architecture. A single physical network for voice, video distribution, or data transport will be replaced by multiple logical networks on a single physical network. Look for separation of logical IP layers utilizing multiprotocol label switching (MPLS), multiple VRFs within a campus network, and multiple optical links via some wave division mechanism to better utilize the fiber plant.
- 911 service. Traditional 911 service will be replaced by more flexible systems, taking into account updates outside the LEC or geographically assigned PSAP, to satisfy the challenges brought about by mobility and geographically remote campus outposts.

Invest in good network management tools; work smarter, not harder. Keep a finger on the pulse of communication flows and the types of content being pushed.

Make sure applications that require low loss or latency can achieve this end-to-end in the network. Align the IT workforce with skill sets that are network-centric, specifically in IP communications. Transform this skill set to match needs for networking operations and applications based on e-services. Minimize vendor numbers, but keep several in your vendor stable.

Formalize the communication business model with an accounting metric that corresponds to the services offered; a good metric matches a utility-funding model.

Adopt a set of base IT communication services for the university funded independently from departmental budgetary controls. Give all business units and departments an equal chance at success with basic IT services like 10/100 Ethernet ports, voice lines, unified messaging, or wireless.

Design your network with fault-tolerance and compartmentalization.

Develop a comprehensive disaster mitigation and recovery plan.

Develop extensive in-building broadband wireless RF coverage (both to support cellular and to support broadband RF and WiFi).

Sensors will be everywhere. Whether it is an RFID-like device, a device calling home, an event parameter that needs to be studied, or some other form of information that needs to be stored, it will be digitized in real time and data-mined later.

The overriding trends are clearly toward convergence of multiple communications transport systems into the IP network. We are a digital world, and the network is the computer. The campus that starts now can prepare itself for 2012.

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Author's note: I would like to thank the thoughtful additions and corrections to this piece from Dr. Mladen Vouk and Dr. Henry Schaffer, both at North Carolina State University.
Best Practices in Deploying a Successful University SAN

IT departments at many universities are struggling to meet a growing demand for fast, secure access to distributed data. For Long Island University (LIU) and the University of Minnesota, that problem became history when they implemented a storage area network (SAN). A multiprotocol SAN at each school now meets the daily high-speed data-access needs of students, faculty, and administrators while supporting innovative applications such as online registration.

Two Schools, One Set of Storage Needs

Planning and deploying a SAN at a university is an especially challenging process because the data-storage requirements tend to be so large and so varied. Mission-critical business data must be available at all times, sensitive data such as student records must be protected from unauthorized access, and the data required for high-performance scientific applications must be accessible without delay. And that’s just a sample of a single day’s storage-access requirements. Universities must also plan for the future by maintaining a scalable storage environment that supports cost-effective growth as more and more activities call for online resources.

The IT departments at LIU and the University of Minnesota knew that they needed to improve their data-access capabilities and position their schools to manage even more extensive storage demands. The University of Minnesota–Twin Cities campus had two centralized storage facilities and multiple departmental systems. These islands of storage were reliable but not scalable. Sharing the data with systems that were not directly connected to each storage device was also difficult, as was moving the data between the storage islands for backup and recovery.

LIU was using mainframe-based storage systems that were not entirely reliable and were difficult to scale, support, and upgrade. Disaster recovery for the disparate solutions was cumbersome to manage because separate backup and recovery applications were required for each system. The school needed a scalable, centrally manageable storage system that was easy to use to support its new enterprise resource planning (ERP) system, which included payroll, human resources, and online registration applications.

Planning Is Critical

Careful up-front planning is critical to designing and deploying a SAN that cost-effectively meets current needs and that readily adapts to expanding requirements. The primary issues that both schools addressed in the planning phase were:
Performance and scalability. SAN performance is determined by factors such as the number of servers in the network, the number and types of applications requiring storage services, the number of users accessing the data, and the available bandwidth. Combining this information with projected enrollment and budgetary growth helps storage network designers create solutions that will support a university’s needs while maintaining sufficient performance. This information also helps designers create a scalable network topology using the most cost-effective storage products.

Investment protection. Creating a new storage environment requires a significant investment. Universities must protect that investment with a solution flexible enough to support a variety of storage devices, network protocols, and server platforms.

Data replication and migration. One of the most important factors in planning a storage solution is addressing how the data will be moved between platforms for backup and recovery operations, and during upgrades to higher-performance systems. Unlike many businesses that have limited or no operations at night or on the weekends, universities must supply students with continuous data access. SAN designs should minimize the downtime required for data replication and migration in order to limit disruption to students.

Availability. The storage network must provide continuous data access, even through individual device failures. Storage network designers can increase availability by creating a redundant design with backup and recovery features and a disaster-recovery capability.

Security. With multiple applications and data residing on the same physical storage network fabric, data security is critical. Applications and departmental data must be separated and made accessible only to authorized users. In addition, the solutions must comply with university privacy policies and government regulations.

Manageability. Universities are vital, growing, changing environments, and university SANs should be designed to readily adapt to new technologies and data-access requirements. Ease of management is extremely important in this dynamic environment.

Total cost of ownership (TCO). Universities should consider long-term operating costs as well as the initial cost of deploying a SAN. Some features that increase the initial capital expenditure (CapEx) will reduce operating expenses (OpEx) over the long term, making them a good investment for universities.

Design Considerations
Carefully analyzing a wide variety of planning criteria led both LIU and the University of Minnesota to implement dual-fabric Fibre Channel SANs using virtual fabrics. The SAN fabric is the network that connects PCs and servers to storage devices. A physical dual fabric provides redundancy that offers data access even when some network components are unavailable.

A virtual SAN (VSAN) fabric logically segments the single physical Fibre Channel network into logically separated multiple networks. This technology maintains physical connectivity among all the storage devices throughout the university, so authorized users can access data from any network location. At the same time, the logical separation provides security by allowing each virtual fabric to be managed individually, with appropriate access and security features.

Resource sharing is another advantage to virtual fabrics that is very helpful for universities. Physical resources such as ports can be configured into different logical segments to meet utilization requirements by balancing resources. Even though the data are separated into segmented, protected virtual fabrics, each fabric can also share expensive resources such as tape libraries by virtual fabric routing. The ability to share resources also provides a higher level of investment protection and the flexibility to adapt to changing storage needs.

In addition to the dual-fabric design, many SAN features can contribute to a secure, scalable network with high availability and high performance. These features include:

Fault isolation. Separating storage devices into logical networks prevents the faults caused by device failures from propagating throughout the entire physical network.

Traffic management. Universities often have labs with high-performance computing clusters for scientific applications that require very fast I/O access to data. A traffic-management capability can provide a dedicated path for storage access or determine which shared path minimizes bandwidth conflicts and optimizes throughput and latency.

Multiprotocol operation. The Internet Small Computer System Interface (iSCSI) protocol is often used with a Fibre Channel SAN, as it
supports location-independent data storage and retrieval over LANs, WANs, or the Internet, using routing and other IP management features. It provides storage access from a server network interface card (NIC), reducing the need for purchasing the Fibre Channel host bus adapters (HBAs) that would be required for the Fibre Channel protocol. Fibre Channel over TCP/IP (FCIP) is an appropriate protocol for moving data between SANs across a WAN, and it is often used as a SAN extension technology. Because FCIP uses the IP infrastructure to transport Fibre Channel traffic, it can be used for data replication and disaster recovery without the expense of adding an optical network with SONET or even dense wavelength division multiplexing (DWDM) technology. The ability to support both iSCSI and FCIP creates an efficient and cost-effective SAN environment.

- **Oversubscription.** Oversubscription lets multiple servers each access shared storage devices through shared network bandwidth at peak performance at different times. This design provides high-performance operation with fewer SAN devices, which reduces the total cost of SAN ownership.

- **Role-based access control.** RBAC creates roles for various job functions, assigns the permission to perform specific tasks to each role, and assigns roles to each employee per virtual fabric base. Changes to permissions are applied to the role, and those permissions are automatically granted to any user with that role. This simplifies storage-management security by eliminating the need to assign and manage permissions for individual users.

- **Control plane scalability.** This capability reduces forwarding com-

plexity by using a single switch with high port density instead of multiple switches. Multiple-switch configurations require an interswitch link that connects the switches and manages the associated routing capabilities. That configuration adds latency and potential points of failure to the network. Using a single switch with high port density on the control plane is a more easily manageable and scalable solution that reduces costs and increases reliability.

**University of Minnesota SAN**

In 2003, the University of Minnesota created a dual-fabric SAN that spanned two on-campus data centers. The virtual fabrics let administrators perform centralized backup while isolating failures to prevent them from affecting multiple departments. The virtual fabrics also support segmented storage access, so each department can access only its own data. Early success with this environment encouraged the IT staff to move its mission-critical business applications to the SAN. This move was also successful, resulting in improved data availability, data protection, performance, and storage-provisioning flexibility for high-profile applications.

The university then looked at using the two data center SANs for disaster-recovery capabilities and at expanding the simple SAN topology to a core/edge design to accommodate even more applications and data. Keeping
the dual-fabric design, the university deployed a core network with edge switches in each data center's fabric. This design replicates data in real time at both sites, so each data center can function as a disaster-recovery site for the other, providing greater data security and business continuance.

In 2004, the university expanded its storage network to include a third campus. With a triangulated relationship among all three campuses, the SAN can continue functioning despite a failure at any one site or any set of paths between the sites.

Today's environment includes approximately 300 terabytes of storage, 500 ports, and 110 hosts attached to the SAN. Hosted data include student material, data warehouses, imaging applications, and research databases. Business-critical applications, such as registration, e-mail, and library systems, are given the highest priority and the fastest service. Applications and data that do not require the same high performance levels are connected through an oversubscribed network to slightly slower, less-expensive devices.

**Long Island University SAN**

In September 2005, LIU began a five-year project to update its storage systems by implementing a dual-fabric SAN to support its 28,000 students and 700 full-time faculty members. The SAN links identical ERP deployments at its Brooklyn and Brookdale campuses. Data is passed between the campuses using an FCIP tunnel to provide high-speed connectivity over the long distance. This feature was important to LIU because the university wanted to store redundant copies of the ERP data at both locations and eventually allow users to access data across the network.

With the SAN in place, LIU is adding ERP modules one at a time, with rigorous testing to ensure performance and reliability. Once the ERP system is fully deployed, the SAN will enable remote data mirroring between the sites so users can access data and applications from either site. Mirroring data will provide business continuity and disaster-recovery capabilities if one site becomes unavailable.

The new ERP system and storage network will help LIU stay competitive by offering the applications that students expect of a high-caliber school. For example, when all the ERP modules are in place, students will be able to access their records to see what classes they've taken in the past and what requirements they need to graduate.

Students will also benefit from the behind-the-scenes administrative advantages of added security, availability, and scalability. The networked storage system will provide the business continuity that the university needs to safeguard operations and the scalability to meet the business needs and increasing storage requirements of a growing student population.

**Future Trends in Storage Networking**

Trends in storage networking mirror many trends in computer networking. Like other network users, universities want fast, secure storage services that are cost-effective and easy to manage. Many SAN services are now being developed to address these requirements. For example, a continuous data protection (CDP) service will back up data as they are stored, instead of requiring a planned backup window that may disrupt user service.

In the future, the SAN infrastructure may also provide automatic provisioning for storage resources. With continuing data and network growth, tools that dynamically provision storage resources will become critical to maintaining IT staff productivity. Other tools that support storage virtualization and that align network and storage services to servers and applications will further optimize IT resources. Many of these tools and features will eventually be embedded in the SAN infrastructure.

And of course, faster will always be better. Today's 4G technology will soon give way to 8G. Data-access demand and data-volume growth will determine how quickly port speed technology evolves.

Both academic life and the business of higher education are increasingly dependent on intelligent networks and access to stored data. Universities can best address their storage needs by analyzing their requirements and investing time and effort into careful planning before implementing a SAN. The resulting fast, secure, and scalable storage environment can also provide a competitive advantage by attracting top-quality students and faculty and by helping administrators work more efficiently.

Tuqiang Cao is a senior technical marketing manager at Cisco. He has worked for the Datacenter Technology Group at Cisco for six years and previously worked at EMC Corporation.
Michael M. Crow became the 16th president of Arizona State University on July 1, 2002. He is guiding the transformation of ASU into one of the nation’s leading public metropolitan research universities, one that is directly engaged in the economic, social, and cultural vitality of its region. Under his direction, the university pursues teaching, research, and creative excellence focused on the major challenges and questions of our time, as well as those central to the building of a sustainable environment and economy for Arizona. He has committed the university to global engagement, and to setting a new standard for public service.

Prior to joining ASU, he was executive vice provost of Columbia University, where he also was professor of science and technology policy in the School of International and Public Affairs. He played the lead role in creating the Columbia Earth Institute (CEI), and helped found the Center for Science, Policy, and Outcomes (CSPO) in Washington, D.C., a think tank dedicated to linking science and technology to desired social, economic, and environmental outcomes. In 2003, CSPO was reestablished at ASU as the Consortium for Science, Policy, and Outcomes.

A fellow of the National Academy of Public Administration, he is the author of books and articles relating to the analysis of research organizations, technology transfer, science and technology policy, and the practice and theory of public policy.

Interview
Michael M. Crow, Ph.D.
Arizona State University

ACUTA: How would you define sustainability? On the university level, how does a sustainability focus differ from current thinking? How does a campus go about making sustainability a core principle?

Crow: Sustainability is the redefinition of the human-environment relationship from the polarizing one of the 1960s and 1970s, when one needed to take a side: either for the environment or for development. Humans are critically important actors on this stage we call planet Earth. We are driven to develop economically, build, industrialize, and so on, but in order to survive as a species, we must conduct our affairs in a way that we do not destroy the very capacity of the Earth to sustain life. To ensure the quality of life on this planet for our generation, and all future generations, we must deploy alternative, regenerative systems that meet the needs of both human and ecological systems without compromising the ability of these systems to meet the needs of all future generations. To be truly sustainable, human actions must reflect not only what is important to us—qualities such as clean air, clean water, health, security, and prosperity—but also must take into account the needs of all living entities and the planet itself.

Science, engineering, policy, and environmentalism alone cannot provide the intellectual regime and the skill set needed to tackle the issues presented by society. After taking a serious look at the intellectual design of the knowledge-creating and educating enterprise called the “university,” ASU is restructuring this enterprise to better address these complex issues. We are addressing sustainability as an accepted discipline by asking how we, as a major research university, can advance our civilization economically, competitively, and socially while maintaining a vibrant, productive Earth for future generations.

We are identifying the problems, not in terms of disciplines—most often, current disciplines do not match the complexity of solutions needed to address current problems. Nor are we laying out a rigid, unchanging plan. Instead, we are looking at sustainability as a central theme, a focal point, a gathering point around which we are creating a design approach. Interdisciplinary collaboration, flexibility, and partnership opportunities, both internally and externally, are key components of this “New American University” design.

Through these key components, we are able to broaden the scope of the institution, to shift the culture of the university from one of a traditional, single-discipline approach to one of an innovative, collaborative, adaptive, solution-focused approach. This approach enables us to envision and design cities, enterprises, and communities that are fully and actively engaged in sustainable practices and, most important, ensure a livable,
What is needed are new, innovative means of exchange that mirror the innovative, flexible nature of technology itself.

viable planet for a perpetual future. It enables us to include dozens of disciplines, dozens of approaches. In doing this, we believe that we are creating an environment that encourages new creativity and new perspectives. We are creating greater opportunities for intellectual engagement, opportunities that do not exist solely in the past but that encourage a whole new paradigm. We are not simply replacing or updating existing systems.

ACUTA: Does communications technology contribute to environmental problems on our campuses? If yes, in what ways? Is it also currently a part of the solution? If so, how; if not, why not?

Crow: Communications technology can contribute to environmental problems through inefficiency generated either by improper planning results or obsolete technologies. It can be a powerful tool, however, for solving a variety of environmental, cultural, and societal problems. New technologies encourage participation in community and global partnerships and enhance collaborative opportunities by eliminating the need to travel and avoiding the generation of carbon emissions; they improve the efficiency and delivery of basic services, thereby decreasing energy consumption; and they promote accountability among decision and policy makers by providing ready access to a wealth of information.

ACUTA: What is the chief obstacle to sustainability from the perspective of the communications technology provider on campus? How might we overcome that?

Crow: There are two potential obstacles for communications technology providers that are closely interrelated. The ever-changing, rapid innovation of technology makes it difficult for providers to plan for the most efficient, most sustainable use of technological advances, which, in turn, creates economic concerns and funding challenges.

Mapping traditional methods of exchange onto new technology has proven to be ineffective in addressing these challenges. What is needed are new, innovative means of exchange that mirror the innovative, flexible nature of technology itself. This works best in a collaborative atmosphere that highly values and supports open communication and creative processes.

ACUTA: Have you noticed any trends in the attitudes of students toward sustainability? Do the students of today differ in their perception of the importance of environmental issues from those of their predecessors, and has sustainability become part of the student culture?

Crow: I believe today’s students do indeed look at sustainability and environmental issues differently. In the past, human systems were removed from the natural ecosystem as a way of protecting it. We have come to realize that this way of thinking has, in reality, harmed the natural environment rather than protected it, and students are becoming more aware of their interrelatedness to nature. They no longer think of themselves as a separate entity but as an integral part of the natural system. The students of today recognize that their world is much smaller ... in some ways, more “personal,” with now over 6.5 billion people sharing space. Globalization and the Internet add to the intimate nature of our existence, with everyone’s actions affecting the others. Students have embraced concerns about climate change and see themselves playing integral roles in finding solutions to this, the most important environmental challenge humanity has ever faced.

That students are becoming much more aware and involved in a myriad of sustainability issues can be seen at university campuses around the world. Following is a very small sampling of these initiatives:

- In the United States, student organizations are being formed at large universities such as Harvard, the University of California, the University of Florida, as well as at smaller colleges such as Bowdoin.
- In Canada, students at the University of British Columbia are appointing Sustainability Ambassadors to
raise awareness of the Sustainability Pledge through outreach in order to encourage socially and ecologically responsible decisions.

- In Australia, the Adelaide University Greens club, Greenery, brings together students who share the Greens principles of peace and non-violence, social justice, participatory democracy, and ecological sustainability.

- In the United Kingdom, students at universities such as Cambridge are forming groups like CUSU Green, which is the part of Cambridge University Students’ Union that focuses on the environment, social justice, and development. It aims to promote awareness of these crucial issues to the student population and empower students to act upon them in a number of ways.

- In China, the Environment Protect Association is a student-based social-practices organization dedicated to ecological issues.

Indicators at ASU include the interest generated by the recent opening of the School of Sustainability at Arizona State University, which has had more than 80 applicants for the fall of 2007, and by increasing volunteerism exemplified in the Peace Corps recent annual report, in which ASU moved up 16 spots to debut at number 19 on the large-schools list. ASU student organizations and individuals are also taking the initiative in organizing a student coalition to address sustainability issues. ASU’s Barrett Honors College is planning a Sustainability House, initiated by students, where students can live, work, study, and play while exemplifying sustainability principles.

Another major difference is that environmental issues are no longer identified as simply ecological issues but now involve a much more holistic system that incorporates social and cultural as well as economic issues. Sustainability is becoming more important to younger generations as they place themselves back into the
ecological system rather than seeing it as a means to an end. It is becoming an important aspect of their conversations, their culture, and their ethics.

**ACUTA:** Increasingly, the technology landscape of a campus is an important consideration for prospective students. What technology applications set ASU apart from the students’ perspective? Of what recent or current technology project(s) on your campus are you most proud? What can you tell us about it/them?

**Crow:** ASU’s Decision Theater offers an arena with world-class capabilities where scientists and communities come together to visualize possibilities and realize solutions. The theater provides a set of tools for policy makers and the community to participate in immersive, collaborative decision making—to visualize the future through different scenarios. It is far more than just a place; it offers a variety of customized capabilities that can be used inside or outside the Decision Theater facility.

The theater consists of an interactive 3D immersive environment built with cutting-edge graphics technologies. The core component, called the Drum, is a 260-degree faceted screen that can display panoramic computer graphics or 3D video content. The Drum accommodates up to 25 people and includes tools for collecting participant input and interaction. This advanced environment enables individuals to see a detailed 3D representation of the consequences of behavior, decisions, and policy in order to examine potential future scenarios in new and exciting ways.

The Decision Theater creates an ongoing confluence, a place where researchers and policy makers can meet and share their perspectives on an ongoing basis. This ongoing dialog allows policy questions to more effectively shape the research agenda, and provides a way for research, simulation, and modeling to inform the public debate in a much more integral way.

**ACUTA:** In addition to sustainability, what changes would you like to see technology bring to the ASU campus in the next 5 years? In 2007?

**Crow:** Our goal for this year and the next five is for high-quality science and technology, which is fully integrated within ASU, to expand beyond the university, becoming instrumental in finding solutions for societal needs. I believe that, taken together, life sciences, physical sciences, and engineering can improve the human condition. The arts, humanities, social sciences, and engineering can create new art forms, develop experiential media systems, and enhance communications. Only research that goes beyond organizational parameters will truly meet the complexity of real-world challenges.

In addition, technology will be instrumental in fully integrating collaboration among ASU’s four campuses in metropolitan Phoenix, each representing a planned clustering of related colleges and schools, to realize our goals of being one university in many places.

As ASU continues to pursue excellence, expand access, and deepen its impact on the community, technology will play an increasing role in learning, discovery, and the connection between ASU and its surrounding community. Technology will deepen the connection between the institution and its various stakeholders, transcending limitations of time and space.

**ACUTA:** In a recent survey conducted by the Council of Higher Education Management Associations (CHEMA), respondents identified these as the top three strengths that will enable higher education to succeed in the future: the ability to innovate, a strong sense of mission, and capable executive leadership. As the president of a major university, do you agree with this conclusion? If not, how would you disagree?

**Crow:** Yes, I do agree. My vision is for ASU to serve as the prototype for a New American University, redefining the existing conception of research universities. We are building a comprehensive metropolitan research university that is an unparalleled combination of academic excellence and commitment to our social, economic, cultural, and environmental setting. This vision provides our stakeholders with a strong sense of mission while creating an innovative culture of academic enterprise that breaks from traditional disciplinary and organizational constraints and allows the university to harness its knowledge in new ways.

**ACUTA** expresses our thanks to Dr. Crow for sharing his time and expertise with us and for offering his perspective on an issue that will surely be of increasing importance in the years to come.
Beyond Convergence: How Advanced Networking Will Erase Campus Boundaries

Douglas E. Van Houweling
President & CEO
Internet2

When aspiring professional cello player Andra Lund walked into the practice room at the New World Symphony in Miami, Florida, last spring to begin her master class, she greeted her coach, Steven Geber of the Cleveland Orchestra. As she played, Geber offered Andra suggestions about phrasing nuances and bowing and fingering technique for particularly difficult passages of the Handel Concerto for Cello and Orchestra and the Rossini Overture to William Tell. All of this would have been rather unremarkable except that Geber was 1,000 miles away in Cleveland, Ohio, and the student and coach were working together using a DVD-quality videoconference link.

Internet Collaboration is Growing

Five years ago, students studying at the New World Symphony had to wait for visiting coaches and guest artists to work with them, because the technologies to support high-quality, real-time collaboration were not generally available. Today, however, the New World Symphony is increasingly using advanced Internet technologies to provide high-fidelity video and audio links between its campus in Miami and music schools around the country. These connections provide the visual and aural resolution required by coaches from renowned metropolitan orchestras and faculty from major music programs to support rich interaction with their students. The New World Symphony is also looking to move to HD-quality video and CD-quality sound.

Of course, using networking technologies to support collaboration among increasingly distributed communities of students, faculty, and staff is neither new nor isolated in academia. As a recent report from the University of California's systemwide IT Guidance Committee noted, “Nothing is more fundamental to UC than collaboration, both in research and in education.” Supporting that statement, the UC IT Guidance Committee set forth an objective of making desktop videoconferencing “as ubiquitous as telephones.” These new capabilities represent more than simply a quantitative change; advances in network technology enable individuals to work in qualitatively new ways.

Groundbreaking scientific research and discovery increasingly depends on advanced networking. One of the largest experimental efforts in physics today is centered on the Large Hadron Collider, located in Switzerland, and requires rapidly transmitting data generated by this instrument to thousands of physicists at laboratories and universities around the world. Radio astronomers are linking dozens
of individual observatories into earth-spanning virtual telescopes. These endeavors are exemplary of scientific collaborations that rely on moving massive amounts of data—hundreds of times the capacity of a typical desktop hard drive—in real time or near real time across multiple networks among end points at multiple organizations. Established methods of downloading datasets or shipping magnetic tapes are simply no longer sufficient; networking has become integral to the ability of researchers to complete their most ambitious experiments.

Two Technologies Accelerate Progress

Large-scale and ubiquitous collaborations across organizational boundaries, and the expanding capability of networks to enable them, are self-reinforcing developments that are contributing to the blurring of institutional boundaries. Looking ahead, there are two technologies in particular that have the potential to accelerate movement in this direction. The first is on-demand, customized network connectivity; the second is federated authentication and authorization. Members of the Internet2 community in the United States are increasingly deploying these technologies, as are partner organizations around the world. These capabilities are beginning to catalyze thinking about the next round of Internet-based innovation and invention, just as the fundamental protocols of today’s Internet sparked the development of applications such as e-mail and the Web.

1. Network connectivity. On-demand, customized network connections are now enabled by optical network technology that allows the flexible provision of dedicating bandwidth between two points on the network. The Internet2 community will have access to circuits that can vary in bandwidth from dozens of megabits to 10 GB, be scheduled in advance or made available on demand, and be agnostic to different applications or protocols. These dedicated circuit-based capabilities will complement existing Internet protocol capabilities, forming a hybrid set of services that can be requested, provisioned, and used based on the needs of a user or an application.

   Over the past few years, Internet2 university members and regional advanced networks in the United States have been installing the optical networking infrastructure needed to support these dedicated circuit capabilities. The Internet2 community, including corporate members and international partners, has also been engaged in efforts, such as the Internet2 Hybrid Optical and Packet Infrastructure project, to develop and test these network technologies. By the beginning of the 2007 academic year, the nationwide Internet2 network will implement these hybrid capabilities. The network will initially provide 100 GBps of optical capacity but can be scaled to provide nearly unlimited bandwidth.

2. Federated authorization. Federated authorization capabilities allow local authentication services to provide single sign-on access across organizational boundaries to network-connected resources. For example, federated authorization allows easy and secure use of the on-demand network circuit capabilities by authorized users, while ensuring against oversubscription or misuse of network facilities. And because resource providers do not need to provide their own authentication infrastructure, federated authorization is easier and more cost-effective for them as well. Federated authentication has already been deployed across countries such as Switzerland and Finland. It is also becoming more broadly deployed at institutions in the United States through standards-based Shibboleth technology, the development of which was supported by Internet2 and the National Science Foundation, and by participation in federations such as InCommon, which is operated by Internet2.

   Moreover, academic-focused resource providers, such as EBSCO Publishing and Elsevier ScienceDirect, are enabling access to their services via federated authorization technology. Blackboard, WebAssign, and many other academic software and service providers are incorporating Shibboleth technology into their products or providing federated authorization for access to their online services. Federal agencies are exploring this technology as well. The National Science Foundation’s online grant submission and management system, FastLane, recently demonstrated Shibboleth compatibility. Similar capabilities are being explored by a number of other federal agencies. This broad adoption of federated authorization will enable ubiquitous access to both the hybrid network and the applications it serves.

A Campus for the Net Generation

   These technologies and applications, combined with students’ increasing experience and ease using networking capabilities, will fundamentally reshape the “campus” of the future. Many people have observed that the early adoption by higher education of Internet technology during the 1980s and 1990s spurred its spread to business and the development of the broader Internet community. Today, the flow of experience is coursing in both directions. While it is
still true that universities often offer capabilities that are not available on the commercial Internet, it is also true that capabilities available in the broader Internet are forming expectations within and among campus communities.

Students entering higher education today have grown up with information technology. This “net generation” has long experience with and expectations about the kinds of online tools they are able to use. Blogs, wikis, chat rooms, instant messaging, Web-based group calendaring, voice over IP, and IP-based videoconferencing are integral to these students’ everyday lives. As a result, students’ concept of collaboration is not place-bound. They are comfortable engaging in simultaneous collaboration with multiple people. Using multiple means, they engage with others, irrespective of physical place. They are comfortable assembling their own media objects and sharing them. A growing number of incoming students have established online presences in MySpace or more targeted social networking sites, such as Facebook, or have developed personae in massive multiplayer online games or virtual worlds, such as Second Life.

Student familiarity with commercially available Internet-based services is also already shaping how institutions implement IT infrastructure and capabilities. For example, universities are enlisting companies to provide perhaps the most prominent institution-related aspect of online identity—institutional e-mail accounts—through services and infrastructure not directly managed by the institutions. This past fall Arizona State University joined institutions that have partnered with Google, allowing its 65,000 students to use Google Apps for Education. These applications include Gmail to manage ASU student email accounts, Google Calendar and Google Talk to support online collaboration, and 2 GB of online storage for each student. Through this association with Google, ASU benefits from Google’s development and deployment of new Google services. Even leading-edge research efforts, such as TeraGrid, are discussing the possibility of leveraging commercial services, such as storage and computing clouds provided by Amazon.

Thus, two trends—the increasing availability of today’s advanced networking capabilities, and students...
and institutions that rely on network services that are unbound from place—will reshape campuses over the coming five years. These mutually reinforcing trends are not only causing schools to rethink how they support collaboration within and beyond their campus community, but also are compelling them to reexamine fundamental definitions of their institution. The combination of network-connected resources, the advanced network and authentication infrastructure needed to access them, and the human capital needed to take advantage of them has come to be called cyberinfrastructure.

The Cyberinfrastructure Framework

Cyberinfrastructure is serving as a framework for how many institutions, including research agencies, think about the networking capabilities needed to advance research and education. To support the development of these capabilities, the National Science Foundation has formed an Office of Cyberinfrastructure, and, in late 2005, the American Council of Learned Societies completed a study on cyberinfrastructure requirements for the arts, humanities, and social science disciplines. Within the Internet2 community, a task force to define the characteristics of tomorrow’s campus IT infrastructure urged Internet2 members to position themselves strongly behind these cyberinfrastructure concepts and enable them.

The strategic challenge presented to institutions of higher education by the evolution of cyberinfrastructure over the next five years and beyond is to create a social and technological environment that supports unbound collaborations. This challenge includes networking technologies that provide an increasingly rich set of capabilities to users and communities made up of individuals that are distributed across many organizations. New forms of networking-supported collaboration will bring new opportunities for students and faculty to learn and work. Instead of being solely defined by physical boundaries, collaborative communities will emerge as meta-campuses, alongside and within traditional colleges and university campuses.

Of course, as networking capabilities and network-accessible resources increase in importance to an institution’s communities, network performance, reliability, and security will become even more critical. Thus, a secondary effect of these trends will be that institutions need to invest additional energy and resources to monitor, identify, and adapt to issues that may hamper or disrupt their own cyberinfrastructure. Furthermore, because networks will be more interdependent, campus network and IT management and staff will need to work closely with state, regional, national, and even international networks, as well as resource providers, that connect the larger virtual campus communities and provide the services upon which they rely.

Looking Ahead

Today’s Internet is built on technological foundations more than 30 years old, and many of the applications we use today were initially developed to facilitate collaboration among the academic community around the world more than a decade ago. Since its inception, the Internet has supported rapid innovation and change. The increasing set of network-capabilities available to users, and the increasing capability of users to take advantage of them, combined with a continued explosion of applications, will lead to a qualitatively different Internet environment and present new fundamental challenges to how institutions of higher education are organized. The leader responsible for campus cyberinfrastructure therefore bears a heavy responsibility for ensuring their institution is prepared to take advantage of these changes. Critical questions include:

- How can the campus best obtain access to hybrid network capabilities?
- How can students, faculty, and staff gain access to federated authorization?
- How can the institution take advantage of commercially available applications?

Today, musicians at the New World Symphony are able to provide and receive world-class coaching to students and from coaches around the United States, sometimes without ever meeting them in person. This has enabled members of a community to collaborate in new ways that, until recently, the Internet was unable to support. Five years from now, the New World Symphony student may very well have many hours of high-definition videoconferencing under her belt long before she steps into a practice room in Miami to work with a remote instructor. Even more important, these technologies will provide access to similar applications for research and learning in all disciplines. Will your institution be prepared for this future?

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Distributed Computing: The Path to the Power?

On today's campus, the center of all computing converges on the desktop — connected to a world that includes mobile computing, LANs, VLANs, WANs, client/server systems, remote servers and labs, other desktop systems, and the Internet. Many desktop PCs are better equipped than some computing centers were only a few years ago. With all this power distributed to individuals, it only makes sense to consider ways to tap into that computational potential. Distributed computing may be the path to that power.

Distributed computing represents more than just a trend for the future. It has potential as a practical solution to the ever-increasing need for computational power to make sense of the terabytes of data gathered or generated daily, which must be analyzed and interpreted to be useful.

What Is Distributed Computing?

Back in the 1970s, distributed computing meant using many computers in an organization, rather than one centralized computer system. Instead of single-purpose terminals connected to a mainframe, multipurpose minicomputers were deployed. The current definition of distributed computing is working on large computational problems by sharing CPU resources across a network, essentially creating one large supercomputer. Idle time, or unused CPU capacity, is allocated to an application that is both computationally intensive and programmed for parallel processing. This version of distributed computing is often referred to as either peer-to-peer computing or grid computing.

Distributed computing and parallel processing are similar in concept, but very different in practice. Like distributed computing, parallel processing ties together the processing power of more than a single CPU. However, in parallel processing, the CPUs are harnessed together by very fast bridges and technology that efficiently divides the work between them. Even using less-sophisticated (slower) processors, it is possible for the speed of the processing unit to exceed the speed of a much faster CPU with processing power in excess of the combined speeds of the individual CPUs in the parallel unit. Distributed computing harnesses the unused computing power of many separate CPUs, but is limited by both the intermittent availability of the participant processors and the speed of the network connection.

Perhaps the most familiar distributed computing example is the SETI@home project, in which individual computer users offer some of their unused CPU processing cycles—even while still using their computer—to download and
search radio telescope data for the Search for Extraterrestrial Intelligence (SETI) project. I participated in this project in 2003 and 2004 and very much enjoyed the special screensaver, which showed my computer hard at work on the SETI project while I was having lunch or in a meeting. Despite barely noticeable effects on my own computer usage, this project has sustained incredible computing power—a 60 Teraflops processing rate—for years.

Approximately 1 million hosts participate voluntarily on BOINC (Berkeley Open Infrastructure for Network Computing)–based projects, Great Internet Mersenne Prime Search (GIMPS), distributed.net, Folding@Home, Grid.org, and World Community Grid. Worldwide, according to current research, there are about 1 billion PCs in operation, which means the participation rate is only about 0.1 percent. As more projects become active, it seems likely that the participation rate will increase.

Volunteers Versus the Grid

The type of distributed computing used by the above projects is sometimes called volunteer computing. Users (often anonymously) volunteer the unused computing power of their machines and do not expect to be rewarded, except with recognition, information, or bragging rights.

Just as distributed computing is another form of parallel processing, grid computing is another form of distributed computing. The concept of grid computing closely parallels the concept of the power grid, hence the name. In grid computing, users with the proper credentials and the proper software/hardware plug into the computing grid and draw on the computing power of many other units. These users are charged for the computing power used. These same users then make the unused computing power of their systems available for use on the grid and receive credit for computing power provided. I believe the ultimate intent of grid computing is ubiquitous distributed computing.

Advantages and Disadvantages

Because a great deal of research relies heavily on the kind of jobs at which distributed computing networks do well (for example, processing independent units of data or pure number crunching), there is a ready market for the processing speed and storage advantages inherent in both volunteer computing and grid computing. They can break codes with speeds unmatched by any supercomputer. However, distributed computing is not always the right answer, mainly because of its unique design.

The flaws inherent in distributed computing structures were identified by a well known programmer, Dr. L. Peter Deutsch. Dr. Deutsch, with the help of Dr. James Gosling from Sun Labs, explained that simply comparing the processing power and overall speed of supercomputers and distributed computing networks leads to misinformation because of their inherent differences. The result of their efforts is known as the Eight Fallacies of Distributed Computing. According to these gentlemen, the eight fallacies are eight assumptions made by most everyone when they build their first distributed application. In the end, they say, all eight are incorrect and lead to some difficult lessons. Here are the eight fallacies, followed by my personal comments.

- **Fallacy 1: The network is reliable.** As you would expect, linking so many computers simultaneously dramatically increases the potential for system failures and other problems. Massive redundancy is needed when relying on Internet-connected PCs, because one cannot know who will be available and when they will be available. Machines are turned off before they finish downloads, processing, or uploads of data, and if you are waiting for those data to do another computation, you cannot afford to have one machine bring down your house of cards.
- **Fallacy 2: Latency is zero.** Supercomputers and other parallel processing units on really fast hardware connections have a distinct advantage in how fast data can be transferred and processed over distributed systems that rely on network connections. Data processing in a supercomputer is immediately available for ongoing processes, not delayed while an e-mail is sent or limited by the speed of a clogged network.
- **Fallacy 3: Bandwidth is infinite.** I would not want to rely on the speed of my DSL connection to transfer to and from the project source quickly. My home PC can process data faster than it can download it across the Internet—I’ve watched choppy videos that prove this. On the other hand, supercomputers are designed to move incredible loads of data from processor to storage to memory and back at optimum speeds. There is no comparison between that kind of speed and a dial-up connection.
- **Fallacy 4: The network is secure.** Perhaps the single most important roadblock to development of distributed and grid computing may well be concerns over security. Daily, I am
reminded how dangerous it is to connect to another computer, because there is likely a rather large number of folks out there who are trying to figure out how to peek into my machine and play around with my data. Little wonder that many universities and businesses are shy about participating in distributed computing projects. Many volunteer computing projects rely on redundant computing to decrease the effect of hosts that malfunction or, worse yet, have a hidden agenda for sending back corrupted or incorrect data. A task is sent to two different volunteer hosts, and the results are compared. If they sufficiently agree, the data are accepted. If not, they are sent again to a third host, and so on. This reduces the effective computing power of the project.

- **Fallacy 5: Topology doesn’t change.** Networks are changeable environments. Of the approximately 3.6 million potential participants in the SETI@Home project, only between 400,000 and 500,000 are available at any time. People buy new machines all the time, and network architectures change. The unstructured nature of the Internet is even more vague and unpredictable. Imagine having to program applications to take all of this into consideration.

- **Fallacy 6: There is one administrator.** There is an old joke that the entire Internet is really run by one 17-year-old high school student named Jason. If the Internet were a supercomputer, this might be possible. However, the practical considerations of resource management are a real headache.

- **Fallacy 7: Transport cost is zero.** Unused cycles on computers are not free. There is a cost to creating network latency, and someone has to pay for all that bandwidth. As the number of distributed computing projects grows, the impact of these hidden costs will be come more evident.

- **Fallacy 8: The network is homogeneous.** It’s no secret that homogeneous networks are more efficient than heterogeneous networks. Designing applications that must take into consideration the variety of operating systems, the different types of hardware, and the diverse schedules of availability is difficult at best. These differences rob distributed networks of much of their potential processing power.

This doesn’t mean that the days of volunteer and grid computer are numbered. Forces driving these important technologies forward include the consistent ongoing increases in processor performance, the creation of reliable high-speed networks on a global scale, and the tsunami of data threatening to overwhelm us all. Managing all of this in colleges, universities, and other organizations, which are also widely distributed, requires the computing power and flexibility of these technologies.

### The Future of Distributed Computing

This issue of the *ACUTA Journal* looks at the future just five years off. It seems likely that distributed computing will be with us in 2012 and beyond. Grid computing has received a tremendous benefit from projects such as the Globus Alliance of the University of Chicago. Their Globus Toolkit is an example of the software tools needed to help colleges, universities, and businesses develop their own distributed computing applications. They refer to their collection of grid components as an ecosystem. The future of grid computing may be found there or with other members of the community of grid developers.

Like the Internet, volunteer computing will be there if it can survive malicious attacks and the sheer diversity of the computing environment. But also like the Internet, much will depend on finding common ground for protocols and processes. Desktops now come with terabytes of storage and processors so powerful they need to be cooled by liquid systems. It’s unlikely we could ever use all the power we can put on top of our desks, but there will always be someone asking for all our leftovers.

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Cell Phones on the University Campus: Adversary or Ally?

Today's university students have adopted their mobile phones as their main communication gateway to the world, creating a spectrum of new challenges for university telecommunications professionals. Instead of taking advantage of the mobile phone as a learning tool and campuswide communication device, many universities and colleges are spending time and money maintaining and installing outdated landline and voicemail technology to communicate with students. The result is time-delayed, inefficient, and even failed communications with the student body. Universities and colleges need to take advantage of the proliferation of the mobile device in order to effectively communicate with their students, instead of fighting a technology trend that is here to stay.

Campus Technology Trends

Today, more and more colleges and universities are combining their telecommunications departments and information technology departments to tackle a broader set of issues. In years past, campus telecommunications managers directed their efforts toward installing and maintaining high-end landline systems for communicating critical and noncritical campus information. Personnel were concerned about ensuring reliable and profit-generating long-distance contracts and creating group and remote mailboxes. Telecommunications has become a broader discipline focused on integrating and leveraging technology investments and advancements across the campus. Tasked with solving the problem of tailoring communications technology to meet and advance the university's mission while meeting the new demands of today's always-connected student, the higher-education telecommunications manager's job is even more challenging.

The availability and maturity of today's wireless technologies will evolve continually over the next five years, enabling universities to steadily improve real-time accessibility to information and student communications. Eventually, mobile devices, wireless fidelity (WiFi), voice over Internet protocol (VoIP), radio frequency ID (RFID), and supporting software will mature and converge, and universities will be able to tap the mobile phone as a one-stop shop for student communications and commerce.

The Modern Student Mind Set

In just half a decade, the university student mind set has changed dramatically. The proliferation of communications devices and their universal availability to teens and preteens is a phenomenon unique to this generation. These students are always-connected multitaskers who perceive their cell phones as their lifeline to the world. Students carry their cell phones with them at all times and have chosen them as their main communication device, making traditional landline usage a thing of the past.

Cell phone adoption rates are extremely high. Based on surveys conducted on campuses in the fall of 2005, the Student Monitor Report estimated that 91 percent of college students had cell phones. Adoption rates among younger consumers are high as well, with the rate expected to rise most sharply among 5 to 9 year olds. This signifies that mobile device adoption
is not a blip on the technology adoption curve. Wireless devices and communication are here to stay. As a result of high cell phone adoption, landline use on college campuses is low, posing a severe problem of timely communications with students in both emergency and nonemergency situations.

Higher-education telecommunication managers must not be frustrated by the rapid and high adoption rate of cell phone use. Rather, in order to be successful in their missions, they must view today’s cell phone proliferation as an opportunity to seize. When deployed effectively, mobile access to groups, e-mail, and academic communications allows the university to maintain a lifeline with the student and to implement revolutionary academic applications that promote the well-being of the student and provide timely access to available resources. This results in increased academic participation, improved student retention rates, and stronger student participation in a more well-defined campus culture.

Today’s students grew up with the Internet. For them, online communication and information has always existed and is heavily integrated into the way they see and approach the world. They are used to the unique paradigm of online group communication that successful electronic communities like Facebook.com and MySpace.com pioneered. This type of online group networking has changed how students communicate, interact, and socialize. The popularity of online group communities poses another challenge for higher-education institutions. Since the majority of college students are very heavily involved with their individual online communities, campuses often find it difficult to reach out and effectively integrate and assimilate themselves into the student mind set.

A Case Study: The University of Maryland Eastern Shore

The University of Maryland Eastern Shore (UMES) decided to explore options for taking advantage of high student cell phone adoption rates to see if it could alleviate the challenges that cell phone technology posed to its communications efforts. In August 2006, UMES’s Information Technology Department paired with Rave Wireless, a higher-education mobile solutions provider, to implement a variety of academic- and campus-based communication applications to enable UMES to improve timely communications with students.

UMES is a traditionally African American university, with approximately 4,000 students who come from socioeconomic backgrounds different from most other campuses within the university system of Maryland. The demographic of the UMES student body poses unique challenges. Student retention is one of the university’s highest priorities. The university implemented numerous retention programs, including one-on-one academic advisement and tutoring, to ensure that students receive every opportunity to excel in their studies and remain enrolled to complete their degree program successfully. UMES found that the ability to communicate in a timely manner is essential to its ability to retain students and ensure that they have every opportunity to take advantage of the resources available.

UMES selected a set of mobile applications and services from Rave Wireless. The applications combine Web and mobile form factors for ease of use. The applications are accessible and configured in a manner that is very familiar to students through their use of Facebook.com and MySpace.com. Depending on the group, students are either automatically enrolled in a group or have the option of subscribing to an online group. The student is empowered with two-way communications with teachers, advisers, peers, and the university. Individual classes, as well as most campus organizations, participate in the program including fraternities, athletics, and clubs. Students can receive communications through mobile e-mail, campus e-mail and the most popular—text messaging. Faculty, group members, and group moderators also have the option of online polling. The survey capability is being used for campus-wide surveys and voting and in pilot classrooms for in-class quizzing.

In fall 2006, the optional UMES HawkTalk program was made available to incoming freshmen and upperclassmen. However, marketing and publicity efforts were focused solely on freshmen. Students who signed up for the program received a cell phone, with hardware upgrade options, a choice of plans, and unlimited text messaging. The carrier of choice, Sprint, was able to offer UMES a discounted bulk plan. Rather than collecting additional revenue from the student, the university chose to pass the cost savings on to the student. Students with a previous carrier-commitment contract were able to port their number to Sprint and offset the cost of joining the UMES plan because of the affordable rate of the monthly plan offered.

The results and adoption rates to date demonstrate unprecedented success. UMES experienced a 65 percent adoption rate of the program.
among incoming freshmen and a 22.5 percent campuswide adoption rate. Industrywide, typical adoption rates for optional programs of all kinds hover between 3 and 5 percent. The high adoption rates across the campus are a testament to the important and indispensable role the mobile phone plays in student life, as well as to the need for applications that transform implementations from simple cell phone discount plans to full-fledged, university-sponsored mobile communication programs.

At the forefront of critical student communications is emergency and safety. The current political and social climate makes emergency communication with students imperative to instilling confidence and creating a safe environment. Today’s 18-year-old was only 12 when the events of September 11, 2001, occurred, and only 10 when the shootings at Colorado’s Columbine High School transpired. Unfortunately, these violent acts occurred when today’s college student was at an extremely impressionable age, placing security at top of mind for students and their parents. In addition, the University of Maryland Eastern Shore campus occasionally experiences extreme weather. Using Rave Wireless’s application package, UMES deployed safety applications that enable remote broadcasts and alerting to students for emergency closings and other important safety information.

Further, the campus mobilized all of its essential campus-based systems, including e-mail, WebCT, financial aid, and roaming programs. Students can check their campus-based e-mail on their phones. The UMES WebCT program allows students to check course calendars and assignments and check the status of grades as they are posted at midterm and end of the semester. Students can also receive reminders and check the status of deadlines for financial aid requirements and dormitory assignments. The previous obstacles to timely communications with students often caused missed deadlines and occasionally unfulfilled paperwork for financial aid and boarding requirements. The ability to send reminders and ensure that students are aware of these critical deadlines leads to increased retention and ensures that students are able to tap all of the resources available.

**The UMES Campus in 2012**

In the near future, UMES plans a variety of additional applications to take full advantage of the cell phone as a learning and communication tool. In the coming semesters, it will put marketing efforts in place and continue to make its HawkTalk program available to all incoming and current students. Adoption of the program will enable a standardized communication platform and community for all its faculty and students. In addition, more academic applications are planned, including an escalation in the use of in-class polling, quizzing and surveying, mobile flash cards as study aids, class collaboration groups, and the deployment of video playback for both in-person and online courses.

The UMES campus of 2012 looks markedly different from today. The dominant trends in education point to improved measurement of learning outcomes and teaching strategies. To this end, the university plans to take advantage of evolving technologies to implement a full campuswide wireless community that places the mobile phone at the center of student activity and academics. Students will be able to use voice recognition to search by keyword and playback modules of lectures in order to improve exam and class preparation and maximize study time. Also planned is the rollout of more complete in-class response tools. As handset devices evolve to include RFID standardization, the university will implement RFID-based key card access to dormitories and mobile commerce across the campus, including use in student dining halls and bookstores. The university also plans to deploy dual-mode cellular/VoIP handsets to curb network and cellular plan costs to the student.

The broad introduction of cellular technology, high adoption rates, new group networking paradigms, and the hundreds of mobile devices available to the consumer have changed the way today’s university student communicates. This trend poses numerous challenges for the higher-education telecommunications professional, including the continued execution of timely and critical communications to students, tailoring communications technology to best suit the mind set of today’s student generation, and implementing both academic and campus communications that solidify campus culture and maximize academic resources. Instead of fighting the cell phone, embrace it for what it is: a potentially invaluable tool for academic learning and effective group communications.

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MobileU™ was designed to enhance campus communications by augmenting our ThinkPad environment with highly mobile data access. Believing that mobile communications via handheld devices is the next major technology shift on campus, Wake Forest’s Information Systems Department deployed devices that combine the convenience, power, and functionality of Windows Mobile Pocket PC phones with the data available in Wake Forest’s new integrated wireless university environment.

In September 2005, Pocket PC phone devices, nicknamed Mobis, were distributed to approximately 100 students. All devices were equipped with both WiFi and cellular connectivity and contained a standard suite of Wake Forest–specific software in addition to the Windows Mobile software standard on the device.

Through MobileU, we will migrate to a campus of supermobile computing and communications and more effectively stay in touch with students, who consider e-mail and voicemail all but obsolete. This is also an innovative and fiscally sound means to address the loss of long-distance revenue.

Determining the most efficient and reliable communication tool for students was a central component of MobileU. The university worked with Cingular and Sprint in planning the pilot program. In support of the strategic technological mission of the university, Wake Forest eventually built in applications including location-sensitive building directories, an automatic course schedule download, and a mobile intranet. Liking what they saw, students then began to request additional services that could be “mobified.”

Project Planning

A comprehensive business concept document defined MobileU’s scope, led its implementation, and directed its objectives throughout the project. The MobileU project manager was the university’s assistant vice president for information systems and chief information officer Jay Dominick.

The following deliverables guided the project: vendor agreements for devices and cellular plans; decision on WFU subsidy for devices and/or plans; Wake Forest services and applications for Windows 2003 devices; asset management plan for the pilot; participant management, training, and support plan; publicity plan; plans for participant feedback; evaluation and feedback criteria; analysis of feedback; and recommendations for a full campus rollout.

Promoting the Technology

The university currently relies on a Nortel 81C PBX for campus call routing, and provides local and long-distance service and billing for all students, faculty, and staff. Students are assigned long-distance access codes and billed a competitive rate for long-distance calls. Few students use this method of communication, resulting in a dramatic loss of revenue for the university. As communication patterns for today’s college students have changed, MobileU is creating a dynamic communication service that will change with them.

Wake Forest’s hybrid wired and wireless network is the connecting power behind MobileU. It is a Cisco-based network encompassing 40 routers, 600 switches, ubiquitous 802.11g and 802.11a WiFi, and multilayered security. The network is framed by 19 multi-building distribution zones each served by two routers located in different buildings. This design creates not only redundant router paths, but also redundant power and fiber paths. These same redundancy principles were applied to the server farm, core, and gateway portions of the network. Providing this seamless, redundant connectivity across campus was essential in enabling MobileU and the new communications environment.

After experimenting with PDA devices, we learned that applications on a small mobile device do have merit in the campus environment. However, we experienced limited adoption in earlier pilot programs because students remained reluctant to carry multiple devices. The cell phone was touted again and again as the one device that is central to students’ existence. Therefore, we
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text is an institutionwide framework for evaluating technology decisions.

When one begins to play any new game or sport, the first questions are “What are the rules? Where are the boundaries? How do I score?” Answers to these questions form the context of the game and allow you, the player, to judge and select among the various choices that you will face. (Should I run or pass? Hold or draw? Attack or retreat?)

Some institutions have developed a context when it comes to campus master planning, commonly reflected in a consistent look and feel to buildings on campus. But most institutions don’t have this same kind of context when it comes to strategic planning for technology. Developing such a context should be part of the technology master plan but too often is not. Instead, the “strategic” part of the technology master plan is frequently a plan for phasing and funding the tactical projects.

In fact, developing the context is one of the most important endeavors in the consensus-driven, participatory planning process that is required in the higher-education environment. It will constitute the foundation upon which many future decisions will rest. This task will help you understand the present state of technology on campus and how it appears to the users and the community. It will provide a cross-section of the long-term needs and goals to be met and help define the present and future requirements. In addition, it will help you build consensus by allowing key personnel to sense that they have had direct participation in the process and the decisions.

Wake Forest’s MobileU
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determined that an all-in-one device, the Pocket PC phone, must be the new test device going forward and it was chosen for MobileU.

Cost, Benefit, and Risk Analysis

The key components of cost for MobileU relate to the devices themselves and the service plans associated with them. It is too early to report actual financial benefits, but projected savings to the university are significant. The long-term plan is to partner with a single cellular vendor to provide cellular coverage for all students. Charges will be processed centrally through the Information Systems Department. We estimate the total cellular spend for one year for all Wake Forest students combined is approximately $2.4 million. When all students are signed up with the same vendor, a giant, free “mobile-to-mobile” group feature would be enabled, resulting in a reduction in monthly plans. In addition, our negotiations have netted a substantial discount off the monthly plans for each student in MobileU. Wake Forest will also receive a revenue share that will mitigate the loss of long-distance revenue.

Perhaps the most notable impact on the Information Systems Department includes an increase in support provided to the campus community. Help desk staff members must now be trained on the Mobis and ready to offer troubleshooting advice to customers. A close relationship was quickly developed with the cellular provider to handle questions related primarily to phone service rather than equipment issues.

In the words of Vernon Cooper, a spiritual healer and elder of the Lumbee Native American Tribe, “These days people seek knowledge, not wisdom. Knowledge is of the past, wisdom is of the future.”

My advice to you is that to plan wisely one must plan holistically, focusing not on the specific technology but on how technology fits into the overall institutional mission.

But wait! There is good news, too. As Abraham Lincoln said, “The best thing about the future is that it only comes one day at a time.” Plan wisely.

Geoff Tritsch is a Senior Consultant with Vantage Technology Consulting Group. He has been in the communications industry for over 35 years and an independent consultant specializing in higher education since 1980. He has been directly involved as principal consultant on over 200 projects for more than 100 colleges and universities. Reach Geoff at geoffrey.tritsch@vantagetcg.com.

Feedback from users, including faculty, students, and staff, has been a vital part of our success and will continue to be important in the future. Analyzing usage patterns and examining issues related to the device itself have helped us make informed decisions.

At Wake Forest, emphasis is placed on the education of the whole person. Our mission is to provide technologies for students, faculty, and staff that support and enhance our unique learning environment. It is our belief that MobileU will foster an already outstanding communications environment at one of the world’s top liberal arts universities.

ACUTA congratulates Wake Forest for the success of their MobileU project. If you would like more details, contact Jay Dominick, assistant vice president for information systems and CIO at jld@wfu.edu.
“Campus 2012: Imagine That!” Even though 2012 is a mere five years away, to me it conjures up images of levitating skateboards and subdermally implanted iPods. While the changes may be subtle or major, there are a few things that can definitely be said about the future, including:
1. There will be change; and
2. There is no way we can fully know today what those changes will be and what their impacts will be.

If your institution is like most, you are presently striving to make sure that your technologies align with overall campus strategic goals and support the academic mission and administrative requirements of the institution. And well you should be.

But will your planning provide the results you need? Strategic planning may; tactical planning won’t. How do you know if your planning is tactical or strategic? Both types of planning can be plotted on a two-by-two matrix like the ones at left, looking at both technical and educational issues, internal to and external from the institution.

Here’s the difference. Tactical planning (Diagram 1) starts with a given technology or product. It looks at technology trends, overlays these onto educational trends, and determines how that technology or solution can support the educational mission.

Strategic planning (Diagram 2) approaches things from the other end. It starts with the mission, overlays the educational climate and trends, looks at technology trends, and selects the technologies that best meet the application.

It has always been Vantage’s viewpoint that tactical planning and strategic planning are two points on the same continuum and that tactical planning should not be performed outside of the umbrella of a coherent strategic plan. While there is a place for both types of planning (and the grey-area in between), tactical planning is primarily short-term and focused on a specific issue or problem while strategic planning is longer term and more open ended.

If yours is like most institutions, financial and personnel resources are limited. In order to maximize the time and money invested in technology and minimize dead-ends and stranded technology investments, specific technology decisions must be made as part of a multi-year technology plan. Technology projects should be planned and prioritized to make sure that projects fit in with the longer term strategic plan, build on one another, and obtain the best return on your technology investments.

With all that being said, how can you possibly plan for future technologies when everything changes and we don’t know what those changes may be? The answer is to develop a ‘technology context’. A technology

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The ACUTA Conference is the pre-eminent international gathering of communications technology professionals in higher education. From July 29 - August 2, 2007, we will gather in sunny Hollywood, Florida so that our members can interact, inform, and inspire each other. Don't miss out on this opportunity. We look forward to seeing you there!

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**Digital Generation** \(\text{\textquoteright}d\text{-\textit{juh-tuhl} je-nuh-	extit{ray-shun}\text{\textquoteright}}\)

**Definition:** 1. a group of contemporaneous individuals with cultural or social characteristics, technological experiences and attitudes. 2. individuals who see limitless possibilities through the use of technology - to imagine, to dream, to envision new possibilities, to create and of course, to learn!

Today's students have grown up in a digital world along with a sea of electronic digital devices. Naturally, when selecting a school, they expect the latest in cutting-edge technologies to be offered.

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