Strategic Plan

1997 - 2002

The Pennsylvania State University
Office of Computer & Information Systems

Office of the Executive Director
Center for Academic Computing
Library Computing Services
Office of Administrative Systems
Office of Telecommunications

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EXECUTIVE SUMMARY

The Office of Computer and Information Systems (C&IS) takes very seriously its responsibility to provide the information infrastructure necessary to help fulfill Penn State’s mission of “improving the lives of the people in Pennsylvania, the nation, and the world through integrated, high-quality programs in teaching, research, and outreach.” Without information technology, a considerable amount of Penn State’s current instruction, research, and outreach would not be possible. The challenge for this office continues to be how to provide best-in-class and highly flexible services when funding support continues to lag behind the rapidly expanding needs of faculty, students, and staff.

In this five-year Strategic Plan, we express our Vision, Mission, Assessment, Goals, Strategies, Action Plan, and Budget Plan. Each reflects the paramount importance of information technology to Penn State’s mission, to our society at large, and to the world. Investing in information technology resources is not a C&IS issue; it is a Penn State issue. Whether we like it or not, Penn State is being driven by the rest of the world to expand its investments in information technology simply to remain competitive and relevant.

The public’s changing educational requirements and the speed with which new uses for information technology are being conceived and implemented are two of the primary catalysts for growth in our information infrastructure. Today, the granting of a diploma is simply one aspect of Penn State’s service to the community. Increasingly, people are requiring educational resources to address life-changes that occur after receiving that initial degree.

Corporate America has already acknowledged the critical role technology is playing in our society, and they have “institutionalized” investments in information technology to make them non-negotiable, just as investments in other basic utilities such as heat and lights are non-negotiable. Penn State must take similar steps to institutionalize investments in information technology and to view such investments as fundamental enablers.

The timing of our information technology investments has also become critical. As fast-paced as technological change has been, it is dramatically faster now than it was even a few years ago. New products are now coming to market within 60 to 90 days. Accurate budget planning 18 to 24 months in advance is impossible when major shifts occur in less than a year. Complicating the process is the fact that limited funding has kept C&IS staff to an absolute minimum; critical technology initiatives can be delayed by months when a key staff member becomes ill or leaves. Training for faculty, students, and staff has also suffered because there simply are not enough “experts” to go around.

Central funding for information infrastructure over the five to ten years prior to 1995-96 was flat, not even keeping up with inflation. In addition, over the past two years we have received less than a third of the $4.5 million required to support the University Park telecommunications infrastructure being funded from the $15.8 million in Capital Funds. As a result, the significant supplemental funding to support information technology initiatives in the University’s 1996-97 budget is mostly targeted at “catch-up” issues.

Our mission of facilitating and creating learning communities and supporting top-flight research simply cannot be achieved without the funding to expand and enhance Penn State’s information resources. Few institutions can afford the luxury of reallocating dollars periodically to “catch up.” Today, if an institution is not moving ahead, it is falling behind. Those institutions that fail to keep pace with advances in information technology run the risk of becoming footnotes in the 21st century.
The plan we present reflects some of the best thinking in America on where
technology is going and how Penn State can provide a leading-edge information technology
infrastructure at affordable prices to support the integration of our teaching, research, and
outreach programs. In developing this plan, we have drawn heavily upon the thinking of
our key technology partners, including IBM, AT&T, Bell Atlantic, DEC, and Apple. We
have continued our benchmarking efforts, which are more extensive than those of any other
institution of which we are aware, to better understand how other institutions are addressing
similar problems. We work regularly with the very best universities in the country, all of
which are struggling with the same issues. We hope that Penn State will quickly come to
view investments in C&IS as investments that can be leveraged, not only to save other units
of the University significant dollars over the years to come, but to enable them to pursue
mission-critical functions that would otherwise be impossible.

Vision: In the 1980s, C&IS presented the Administration with a series of visionary
plans for integrating information technology into the research, teaching, and administration
of Penn State. As those plans have been actualized, information technology has become a
part of the academic life at Penn State. In short, we have been quite successful at realizing
the spirit of those earlier visions. However, much remains to be done. The “visions”
presented in this plan are statements of what must be accomplished in order to preserve and
expand the quality and effectiveness of the information technology investments we have
already made.

Mission: To provide the most cost-effective infrastructure and tools to enable the use
of information technology to support the teaching, learning, research, public service, and
administrative activities of the University.

Assessment: C&IS is influenced by many external and internal factors in planning
for and implementing the Penn State information technology infrastructure. External factors
such as the growing importance of life-long learning and changes in technology, and internal
factors such as human support needs and the missions and goals of other units, all play a
very strong role in how C&IS plans for and implements information technology at Penn
State.

Externally, the single most significant pressure on C&IS has been the rapid pace of
the societal and technological change that has characterized the past decade. Although there
are few navigation aids to tell us how to proceed in these fast-changing times, there are some
important indicators:

- Societal expectations of education are greater.
- Our economy is changing as information becomes a key factor of production.
- The kinds of work people do are changing.
- The amount of information we need to know is increasing.
- Job reskilling has become vital.
- Student demographics are changing.

No institution can address all of these challenges on its own. For this reason, C&IS is
actively pursuing partnerships with other institutions and with corporations, and remains
active in national activities.

Internally, the information age is thriving at Penn State. We have gained national and
even international recognition for the development of programs for the classroom, for the
support of research, and for a host of other technology services. To keep a finger on the
pulse of the University, C&IS maintains a relationship with key representative groups
throughout the University. The reactions from these sources and others indicate clear
recognition of the value of information technology to Penn State. Our analyses show that we are doing a good job of combining the myriad of information technology services available.

The greatest single threat to the efficiency of C&IS today is the loss of key staff. Under economic restraint, we have placed greater responsibility in the hands of a core group of individuals who are working exceptionally long hours to maintain our pace. Their work shows the highest level of dedication and self-sacrifice. However, in many offices, we are one serious illness away from a major loss of human knowledge and leadership.

Budget restrictions are also a threat to Penn State’s information technology infrastructure. After years of budget reductions, everything has become a highest priority activity and there is nothing we can “stop doing” in the name of cost saving that will not negatively affect faculty, staff, and students in some way.

**Strategies and Action Plan:** C&IS has developed four broad strategies and commensurate action plans to meet its—and more importantly, the University’s—goals over the next five years. The overall effect of these strategies is to provide the University with an information infrastructure to support learning, research, and outreach, better preparing our students to learn and compete in an increasingly complex information-centered society. These strategies are:

1. Continually enhance and institutionalize the information infrastructure.
2. Continually improve information services.
3. Enable the cultural transformation of the University.
4. Enable external collaboration and resource sharing.

We cannot predict with certainty what changes in technology and society the coming years will bring. It is clear, however, that change will be rapid and take forms that may seem unimaginable today. In this environment, preparedness and swift reaction are the keys to survival, and the laggards will lose. C&IS is working to help Penn State be prepared for whatever changes may come by continually making external and internal assessments, and by working, to the degree possible, to keep abreast of the myriad of technological changes.

**Budget:** For next year, the net budget increase required to maintain and improve the key aspects of the Penn State information infrastructure outlined in this Plan is $2.5 million in continuing funds plus $1 million in one-time funds. With these funds, we can assure the University community of continued service that is best-in-class wherever human effort can make it so, although it will necessitate effective prioritizing, and not all issues will be addressed to the level of excellence we might hope for.

A word of caution, however: Even with this funding, many services will have to be rationed, which poses a threat to the overall effectiveness of Penn State as an institution. Penn State’s information infrastructure is a fundamental building block on which the future of our entire $1.6 billion institution is resting; it is important that the integrity of this infrastructure not be too heavily compromised. The investment required to enable all units of C&IS to continue working to help the University community integrate and use the information technology tools they need is quite modest. Past investments have paid off, but they must be leveraged by continued investments to help the University realize benefits such as:

- Leveraged use of information technology within the University.
- Better management of technology investments.
- Enhanced learning communities.
- Excellent technological support for research.
• Cost-effective administrative processes.
• Provision of seamless services to the Penn State community.
• Continual evolution of a leading-edge information technology infrastructure.
I. INTRODUCTION

The Pennsylvania State University’s mission is “to improve the lives of the people in Pennsylvania, the nation, and the world through integrated, high-quality programs in teaching, research, and outreach.” This broad mission presents all University offices with a highly challenging goal. Information technology has unquestionably taken a very prominent role in fulfilling this Mission. Without information technology, much of Penn State’s current instruction, research, and outreach would not be possible. The Office of Computer and Information Systems (C&IS) takes very seriously its responsibility to provide the information infrastructure necessary to promote education as a life-long endeavor. The challenge for this office continues to be how to provide best-in-class and highly flexible services when funding support for the University continues to lag behind the rapidly expanding needs of our faculty, students, and staff.

Today, the granting of a diploma is simply one aspect of Penn State’s service to the community. Increasingly, people are turning to educational resources such as certificates, additional degrees, seminars, and “short courses” to help them address important junctures in their lives. Although we expect that the University’s traditional student population and their information needs will continue to grow, the percentage of our total student population that these people represent will soon change. The real expansion in our mission will come from serving these students after they have left the role of a traditional resident student. The challenge to Penn State is to anticipate and develop the underlying infrastructure that will support this new learning environment.

It is not an overstatement to say that Penn State’s success in the future is contingent upon the continued growth and improvement of our information technology infrastructure. Whether we like it or not, Penn State is being driven by a number of factors to expand its investments in information technology. We can choose to plan for and manage these investments for maximum leverage, or we can let our investments manage us when individuals and organizations within the University do their own investing.

Technology’s critical role in our society has already been acknowledged by corporate America: Successful corporations view information technology investments as necessary enablers that leverage their important and costly investments in human infrastructure. Successful corporations have “institutionalized” investments in information technology, making such investments as non-negotiable as investments in staff costs and basic utilities such as heat and lights. Penn State must take similar steps to institutionalize investments in information technology and to view such investments as enablers.

The timing of these investments is critical. As fast-paced as technological change has been, it is dramatically faster now than it was just a few years ago. Change is now measured in “web weeks” as new products come to market in 60 to 90 days rather than 12 to 18 months. This makes budget planning particularly complex when the University’s budget cycle requires as much as 18 to 24 months advance planning.

A strong, flexible, and adaptive information infrastructure gives an institution a strategic advantage. However, the most significant strategic advantage accrues to those who move first, providing early access to their workforce and to their students and faculty. In the words of one of America’s corporate leaders, we need to “have the guts to invest in the future. As with any new technology, the risks are apparent long before the benefits . . . but holding onto old franchises for dear life in an era of increasing competition is a prescription for failure.”

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1Raymond W. Smith, CEO Bell Atlantic, Executive Conference, Amelia Island, Florida, April 10, 1996.
Penn State has significantly increased its information technology investments over the past 18 months. The promised, but continually delayed, $15.8 million in Capital Funds from the Commonwealth to support information infrastructure at University Park is critically important to lay the foundation for future years’ successes. This Strategic Plan is predicated on the continuation of this important funding stream. Additional delays in the release of these funds from Harrisburg will imperil our ability to “keep pace.”

Penn State’s central investments in information technology were basically flat for the five- to ten-year period prior to the 1995-96 academic year, not even keeping up with inflation. This point is not well understood within the University, partially because of the significant advances we have made in the technology infrastructure in spite of limited funding and partially because of confusion over the implementation of the initial Student Computer Fee. In fact, this progress with such restricted funding was one of the first things commented on by our corporate partners during our external assessment. Progress has been achieved through the hard work and long hours of a very lean staff. Our greatest management challenge is keeping this staff intact. We have no “bench.” When staff members become sick, their work goes undone. Critical technology initiatives can be significantly delayed by the illness or loss of a single key staff member.

The mid-year appropriation of $1.08 million to C&IS in November 1995 helped address a chronic need for student computing at University Park, but it really only provided “catch up” funding to meet back-logged demand resulting from years of underfunding. The significant additional funding provided to support information technology initiatives in the University’s 1996-97 budget will be helpful in building the necessary infrastructure to support faculty, student, and staff needs. But these funds were mostly targeted at making up for the Commonwealth’s failure to provide the $4.5 million in permanent funding required to provide continuing support for the telecommunications infrastructure being funded from the $15.8 million in Capital Funds. Despite continuing efforts on the part of the University, less than a third of this required funding has been provided over the last two years. The $4 million generated from the increase in the Student Computer Fee has helped us keep pace with student computing needs, particularly in the areas of student labs and modems. Still, given the need to remedy inequities in the way that the initial Computer Fee was allocated and the allocation of $500,000 of the University Park-specific funds to University Park colleges, there are no funds left to build additional student labs at University Park at a time when student demand still outpaces available supply. Thus, while these recent allocations to enhance Penn State’s information infrastructure indicate a commitment from the University leadership, they do not enable us to meet current demand, let alone position us for the future.

Continued information technology investments are, in fact, critical to the future of Penn State. Our missions of facilitating and creating learning communities and supporting top-flight research simply cannot be achieved without them. Faculty, students, and parents demand that we do so. Today, if an institution is not moving ahead, it is, in reality, falling behind. And falling behind is a much greater threat today than it was in years past because of the difficulty or even impossibility of ever catching up again. Given the dramatic budget cutbacks that have taken place, few institutions can afford the luxury of “staying static” for a year or two and then reallocating dollars periodically to “catch up.” Those institutions that fail to keep pace run the risk of becoming footnotes in the 21st century.

Our Plan does not present the “Impossible Dream”; it describes the “Art of the Possible.” It reflects some of the best thinking in America on where technology is going and how Penn State can provide leading-edge information technology services at affordable prices. It focuses on the integration of our teaching, research, and outreach programs. In developing this plan, we have drawn heavily upon the strategic thinking of our key
technology partners, including IBM, AT&T, Bell Atlantic, DEC, and Apple. We have continued our benchmarking efforts, which are more extensive than those of any other institution of which we are aware, to better understand how peer institutions are addressing similar problems. We work regularly with the very best universities in the country, all of which are struggling with the same issues.

Yes, additional investments will be required to keep Penn State competitive. But investments are simply a proxy for progress. We fully recognize that the rapid pace of change has put, and will continue to put, enormous pressures on the University for additional expenditures in a time of fiscal constraint. It needs to be recognized that this challenge is not “a C&IS issue.” It is an institutional issue—we are simply the messenger. We agree with the Budget Strategies Committee when it says that the fundamental problem that we are facing is not allocation or reallocation of resources, but that the University’s current information technology resources are insufficient to support Penn State’s academic aspirations.²

A recent Gartner Group study of large universities and corporations showed that 74 percent of them rated Web-based information as either “critical” or “very important” to their economic survival. Yet three-quarters of them are spending less than $1 million per year in exploiting the World Wide Web.³ The issue is one of priority. How do we allocate the funds we have? How does this track with our priorities? Penn State needs to be bold in exploring new ways to fund the information technology infrastructure required by faculty, students, and staff during the next five years.

This Plan covers a five-year period. However, because technology and the way people use it turns over in months rather than years, we cannot know what we will be investing in five years hence, or even much beyond two years. Some wonder why it is that, when advances in information technology are so predictable, its future uses are so unpredictable. The answer is simple: Real progress results from the confluence of enabling technologies—not from the base technologies themselves. Three years ago we couldn’t have predicted the World Wide Web; today, it is one of the key services that we are trying to support. What is tomorrow’s Web? We really don’t know, but we expect that it will be at least as exciting and challenging. Continuing investment is essential to ensure that we will be ready to exploit the new opportunities that will evolve.

Investments in the Office of Computer and Information Systems are investments in services that many parts of the University now require to fulfill their mission. In many cases, investments in C&IS enable other organizations to reduce costs. The University needs to view investments in C&IS not as costs, but as investments that can be leveraged, not only to save other units of the University significant dollars over the years to come, but to enable them to pursue mission-critical functions that would otherwise be impossible. To the question “When will we have invested enough?”, we must answer—only when the expansion in opportunities for learning and research abates. As Ray Smith of Bell Atlantic said, “In the race for excellence, there is no finish line.”⁴

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²Budget Strategies Committee Report to the University Planning Council, February 1996.
³Mike Zastrocky, Gartner Group, Coalition for Networked Information Meeting, December 6, 1996.
⁴Raymond W. Smith, CEO, Bell Atlantic, Executive Conference, Amelia Island, Florida, April 10, 1996.
II. VISION

The vision for the Office of Computer & Information Systems continues to be focused on providing the ubiquitous information infrastructure and tools that enable work that would otherwise be impossible. We live in a turbulent time marked by the emergence of knowledge and information as a fundamental capital of our society. Universities are the primary creators of information and knowledge, and they have played seminal roles in the use of technology to move society into this new era. To remain a leading institution in the 21st century, Penn State must leverage and expand upon its base of mission-critical information technology.

In the 1980s, C&IS presented the Administration with a series of visionary plans for integrating information technology into the research, teaching, and administration of Penn State. Initially, much of the progress toward these plans went more or less unnoticed by most of the University community. More recently, dramatic changes have occurred: information technology has become part of the fabric of academic life at Penn State, and it is being used in ways never before imagined by people who never imagined they could use it. Prospective students and parents are no longer impressed that we have microcomputer laboratories; they want to know how many, and what capabilities they have—and they find it unacceptable to stand in long lines to use them. Faculty are no longer impressed that they are able to use computer technology in a few classrooms; they want to know why they can’t use it in more classrooms, why there are not sufficient staff to keep them operating, and they are demanding increasingly sophisticated capabilities. Connectivity is assumed to be “a given,” and the demand for faster and more robust connectivity continues to grow. Failure of any of these key services causes extreme dissatisfaction because it suspends the ability to work.

In short, we have been successful, to a varying extent, in realizing the spirit of the visions laid out in earlier planning documents. But to provide users only with the appearance of completeness and not the real substance will rapidly and dramatically undermine the University’s aspirations to preeminence. The “visions” described in the following pages are statements of what must be done in order to preserve the quality and effectiveness of the information technology investments we have already made. We recognize the fiscal uncertainty of these times. It will take a concerted effort to continue moving forward. However, maintaining the status quo today means to lose ground. Quite simply, the status quo is not an option.

Strategic Vision for Academic Computing

By the end of the decade, scholars will not be considered literate unless they can use information technology as a fundamental tool of their work. The trend of the last five years toward academic reliance on information technology to generate data, communicate with colleagues, enhance the classroom environment, and facilitate the creation of knowledge is accelerating as we approach the year 2000.

The Penn State community has embraced information technology tools enthusiastically. In 1990, students were only given access to technology to complete specific course requirements; now students require (and have) nearly universal access to information. Five years ago, few faculty used computers in the classroom; now, over one-third do. Today, any faculty member or student who desires to do so can use electronic mail to communicate with others.

With the addition of real-time images and collaborative tools, we envision an academic information technology environment in which faculty and students can collaborate easily across space and time, can perform complex calculations without complex technical
knowledge, can explore and manipulate visual images in ways that are natural to them, and will be able to experiment in a wide variety of disciplines. We envision an environment where faculty and students who can visualize exciting new ways to improve research and teaching with information technology have the means and the encouragement necessary to do so. Our goal, in fact, is to provide the means necessary to enable the University students, faculty, and staff to fully integrate information technology into their work.

**Student Access:** Over 60 percent of University Park students now own a computer and more than 70 percent have access to one outside of the Center for Academic Computing (CAC) labs. Although it is clear that in the next five years most students will have some kind of device, it is far less certain what that device or combination of devices will be. New types of computers are emerging that are really information appliances that bridge the gap between full computers and calculators. Project Vision in the Commonwealth Educational System (CES) is demonstrating the value of all students having their own computer. Other institutions, such as Crookston in Minnesota, Drake in Iowa, Wake Forest in North Carolina, and Drexel in Pennsylvania, have policies in place that give almost every student access to their own machine. However, given the range of academic disciplines at Penn State, it is unlikely that a single device would serve all undergraduate curricula.

Some see requiring each student to buy their computer as a way to reduce institutional costs. It is not. Experience elsewhere has shown that there still is a need for student microcomputer laboratories even when all students have their own machine. These labs provide specialized equipment and expensive software required by some courses. Modem connections for off-campus users and Ethernet connections in the residence halls also have to be increased substantially when every student has a computer. Our experience at Penn State has shown this to be true. A recent student survey showed that although more than 60 percent of students now own their own computer, more than 85 percent use the computers in the CAC labs. As student ownership has gone up, so has student lab use!

We estimate that a notebook computer can be provided to every student for $500 per semester, but the institutional cost of supporting these computers will continue. The Gartner Group places support costs at 40 percent of the hardware costs, or $200 per semester. We believe that this figure is high, but a realistic figure would certainly more than consume the entire current student Computer Fee of $70 per semester. Thus, if all students are required to have their own machine, whether it is provided as a part of the residence hall fee such as Drake does, or as a part of the tuition as Wake Forest and Crookston do, or as a separate charge as Drexel does, the cost to the University will not decrease and the cost to the student will increase dramatically.

At an institution with such a diverse academic program as Penn State, the decision to require ownership is probably best made at the college or departmental level. In this way, the special needs of the curriculum can be considered in determining whether or not a computer is required and what kind of computer is required.

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5Penn State Pulse Survey on Computer Experience, November, 1996. [Note: The students were a random sample of undergraduate and graduate students at University Park.]
6Penn State Pulse Survey on Computer Experience, November, 1996.
7In some disciplines, such as engineering, the cost will be higher because the computer required will be more complex. In others, such as Communications and the Arts, the need for high fidelity displays and sound will increase costs as well.
Future Tools: It is difficult to predict what specific technologies will predominate in five years. In 1990, the World Wide Web was focused in a few high-energy physics labs that worked with CERN in Switzerland. Today, it is the metaphor used for all aspects of computing and truly does form a world-wide web of information, as its name implies. It enables everything from instruction to research to administrative data access. What will be the next enabling technology?

Synthetic Environments, which combine scientific visualization, audio, and haptic (tactile) information and the use of very high-performance parallel computers to create artificial realities, may well be the next World Wide Web. Disciplines as disparate as statistics, engineering, architecture, and marketing can make effective academic use of this technology to improve understanding of complex analysis. Penn State, with a solid base in parallel high performance computing and scientific visualization, is well positioned to employ this emerging application of technology. Coupled with high-speed networks like Internet 2, this technology may well provide the basis for collaboration imposed by location. The implications for life-long learning are obvious.

Strategic Vision for Administrative Computing

What the past decade has been for the automation of administrative processes, we envision the next decade will be for the improvement of administrative processes. Penn State enjoys one of the premiere administrative computing systems in higher education, but these premiere systems have not substantially changed the way that the University does business. The potential for process improvement has barely been tapped. Recent accomplishments in voice response registration, stockless warehousing, a University Purchasing Card, payment by exception, and electronic funds transfer have proven without reservation that the potential for process improvement is substantial. In our vision for the next five years, the University must recommit itself to the principle that information technology can be transforming.

The University’s Future Computing Environment (FCE) Committee spent the past two years defining the administrative computing environment that will follow the extremely successful environment that was established in the early 1980s and that has supported us so well until now. Microcomputers and distributed computing have emerged as the technology of the future, and client/server computing is the technology that will link client microcomputers with database servers. Client/server computing requires a re-tooling of administrative computing systems to better link the existing Administrative Information Systems (AIS) databases with modern, high-powered microcomputers. FCE envisions a future computing environment that is an open, client/server environment, based on the World Wide Web and other such standards. This type of computing is not a solitary activity that affects only C&IS; it affects all offices of the University. Client/server computing brings with it a new organizational culture that crosses over traditional organizational boundaries by supporting closer ties and collaboration.

Client/server computing provides a link between the traditional academic computing and administrative computing organizations. Today, students can use OASIS (Open Access to Student Information System) to access administrative data such as transcripts, bursar accounts, and class schedules. Similar systems to provide faculty and staff access to accounting and other administrative data are being piloted today. The CAC and the Office of Administrative Systems (OAS) are consolidating many of their operations to facilitate these new systems while preserving the security required by administrative systems and the openness required by academic systems. We envision a time when specialized applications, probably using the World Wide Web metaphor, will provide tailored access to information
without regard to its origin. These applications will adapt to the needs of the user rather than forcing a single metaphor on all.

Strategic Vision for Library Computing

As the Internet developed and scores of information resources were made available at the click of a Netscape button, the demise of the library as the primary information resource for university research and instruction was predicted. The library was viewed as an institutional dinosaur, a place to hold dusty books and institutional archives. However, as the magnitude of information resources available over the Internet has grown, without any quality control, without adequate search and navigation tools, and without any assurance that the information available today would still be there tomorrow, the need for librarianship has actually increased.

In our vision for Library Computing, Pattee Library will be expanded and modernized in the next five years to provide better access to the world’s information for the scholars and researchers of the Penn State community. Pattee Library will be reorganized to become a number of libraries within a library. Just inside Pattee, scholars will find the Gateway Library, a computer-driven focal point for general references and the introduction to the subject-oriented libraries and the other specialized libraries contained within the walls of Pattee. Every subject library will contain the resources and information tools unique to that discipline. Specialized libraries will house specialized materials, such as rare manuscripts in the Rare Books Library or maps and gazetteers in the Maps Library. Electronic resources specific to each area will be available to augment the books, journals, maps, and documents housed in each of these libraries. Reference librarians will be available in each library with expertise specific to the subject area. Conference areas will be conveniently located for scholars to interact with other students, faculty, and researchers.

Also within the next five years, the Library Information Access System (LIAS) will be expanded and modernized to provide better access to the world’s information for the scholars and researchers of the Penn State community. LIAS will be reorganized to become a number of information resources within an information resource. When accessing LIAS, the scholar will encounter the Information Gateway, the focal point for general references and the introduction to the subject-oriented information resources and other specialized databases contained not only in LIAS itself, but in the individual colleges, departments, and faculty offices throughout the University as well as in other universities, corporations, and information facilities around the world. Each information resource within LIAS will contain the databases and access tools unique to that discipline, including indexes, abstracts, full text, hypertext, charts, graphs, images, audio and video clips, statistical databases, and geographic information systems. Specialized information resources will house specialized data, such as scanned images of fragile material from the University’s archives or from other collections in such places as the Vatican, the Getty Museum, or the NASA space image databases. Electronic information specialists will be electronically accessible and offer expertise specific to the subject area. Electronic conference facilities will be available for scholars to interact with other students, faculty, and researchers at Penn State and other institutions around the country. All of this will be available to any Penn State scholar, whether they are walking through Pattee Library, sitting in the commons area at Beaver Campus, working in their office in Hammond Building, or sitting with their laptop computer at home. Again, the World Wide Web metaphor will provide much of the basis for this broad access to information.
Strategic Vision for Telecommunications

The information technology focus in the last five years has shifted from computing power to network bandwidth. The demand for increased bandwidth will grow as more applications make use of graphics, video, audio, and haptic information. The blurring of boundaries between Penn State and its peer institutions will encourage more collaboration. As a result, the ability of the Penn State Network to provide ubiquitous data, video, and voice services to those who need them will remain a critical component of our information technology infrastructure. Our strategic vision for networking reflects the profound changes that will occur in the regulatory, technological, and educational environments over the next five years.

Regulation: Deregulation of tariffed services by commercial telecommunications service providers will result in a cornucopia of services and providers. Partnerships will continue to be created among firms once uniquely associated with cable TV, local phone service, cellular systems, two-way radio, computers, and long distance communications, as well as with others not typically associated with communications, such as owners of pipelines, power companies,9 and movie studios. We will continue to follow such changes and leverage them to the benefit of the University.

Technology: Technology vendors will continue to take advantage of decreased costs and new capabilities at the chip level. Technologies still in labs will be deployed on ever-faster schedules, increasing the pressure to keep pace. Portability will become critical, and “anytime, anywhere” communications will be taken for granted. Satellite-based service will provide coverage virtually anywhere on earth, albeit at some cost, likely giving rise to innovative pricing schemes and highly customized service offerings. Miniaturization will reduce differences between what is possible “in the office” and “on the road,” with further integration of video, imagery, text, and voice into portable devices with extraordinary communication capabilities. The arrival of low polar orbit satellites in the next five years or so will remove much of the delay that has made data transmission via satellite less effective than ground transmission methods. Every point on the earth may soon be “equal” from a network perspective. The result will be much greater location independence and elimination of the penalty imposed by remote locations. Use of fiber optics will become much more prevalent, although advances in technology will continue to squeeze increased bandwidth out of current twisted pair technology, especially in rural communities and where infrastructure replacement is most difficult and expensive. The radio spectrum will become much more crowded, requiring new encoding techniques to ensure privacy and efficient use of resources. Once again, the implications for life-long learning are obvious.

The device providing “dial tone” service will evolve from providing services via directly wired telephones to providing services via the campus network, with individual phone instruments eventually being connected via personal computers, if not completely displaced by audio-capable personal computers (albeit still involving a handset or headset for privacy). The key point is that “telephone service” will eventually become merely another digital service with “voice” information traveling the same pathways as “computer” and “video” information. The integration of voice with other digital information will not be limited to the campus. The Internet will become the vehicle of choice to carry voice communications.

Education: The demands of researchers will continue to push the envelope of high-speed networking. Multi-gigabit networks will become more common, are likely to be based

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9Although not widely recognized, electric power companies already possess much of the infrastructure required to provide voice, data, and video networking services.
on SONET\textsuperscript{10} standards, and are likely to use ATM\textsuperscript{11} as the architecture. Demands will grow for seamless service to the home. The obstacle to meeting this demand will be economics, which will also inhibit truly equal access from all University locations. Even so, the stratification of services to a department, within a campus, to other campuses, and to rural locations will become less noticeable than it is today simply because so much will be possible at even the most remote location. “Classes” will take on a whole new context, and students will have a virtually unlimited array of information literally at their fingertips, wherever they happen to be.

**Strategic Vision for Network Security**

Fundamental to accomplishing C&IS’ goals in all areas is practical, integrated, and interoperable network security solutions. Our goal is to provide reasonable protection for the data and system resources of the academic and administrative communities as the University and the wider Internet community transition to more widely distributed, client/server computing environments.

The vision for network security is that, in the future, researchers, administrators, and students will be able to identify themselves once to the network to gain access to any network resources essential for their respective missions; that sufficient levels of control can be achieved to minimize abuse of access privileges; and that data in all its forms (voice, video, sound, and text) can be substantially shielded from interception, unauthorized modification, or destruction. Measures will be developed to enable reliable tracing of suspected abuse to an individual user, making it possible to hold individuals accountable for breaches of network security.

The technical solutions will be open and supported on all of Penn State’s operating systems and system architectures and will interoperate with the planned solutions of our peer institutions. They will also be cost-effective, with the cost of preserving integrity not exceeding the cost to the University if it is compromised. Sufficient training and awareness programs will be in place to ensure users understand the importance of their roles in achieving a secure computing environment for Penn State.

\textsuperscript{10}SONET: A Synchronous Optical Network is designed to use optical fiber as a transport media, with standards currently defined for incremental speeds up to billions of bits per second.

\textsuperscript{11}ATM: A standards-based networking architecture based on Asynchronous Transfer Mode of relaying information, using information cells of fixed length, and capable of supporting video, data, and voice transmissions at appropriate levels of quality.
III. MISSION

The Office of Computer and Information Systems ensures that faculty, students, and staff have the information technology tools and infrastructure necessary to carry out the University’s Mission. We provide the infrastructure that enables members of the Penn State family to make maximum use of the appropriate information technology tools in their learning, teaching, research, outreach, administration, and support activities. We provide the cost-effective information technology resources required to support continuous improvement in the University’s ability to fulfill its diverse mission.

In partnership with peer institutions, national organizations, and key vendors, C&IS evaluates emerging information technologies for potential use at Penn State. We actively re-evaluate existing tools and services in the light of missions of the University. To accommodate changes in technology and missions, we enhance some tools and services, replace others, and add still others. In all of this, we respect people as individuals regardless of the artificial barriers imposed by cultural differences or human condition, and work towards removing such barriers.

C&IS, through the Office of the Executive Director and its four operating organizations (the Center for Academic Computing, Library Computing Services, the Office of Administrative Systems, and the Office of Telecommunications), is working to achieve five broad goals:

• Help faculty improve the way education is delivered.
• Provide students with resources to enrich their educational experience.
• Create and sustain an environment that enables leading-edge research.
• Help to improve productivity.
• Establish the information technology infrastructure necessary to maintain Penn State’s preeminence in integrating high-quality programs in teaching, research, and outreach.
IV. ASSESSMENT

The Penn State information technology infrastructure is affected by many external and internal factors. Figure 1 shows some of these factors, their interrelationship, and how they impact the resulting infrastructure that C&IS is primarily responsible for.

Figure 1. Determining Factors in the Direction of the Penn State Information Infrastructure

External factors, such as the growing importance of life-long learning, influence the vision, mission, and goals of both the University as a whole and C&IS in particular. Early understanding of the direction and influence of these factors can help us plan for and anticipate fundamental changes in the University. The External Assessment section of this Plan looks in detail at some of these factors.

As a service organization, C&IS is influenced by the missions and goals of other units internal to Penn State. For example, Human Resource policies very directly influence recruiting and retention of C&IS staff and can mean the difference between a highly effective infrastructure and an inadequate one.

The Penn State information technology infrastructure for which C&IS is responsible does not have to be the best possible infrastructure in every area, but it must be effectively linked to the overall mission and goals of the University to enable Penn State’s continued preeminence in teaching, research, and public service. To C&IS, this means that we must provide seamless services that enable users to have confidence that there will be the connectivity and appropriate processing capabilities to support their needs at the appropriate time. The services that this environment should support can be characterized as follows:

- Our Telecommunications infrastructure must provide ubiquitous and reliable voice, video, and data services.
- Academic Computing must enhance the classroom environment, facilitate the creation of knowledge, and act as a viable tool for the researcher.
- Administrative Computing must empower the user to realize the benefits of process improvement.
• Library Computing must provide easy access to the world’s information for Penn State students, scholars, and researchers.

• Network Security must provide each member of the Penn State community with an environment that is free from unauthorized modification, destruction, or disruption of day-to-day business.

• All offices must build a welcoming and tolerant work environment where all individuals are readily accepted, as well as eliminate artificial barriers to information access, particularly those encountered by the disadvantaged and the disabled.

A. External Assessment

The single most significant external pressure on C&IS has been, and will continue to be, the rapid pace of societal and technological change that has characterized the past decade. Information technology is the defining technology of our time. Computers now outsell television sets. In the next decade nearly everyone in the United States will become a computer user. Time and geography will no longer determine access or opportunity.

Around the world, universities are being called upon to lead and to react to the sweeping growth in capabilities and the increasing demand for better, faster, and smarter automated tools in support of research, education, and public service. Gordon Moore, co-founder of Intel Inc., correctly predicted 30 years ago that the power of computing would double every 12 to 15 months as photo-lithography reduced circuit size by 10 percent. Advances in technology that enable this growth are expected to continue until at least the year 2007, and worldwide there are 209 micro-circuitry plants under construction that will assure an adequate supply. This means that personal computers in the year 2000 will process 2,000 million instructions per second (MIPS) compared to the 100 to 400 MIPS possible today.12 These accelerated processor speeds will make things commonplace that are impossible today—for example, natural language translation. In a similar fashion, disk storage densities will continue increasing at a rate of 60 percent per year. By the year 2005, the printed content of an average library will be storable on a single PC hard disk.13

Just as standards enabled the electrification of America, standards are enabling high-speed, global switched data communication. In electronic terms, California and Alaska are as close to the University Park campus as Harrisburg and Boalsburg. Nearly all of Penn State’s faculty and staff now have desktop computers that have access to this global network.14 The implications are significant to a once-rural university community, because distance is no longer a penalty. However, bandwidth limitations can be. The new challenge is bandwidth.

While technology advances at a relatively constant rate, the resulting changes in the technology tools used by the university community tend to come in bursts. The trend has been that each burst brings with it a greater computing power for equal or less cost, creating a surge in the number and complexity of computing systems and in the number of people using them.15 Thus, savings realized in less expensive technology are quickly consumed by

13The Outlook for Information Technology, L. G. Waterhouse, IBM Corporation, August 29, 1996.
15Bruce Claflin, Digital Equipment Corporation, September 1996.
more robust, new technology and greater numbers of users. How to keep up with technology is a problem for universities all over the country and there are few navigation aids to tell us how to proceed. How fast should we go? How much should we invest? How quickly should we replace obsolete infrastructures? There are no "magic" answers, but there are some important indicators:

- **Society’s Expectations of Education Are Greater.** Typically, when Americans are asked to list the greatest problems facing America, they rank education near the top. Our secondary schools are not competitive on a world scale, and universities are too expensive.

- **The Economic Base is Changing.** Information has been added to property, capital, and labor as the fourth factor of production. Information jobs are growing more rapidly than any other job category in the marketplace. Employment in software occupations alone, which averaged 9.6 percent between 1987 and 1994, jumped to 11.7 percent in 1995. At the University of Illinois at Champaign-Urbana, recruitment for software engineers has doubled since 1994. Companies are grabbing all the talent they can find. “We hire the good people first, and we figure out what they are going to do later,” explains the chief technology officer at Sun Microsystems Inc. Competition for workers with at least three years’ experience is so intense that current employees must be treated as though they were being recruited to stave off raids by others. Information jobs are churning the marketplace as they displace other jobs.

- **Work is Changing.** In 1865, 85 percent of the US workforce had agricultural jobs; today less than 3 percent does. In 1950, 73 percent of the US workforce had manufacturing jobs; today less than 15 percent does. By the year 2000, the Department of Labor estimates that 44 percent—that’s nearly half—of the US workforce will be doing information services jobs. Fifteen years ago we taught service workers to intermediate between customers and information services; today we are disintermediating them. Ten years ago none of our workers had desktop computers; today most of them do. Five years ago routine correspondence was in paper form; today it is electronic. Work is changing more rapidly than people change and the life-long learning backlog is growing.

- **Knowledge is Increasing.** There was a time when libraries were government or church property, with scholars’ access limited. Today, knowledge is doubling every seven years, with 10,000 scientific articles being published every day. The volume of new information is increasing at such a rapid pace that the Penn State Class of 2000 will be exposed to more information each year than their grandparents encountered in a lifetime. Libraries are changing from repositories of knowledge to knowledge reference agents. Students and faculty are increasingly required to access, filter, and apply this knowledge in their day-to-day work.

- **Reskilling is Vital.** Although many of the critical skills required in science, engineering, finance, and law remain the same, much of the knowledge in these and other fields must be constantly updated. In the four years that it takes to get

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18Distributed Learning, CAUSE Professional Paper, 1996.
19Distributed Learning, CAUSE Professional Paper, 1996.
an engineering degree, half the engineering knowledge is revised or changed.\textsuperscript{20} Reskilling is becoming a natural expectation for knowledge workers. The American Society for Training and Development tells us that 75 percent of the current workforce will have to be retrained by the year 2000 just to keep up.\textsuperscript{21}

- **Demographics are Changing.** Five million working adults are enrolled part-time in American colleges and universities; one-third of those (of which two-thirds are women) are over age 40.\textsuperscript{22} This number masks an even larger adult population that would like to receive a college education but cannot attend a traditional college due to inconvenient class hours, campus inaccessibility, family responsibilities, business travel, or physical disability. Students are more diverse and more technologically capable than in the past. They are also more discerning, expecting greater value for their education dollars and greater technology services. They perceive computers to be a routine part of their learning paradigm.

These economic, social, demographic, and educational changes affect and are affected by the rapid expansion of computer and telecommunication services. William Richardson, past University Provost and now the President of the Kellogg Foundation, says that we are at a once-in-forty-year period when it is possible to re-think the way that we do scholarship.\textsuperscript{23}

If Penn State is to be part of this rethinking, we will need to enlist the aid and resources of others. In this era of dramatic change and opportunity, no institution can address all of the challenges on its own. C&IS has established extensive relationships with other leading universities, corporate partners, and government leaders to collaborate on solutions.

**Higher Education Partners:** One key relationship is with the Committee on Institutional Cooperation (CIC), the academic arm of the Big Ten Universities. In an effort to control costs and respond to increasing demands for information, the CIC is succeeding at resource sharing among member institutions.\textsuperscript{24} Penn State is also an active member of the Common Solutions Group, which seeks to ensure that compatible technologies are employed by peer institutions so that technology does not become a barrier to collaboration.

**National Partners:** One area of critical importance to Penn State, and a major focus for C&IS, is participation in national efforts to enhance the nation’s information infrastructure. Penn State is viewed as a national leader in the use of information technology in attacking the problems of higher education. Active and continuing participation in national issues is critically important to ensure that Penn State is positioned to provide our faculty, staff, and students with the information technology tools and resources they require. By being involved in national activities, we can help influence what direction the development of such tools take, ensure that they address our needs, and position Penn State to be an early adapter of new and promising technologies. Penn State’s leadership position in the

\textsuperscript{20} The Monster Under the Bed, Stan Davis and Jim Botkin, 1996.
\textsuperscript{21} American Society for Training and Development, July, 1996.
\textsuperscript{23} 1996 John W. Oswald Lecture, March 25, 1996, University Park, PA.
\textsuperscript{24} Last year, for example, in response to a challenge from CIC Presidents, the CIC libraries began work on the Virtual Electronic Library. This project, aimed at sharing the combined library holdings of all CIC libraries, was funded by the U.S. Office of Education to enable library catalog information to be shared.
development and implementation of Internet 2 provides a prime example of the importance of these activities.

Corporate Partners: C&IS is also aggressively involved in working with corporate partners—and we spend a lot of time and effort developing and nurturing these relationships. It is commonly agreed that higher education can no longer afford to do everything itself. We need corporate partners to help us explore new technologies and new solutions. The respect that Penn State carries within the business community has enabled us to work with leading-edge information technology firms over the past decade to the benefit of the University in many and varied situations. We plan to aggressively pursue such activity in the years ahead.

B. Benchmarking

The Office of Computer and Information Systems has received significant value from its benchmarking efforts, so much so that it is continuing to benchmark with one best-in-class institution each year. In 1994, we first benchmarked with five institutions that were determined to be “best-in-class” in their use of information technology (UCLA, the University of Illinois-Urbana/Champaign, the University of Michigan, the University of Texas-Austin, and the University of Wisconsin-Madison). In 1996, we benchmarked the University of North Carolina-Chapel Hill.

The primary goals of this effort are to identify the underlying processes that facilitate excellence and to determine how similar processes at Penn State can be improved or re-engineered. While the driving force at all of the institutions is the need to adapt rapidly and effectively to technological change, it is evident that there is no single “right way” to address this need. Practices that serve well in a particular environment may not be applicable to others.

To date, our benchmarking efforts have shown C&IS to be a high-quality, efficient provider of information technology services. Compared to the six benchmark institutions, we find that C&IS delivers services that are as comprehensive as any, at a lower cost. We attribute this greater efficiency to the long tradition of planning in C&IS. Altogether, the Penn State planning process has been more thorough and exhaustive than that of the institutions with which we have compared ourselves. Some specific findings of our benchmark include the following:

- In the area of administrative computing, the Office of Administrative Systems has been repeatedly shown to operate with a budget that is, on average, 40 percent lower than at other schools. We attribute this efficiency to planning and the consistency of the AIS systems effort that has been underway for more than 10 years. OAS is also going to be able to side-step the $60-80 million investment many of our peer institutions are making to reengineer their core administrative processes before the year 2000.\textsuperscript{25} In the 1990s, OAS expects to save between $80 and $100 million over peer institutions, although there are no institutions that equal Penn State’s current administrative scope and complexity.

- Our networking program is more comprehensive than any other benchmarked university, especially in providing services to our residence halls and to our multi-campus system. In addition to having the most extensive residence hall network, the manner in which issues such as network security and scalability are

\textsuperscript{25}Indications are that most of the CIC institutions are planning to make investments of this size before the year 2000 to address their administrative computing system needs.
handled is considered leading-edge. Our cost to install the necessary wiring was among the lowest we found, due in part to our approach of using student labor and engineering the system to use portions of existing wireways. We also found ourselves to be leaders in deploying services among geographically distributed locations, especially services such as interactive video and data networking.

- The need for multi-institutional resource sharing to maintain best-in-class access to critical information resources has been revalidated. Those institutions who engage in cooperatives and coalitions similar to our involvement in the CIC provided better access to more quality resources at lower cost. LIAS and its ability to take maximum advantage of cooperative agreements and shared resources continues to make Penn State a recognized leader in the evolution of the digital library.

- The CAC’s support of students and faculty in education and research is both ambitious and comprehensive. The effort to support teaching and learning is widely recognized for both its excellence and innovation. Faculty and CAC staff have won a number of national awards for excellence in this area. Of the benchmark institutions, only the University of Michigan has a program comparable to ours.

- In the provision of Student Microcomputer Labs, progress is still needed to meet student demands at University Park—and to match services provided by our peers. For example, the University of Michigan has over 1,600 centrally funded machines at Ann Arbor. This compares to the roughly 1,400 machines that will be available centrally at University Park later this year to serve a larger number of undergraduates.

- Penn State is a leader in network security. We were one of the first universities to recognize the importance of having a central coordinating office for network security functions, appointing our first University Computer, Network, and Information Security Officer in 1993. We were one of the first universities to participate in the Forum of Incident Response and Security Teams (FIRST), an international organization dealing with Internet-related security incidents and vulnerabilities. The innovative programs in vulnerability assessment that we have implemented have received national attention. We were recently named runner-up Information Security Program of the Year by the Computer Security Institute, the first university ever to be so honored.

Our general benchmark findings can be grouped under four broad principles that indicate directions for major research institutions. The degree to which institutions have internalized these principles is directly related to achieving the excellence integral to “best-in-class” institutions. The four principles are:

- Best-in-class institutions use planning, policy, budget, and strategy measures to maximize the benefits of information technology.

- Best-in-class institutions encourage early implementation of information technology infrastructure and standards.

- Best-in-class institutions emphasize customer service in order to integrate technology into the institutional culture.
• Best-in-class institutions use the elements of standards, security, and architectural planning to foster a supportive environment for change.

C. Internal Assessment

A high-speed campus network serving over 32,000 registered Internet addresses! A million "hits" a week to Penn State's Home Page! A million electronic mail messages a day sent to or from Penn State students, faculty, and staff! Electronic mailboxes on a single system being checked at least once a week by 50,000 different people! More than five million LIAS transactions each month! More than 37,000 electronic business forms processed each month! Electronic transcripts of students dating back to 1907! Undergraduate students ranking "using computer and information technology’ as first in importance among the goals of undergraduate education!"  

A President who personally participates in the electronic revolution!

Clearly, the information age is thriving at Penn State. Even with much work remaining to be done, our students, faculty, and staff are reaping the benefits of information technology that have accrued since the first strategic plans for telecommunications and academic computing were written. During that time, Penn State has gained national—and even international—recognition for the development of programs for the classroom, for networking, for client/server computing, for access to library information, and for other aspects of applying information technology to the needs of higher education.

According to a November 1996 survey of students at University Park, computers not only play an important role in education, they are also expected to be critical after graduation.

• 97 percent of students have activated their Access accounts.

• Students reported a need for spending at least two hours per day using a computer.

• In a typical week, 82 percent of students used E-mail and nearly 51 percent used the World Wide Web.

• 87 percent of the students at University Park used a CAC public lab at least once despite the fact that 63 percent owned their own computer.

• 55 percent of the students recommend that the amount of required work with computers should be increased somewhat or increased significantly. Less than 5 percent thought the amount should be decreased.

• 85 percent of students felt that the use of computers will be very important or extremely important after graduation.

C&IS has maintained its commitment to diversity, continuing to sponsor and participate in the programs that contribute directly to improving and enhancing diversity at the University, especially in the information technology field. Our continuing support for maintaining a more diverse student body and providing a welcoming campus environment for all are demonstrated by our sponsorship of the Academic Computing Fellowship.

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\( ^{26}\)Graham B. Spanier, April 15, 1996, The Daily Collegian.

\( ^{27}\)Pulse Survey, November 1996.
Program and our cooperative effort with the Office of Disability Services to place technology tools in the student labs to enable the physically challenged to take advantage of information technology. Our Professional Development Program (partially supported by the President’s Opportunity Fund), the OAS Job Enrichment Program, and our participation in the Office of Human Resources Summer Staff Assistant Training Program all demonstrate our commitment to developing a diverse student body and workforce and providing a welcoming environment for all.

In order to emphasize our Continuous Quality Improvement (CQI) activities, a key new position has been created in the Office of the Executive Director. A major role for the Coordinator for Process Improvement will be to guide the University in more effective and efficient uses of technology in order to fully realize the productivity potential of these investments. Our CQI Council has completed their review of a diversity climate assessment that was distributed to the staff in December 1995. Two focus groups reviewed the individual comments of staff members and the CQI Council is currently in the process of recommending the development of programs to address the issues the employees are most concerned about. We plan to establish two additional focus groups this year.

To develop a comprehensive, objective, and broadbased view of the status of services provided by C&IS, those within C&IS maintain relationships with key representative groups throughout the University. These include formal relationships through memberships on standing committees such as the Library Dean's Council, ACOR, ACUE, and the Distance Education Education Advisory Council; participation on task forces and study groups such as the Study Group on Information Infrastructure and the Security Policy Committee; the formation of a Student Advisory Committee; special faculty-based advisory committees such as FACIT and FACAC; and leading strategically important work teams such as those defining the Future Computing Environment and implementing AIS. To further complement the flow of candid, timely, and insightful information from these interactions, a high degree of personal contact is maintained with each college and administrative organization both at an executive level and at a working level. In particular, the Executive Director's annual meetings with each Dean provides a long-term view of key executives’ views of the information technology services provided by C&IS.

From these lines of communication, several common themes have emerged that summarize the University community’s view of how C&IS in particular, and Penn State in general, is doing in providing information technology services. The reactions from these sources and others indicate clear recognition of the value of information technology in our environment. Statements made by the University Future Committee recognized "the strategic importance of computing and telecommunications to achievement of Penn State's vision," leading them to recommend that, within available resources, "high priority should be given to the development of the University's Information Technology initiatives." Many have suggested that C&IS should have a closer involvement in University-level planning and budget-setting, as well as broader participation in the overall decision making processes already in place at executive levels. This would enable increased involvement by C&IS in establishing policies and practices to leverage the use of information technology to the University’s strategic advantage.

28This survey predates the Faculty/Staff Survey and addressed many of the same issues. Our analysis and actions in response to this survey are also addressing the most significant findings of the Faculty/Staff Survey.

Users of information technology services have grown to expect reliable, professional support. Those using services now range from prospective students to alumni, from corporate executives to farmers, from employers to government, and from undergraduate students to life-long learners. To support the varied needs of these people, C&IS offers what might be considered a "federation" of services. Contained within this federation of services is a vast array of discrete services (e.g., training, high-performance computing, library computing, interactive video, access to records) that together complement and leverage each other. Through the integration of these services Penn State is able to provide an overall environment suitable to meet the diverse needs of the Penn State family. Our analysis—borne out by the findings of formal benchmarking activities—shows that C&IS is doing a good job of combining the myriad of information technology services required.

The greatest risk to C&IS today is the loss of key staff. Over the past five years, while we have been “doing more with less,” we have placed greater responsibility in the hands of a core group of individuals who are working exceptionally long hours to maintain pace. The extreme amount of critical information these individuals possess is not readily replaced. In many areas, we are one serious illness away from a major reduction in key services.

We are also highly vulnerable to corporate recruiters. For example, one of the key programmers who developed the “Alumni Kiosk” was hired by the Disney Corporation to do similar animations for them. One of the key instructional designers for an engineering project was hired by a private Web-development company in Boston at double her salary. The point is that C&IS has competition not only from other educational institutions, which is true of every academic unit, but it also has formidable competition from the private sector, even locally. We have been fortunate that we have not had many defections from this nucleus of key staff because, when we do, we are not able to replace them at Penn State’s non-competitive salaries for information technology professionals. The importance of preserving the integrity of Penn State’s information infrastructure is significant enough to warrant an extra effort on the part of Penn State to ensure that the key people planning for and implementing those plans remain relatively stable.

The guidance that C&IS has received from the University Planning Council is to support only the highest priority activities within the limited resources available. As a service organization, tens of thousands of faculty, staff, and students are dependent on us for high-quality, highly-reliable service every day. After years of budget reductions, everything has become a “highest priority activity” and there is nothing that we can “stop doing” without impacting faculty, staff, and students somehow.

Budget recycling has been a long-standing practice in C&IS. We have historically phased out old technology and used the dollars saved to invest in emerging technology required by our user community. It is the only way we have made progress during a decade of flat budgets. The practice of across-the-board budget reductions has disrupted our historic practice of managing change through recycling. For the past several years, we have been surrendering recycling dollars in exchange for “enhancement” funds. The net result is that some areas have been particularly hard hit at a time when external belief is that C&IS has benefited from these across-the-board budget reductions. For example, by the end of this two-year Plan, OAS will have taken over $1 million in permanent budget reductions and received only $230,000 in enhancement funds over the last five years. In addition, OAS has paid an enormous price in the time and effort required to extract themselves from aging technologies that are embedded into the routine business processes of the entire University. The time and effort that OAS has expended is an additional burden beyond the direct dollars they have given up. OAS provides only one example of the impact felt by offices within
C&IS that no longer have access to recycled funds to invest in the new technologies required by our users.

It is hard for some of our users to understand that doing more with less in a service organization such as C&IS means that they have to do more with less. The common belief is that C&IS has been adequately funded despite the fact that we have had zero growth in our budget for the decade prior to the 1995-96 fiscal year—a decade when we saw explosive growth in the demand for the services we provide. This year has seen some significant improvements, but those improvements have been possible only in selected areas, leaving other key areas significantly leaner than they should be.

**D. Special Areas of Concern**

Under the University’s tightly constrained fiscal environment, we must maximally leverage the investments we make. In this regard, C&IS is concerned that there are some key areas where the University has not taken full advantage of the investments made or the opportunities that exist. These include:

**Training:** University offices continue to be unevenly committed to enabling staff to take time away from tasks to be appropriately trained to maximize the value of the investments made in technology. Over the course of a year, entirely new technologies come and go, impacting how nearly every member of the University should (or could) carry out his or her job. We must keep pace with these ebbs and flows or we will fail both as an institution and as an employer. It is ironic that the “Temp Agencies” in State College are now requesting our Office of Human Resources to train their workforce in University information systems (such as IBIS) to better prepare them for part-time University jobs when many University offices are reluctant to free their current employees for the same training. MIT has, for the first time, devoted $1.5 million of central funds to provide staff training, seeing it as an important way to facilitate the type of process change needed to reduce administrative costs. Penn State needs to take similar steps.

**Infrastructure Support:** As with most universities, Penn State finds it easier to make one-time investments in information infrastructure than to make continuing investments to support that infrastructure. However, infrastructure investments must account for 1) the need for life-cycle funding to replace equipment as it ages, and 2) the human infrastructure necessary to support effective use of this technology. More attention must be given to the support costs of the technology infrastructure.

**Grade/Salary Structure:** The University’s ability to attract and retain those with the necessary skills and experience to support our information technology needs appears to be getting worse. Staff who depart cite substantial salary differentials, and new staff have become very difficult to hire at current rated grades and salaries. As a result, we are slowly becoming understaffed in the skill base we need, in addition to being chronically understaffed in terms of the sheer numbers of positions funded. C&IS has, in fact, become a training ground: We invest in people, train them, and then other organizations reap the dividends by hiring them at competitive salaries. Organizations committed to being “best in class” typically recognize that it requires something close to a "best in class" compensation package. In the area of information technology, it is becoming increasingly difficult to provide sufficient non-financial incentives to account for our below-average compensation levels.

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30Jim Bruce, Common Solutions Group, January 1997.
Improved Information for Decision Making: The Steering Committee for Improved Administrative Information Systems Processes has identified the need to provide improved information for executive decision making. The University’s AIS systems have fulfilled their mandate for automating the University’s business processes, but they have not succeeded in changing the way that decisions are made. In this respect, the University’s administrative systems are “input rich” and “output poor.” Appendix A provides a listing of the types of data that are available in the AIS Data Warehouse. This listing makes the point that although we have lots of data (over 53 million records at this time), it is not being used to its best advantage. The University must improve the accessibility of the data in the Data Warehouse and stimulate its use for better decision making.

Network Administration: With the growing number of departmental networks, the importance of the Network Administrator position continues to grow. Network Administrators are key to keeping departmental networks operating and secure. Too often these important tasks are allocated as “other duties as assigned” to already overloaded staff members who often have inadequate technical knowledge to effectively carry out these tasks. Executives who rely on such networks must ensure that those assigned these responsibilities have both the time and the skills necessary to do the work.

Process Improvement: Although significant efforts continue to be made through the University’s CQI initiative to provide process improvement, there is still no University-wide commitment to take advantage of technology to re-think and re-craft key business processes. As a result, we still are “paving over” too many “cow paths.”

The Courage to Experiment: All of those we talked to in our external assessment confirmed that having the courage to experiment with new approaches and new applications is critical to staying on the leading edge. Penn State is traditionally a rather conservative institution, and as such, it is sometimes difficult to gain executive support for experimentation in new areas. To maximize the benefit of technology investments, broad-based executive support for appropriate experimentation in new approaches to leveraging our information technology investment is important. Experimentation includes the likelihood of occasional failures—and it must be understood that it is part of the landscape we must cross. With the pace of technology change measured in months, we cannot afford to wait to see what succeeds elsewhere before trying it.

Asbestos Removal: The presence of asbestos in some buildings can cause a substantial financial and operational setback in spite of cabling infrastructure installation procedures that minimize cost, delays, and complexity. The cost estimates for wiring University Park buildings compiled by the University’s Study Group on Information Infrastructure specifically excluded the costs of removing or working around asbestos because it was expected that such costs would be borne by budgets associated with Physical Plant Maintenance, and perhaps administered by OPP. However, OPP has clearly stated that funds for removal or workaround have not been allocated to their departmental budget. The number of buildings at University Park with asbestos in them is unknown. Of those known, several are of recent construction and quite sizeable (e.g., Eisenhower Auditorium). Unless a source of funds is identified for asbestos removal in the 100+ buildings earmarked for cabling upgrades as part of the state-funded University Park Information Infrastructure Upgrade program, we run the risk of not being able to spend the funds being provided by the Commonwealth for this project.

Electrical Power: As expectations and demand for network reliability continue to grow, we must address a weak link in our infrastructure—the availability of reliable, conditioned power. Conditioned power needs to be available where sensitive electronics gear demands it, to provide uninterruptible power for critical telecommunications and
computing gear, and to make sure that essential network management capabilities are supported during problem periods. Without the availability of reliable, conditioned power, the reliability of our information infrastructure will deteriorate.

Budget/Funding Policies: As was noted earlier, given the predicted limits on traditional sources of funding, it is imperative that new sources of funding—and new approaches to funding—be identified if Penn State is going to successfully address the University’s information technology needs. In addition, changes to current budget/funding policies to make them more flexible and responsive in a fast-changing environment are needed. Some suggestions for areas of exploration include the following:

• University financial policies must eliminate disincentives to the use of new technology. The disincentive that we have cited in the past has been the requirement to cost-recover network connections to the University backbone, while providing free service for 1970-era SNA technology. We are pleased that the University is supporting our move to begin cost recovering SNA connectivity in July 1997, and we encourage the University to look more broadly for similar incentives to encourage appropriate use of technology.

• University policies that discourage investment in and use of information technology tools must be eliminated. A key issue is which services are considered “cost-recovery” and which are centrally funded. This is especially important given the “overhead taxes” that follow cost-recovered services. One key example is data communications. In late 1993, after conducting a formal review of the University’s Auxiliary Enterprises, a committee chaired by now-retired Senior Vice President Steve Garban recommended that the University continue to fully cost recover dial tone and long distance services, but that data networking services be considered a core utility service with the costs of the network centrally funded. Moving forward on this nearly four-year-old recommendation is critically important to ensuring the continued development of the University’s data network.

• This same 1993 study implemented a three percent “overhead tax” on all Auxiliary Enterprises to ensure that no General Funds were used to subsidize Auxiliary Enterprise activities. Organizations within C&IS, particularly CAC and OAS, provide services (e.g., Access Accounts, IBIS processing) to Auxiliary Enterprise offices without receiving any compensation. Funds generated from this “overhead tax” could be shared with C&IS to appropriately eliminate the current subsidy C&IS is providing to Auxiliary Enterprises.

• The University needs to more aggressively seek out “discretionary” services and begin cost-recovering them. A prime example is provided by those who continue to generate printed output. Nearly $500,000 in centrally subsidized printing (nearly half of which is paid for by OAS) is spent annually to support the (largely discretionary) printing needs of central administrative offices. This one change in policy could eliminate all requests for additional funding from OAS for the first two years of this Plan—and place the responsibility for controlling printing costs where it belongs—in the hands of the end user.

• The University should consider implementing a process for mid-year budget increases. Predicting the types and demand for information technology services

31It is estimated that at least $250,000 in continuing funds is needed to initiate this program.
over a period of 18 months is difficult, if not impossible. In order for Penn State to be agile enough to meet the demand imposed by advances in technology, it is critical that we be capable of reacting to demand within the few-months-long timeframes in which many of these services mature. A provision for mid-year budget allocations, such as that provided in November 1995 to address student computing needs at University Park, provides a notable step in that direction.

- Don Norman of Apple Corporation strongly suggested that we look carefully at the distance education function as a source of funding for information infrastructure. He made the point that even current distance education activities depend heavily upon that infrastructure (not only at the “remote location,” but also on campus) and that, even though distance education is often treated as a “cost-recovered” function, it often is not paying “its fair share” of infrastructure costs. He suggested that, as we expand our outreach efforts (as he correctly assumed we would be doing), we should look closely at this as a potential significant funding source for the University’s information infrastructure.

- Additional funding strategies that the University could consider to fund information infrastructure include:
  - Issuing bonds.\(^{33}\)
  - Focusing upon information technology in our Capital Campaign.\(^{34}\)
  - Identifying and reallocating some of the return gained via research funding.
  - Capitalizing upon the creation of intellectual property.

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\(^{33}\)The University of Iowa used bonding authority to specifically fund their information infrastructure in 1994.

\(^{34}\)Northwestern University has included information infrastructure as a major component of their soon-to-be announced Capital Campaign.
V. OVERARCHING GOALS

In order to carry out our Mission, the Office of Computer and Information Systems has defined a set of Goals. These goals define what we hope to help the University achieve through the cost-effective application of information technology. C&IS will work to:

- Achieve national leadership in undergraduate education by empowering faculty and students.
- Enhance Penn State's position in graduate education and research.
- Leverage technology to support outreach.
- Transform the way the University Libraries deliver information.
- Transform the administrative operations of the University.
- Aggressively explore emerging technologies that show potential for application in all mission areas.
- Increase the diversity of the information technology workforce.
- Eliminate barriers to information access faced by the disadvantaged and the disabled.
VI. STRATEGIES

C&IS has developed four broad strategies to meet its—and more importantly, the University’s—goals. The overall effect of these strategies is to provide the University with an information infrastructure to support learning, research, and outreach, better preparing our students and faculty to compete in an increasingly complex information-centered society. This section outlines the specific areas of each general strategy that we will be targeting for action in the next five years.

A. Continually Enhance and Institutionalize the Information Infrastructure Necessary for the 21st Century

Penn State’s information infrastructure must be an institutional enabler, providing ubiquitous access to the student, faculty member, and administrator, anytime and anywhere. It must serve as a basis for increased information access, expanded research and instruction, and external collaboration and resource sharing. To consistently meet these challenging requirements, C&IS must continually enhance the federation of services it provides, whether it be adding more training services or replacing equipment. Institutionalizing (i.e., permanently funding) these predictable enhancements is essential to the integrity of the infrastructure already in place. Our specific strategies for achieving this over the next five years include the following:

• **Attract and retain qualified people who represent the nation’s diverse population.** It is of primary importance that the human infrastructure evolve to support the increasingly complex network of information services and systems. These skills are in high demand in our society, making this strategy a challenge to implement and emphasizing how critically important it is to our students and faculty that we provide best-in-class service. Of particular concern are staff to support our telecommunications infrastructure, our efforts in advanced technologies, and our network security needs.

• **Provide a secure information infrastructure.** As the number of services, servers, and workstations increases, protecting the University’s information assets becomes more critical. The only acceptable strategy for securing our information assets is to plan for information security as we plan for our information infrastructure. Security must not be reactive or implemented as an afterthought.

• **Increase investments to improve, maintain, and expand our information assets.** To keep up with the demands of quality undergraduate and graduate education and research, the overall architecture of the University’s information infrastructure (which includes hardware and software) needs to be continually enhanced. The University will have to embrace life-cycle funding, invest in the intercampus network, and support the development of methods of supplying compute cycles. As researchers integrate high bandwidth images and simulations into their teaching curriculum, networking bandwidth must be augmented to accommodate this need. Access to information technology in classrooms needs to be as commonplace as access to whiteboards, blackboards, and chalk. Network access in libraries, research laboratories, and faculty offices should be as pervasive as lights and electrical outlets. Accessing electronic mail and the World Wide Web should be as easy as sending paper mail or watching the news.

• **Institutionalize a University-wide information utility.** Penn State must institutionalize a University-wide information utility reaching every administrative
and faculty office, research facility, and classroom in the same way that other utilities, such as heat and electricity, are provided. Access to the University information highway cannot be limited to those who have the funds to pay for it. Cost should not be a barrier to access. The information infrastructure needs to be funded as a core utility to eliminate the financial roadblocks and enable colleges to develop more efficient and effective programs. The basis for funding the information utility should be the same basis as funding electricity and heat. Researchers aren’t limited in their use of kilowatt-hours of electricity because that is all that is currently funded—the necessary electric “bandwidth” is provided by the institution to meet the growing demand. The use of digital bandwidth should be similarly supported.

B. Continually Improve Information Services

Our second strategy, to continually improve the University’s information services to meet the changing needs and demands of a diverse population, includes the following specific strategies:

- **Continue modernizing the University’s administrative computing systems.** The University must move its administrative systems to a client/server environment to enable end users to realize maximum benefit from the massive amounts of information available. Areas of specific opportunity include the creation of a data warehouse to improve executive decision-making, on-line systems to help students “help themselves” in key areas such as advising, and enabling faculty to better support the administration of their classes and research projects.

- **Expand the University’s learning information resources to meet growing expectations and demand.** For this planning period, C&IS will focus its strategic activities on expanding the number of technology classrooms and student workstation labs at University Park to match student demand. Desktop services in residence halls and faculty offices also need to be expanded to provide the enhanced tools needed to reach the information resources necessary for instruction and research. We will continue to expand our investments in parallel computing and educational technology to meet growing demands.

- **Develop pilot projects.** With the rapid pace of technological change, the diversity of the University’s needs, and the complexity of our information infrastructure, it is simply bad business not to be doing at least a minimal amount of viability assessment on emerging technologies before investing in them. The Penn State federation of services works as well as it does because it is very carefully orchestrated to meet the specific needs and constraints of the Penn State environment. As it grows in complexity, and as the possibilities technology offers grow in complexity and cost, it becomes ever more critical that we test on a small scale before we invest on a large scale.

C. Enable the Cultural Transformation of the University

- **Expand our staff to stimulate cultural changes in business processes, learning, and research.** Our third strategy recognizes that as technology and its uses change, the University “culture” must also change. New teaching and learning paradigms are evolving as information technology becomes more pervasive. Entry into emerging research areas is enabled because of the availability of
information technology tools and services. Business practices must be reengineered to provide more effective and efficient administrative operations. These changes can only occur if the developers of the “transforming applications” are in place. Additional consulting staff are also needed to assist students in the use of information technology tools, to assist faculty in the integration of information technology into the curriculum and to assist researchers in developing methodologies and strategies for inter-institutional collaboration.

D. Enable External Collaboration and Resource Sharing

- Focus particular attention on support for external collaboration and resource sharing. As the number of information resources continues to escalate along with the associated costs, institutions will have to share resources in order to remain competitive. Information technology should enable the sharing of library resources, numerically intensive computing services, and learning technology development. Collaboration of researchers is likewise enhanced through information technology, enabling the University to more effectively compete for limited research dollars by enabling the sharing of multi-institutional assets. Participation in such efforts as the National Learning Infrastructure Initiative (NLII), the NSF Partnership for Advanced Computing Infrastructure (PACI) with Cornell, the NSF Connections Program, and Internet 2 are key to this strategy. Each leverages Penn State funds with outside funds so that Penn State’s efforts are amplified.
VII. ACTION PLAN

The most recent comprehensive survey of the University’s information technology investment needs is the 1993 Report of the Study Group on Information Infrastructure. Although this Report summarized the University’s Fall 1993 need for investment simply to “catch up” with the current demand, it still provides a useful reference point. The recent (and promised) significant investments in information infrastructure address some of the needs identified in that Report and thus enable us to identify more specifically those critical requirements that remain unaddressed since 1993. A summary of the most critical unmet needs includes:

- Telecommunications Infrastructure. Although we are still assuming that the $15.8 million for the University Park information infrastructure will be forthcoming from the Commonwealth in a timely manner, it must be recalled that the success of this project is dependent upon C&IS receiving $4.5 million in continuing funds to support infrastructure needs at all campuses and to provide the needed ongoing support (e.g., staff, life-cycle funding) for investments made with the $15.8 million. Over the last two years, $1.28 million of the $4.5 million has been provided. It is imperative that the remainder of these funds be provided quickly to meet back-logged demand.

- Human Infrastructure. Investments in the human infrastructure necessary to get maximum value out of University technology investments become ever more critical as computing power continues to be distributed to the college, the department, and the desktop. Of equal concern is our ability to create appropriate grade structures, offer competitive salaries, and provide incentives that will enable us to attract and retain the highly skilled individuals we need.

- University-wide Bandwidth. Funding to enhance the bandwidth connectivity between and amongst our 23 campuses is still not available. Fortunately, the Office of Telecommunications (OTC) has been able to take advantage of new services that have provided significant enhancements in bandwidth to the campuses without any increase in funding (changing from 56 KB to over 1MB to every campus). However, the next stage of improvement (e.g., to the 4 - 34 MB level) will require additional investment. This investment is critical to make because we are fast approaching the point where the Internet connectivity provided between University Park and the global community will be 100 times faster than the connectivity between University Park and other Penn State campuses. This will significantly impact how faculty and students at our campuses are able to interface with the global community, a particularly important issue in light of the restructuring of the CES campuses. We also need to plan for substantial enhancements in the bandwidth of our connection to the Internet. Internet 2 (and its successor) will require significant additional investments over the next five years.

- Network Security. Ensuring the security of the University’s computer and networking systems is becoming an increasingly difficult task. Penn State is one of a few national leaders addressing this complex and growing problem. But with virtually every member of our student body and our faculty becoming dependent upon the Internet for the conduct of their business, we must significantly enhance investments in network security. We must understand that the cost of a security breach may well exceed the cost of preventing it.
It may seem curious that, despite the unfinished status of many of the important requirements identified in the 1993 Report of the Study Group of Information Infrastructure, this Plan recommends addressing other items not mentioned in that Report. For example, much of our current information infrastructure still is not supported by life-cycle funding. At the same time, the demands for new services are such that our highest priority has to be to expand this infrastructure, even though funding has not been identified to replace the currently installed infrastructure as it ages. This helps demonstrate the dilemma the University faces. The reality is that we must keep moving. We cannot afford to stop and consolidate our current systems, or we may well find ourselves in several years with a full complement of equipment that is five years out of date.

The Action Plan that follows summarizes the specific actions that need to be taken to provide the information infrastructure to support faculty, staff, and student needs. The priority of each specific recommendation is reflected in the next section of this Plan.

A. Continually Enhance and Institutionalize the Information Infrastructure Necessary for the 21st Century

One of the most critical programs to enable Penn State to meet the challenges of the future is the continual evolution of the necessary information infrastructure and its ongoing support. This is not just an issue of physical infrastructure, but also human infrastructure. Funds must be identified to support both aspects of our information infrastructure on a continuing basis.

1. University Park Infrastructure Upgrade

Upgrading University Park's information infrastructure is key to the success of Penn State's overall information technology program. Even with the Commonwealth's promised $15.8 million in Capital funds to complete this project, progress cannot be made without continuing funds to support staff to provide ongoing support for equipment being purchased.

a. Staff

The Report by the Study Group on Information Infrastructure specified a need for additional support staff just to maintain the service levels that were available in 1993. The needed staff skills identified were primarily analysts and engineers. While some funds have been made available for staff resources related to the $15.8 million University Park Infrastructure project, the amount provided to date falls far short of that recommended by the Study Group and required to complete the job. Additional staff must be provided in both 1997-98 and 1998-99. Without adequate and appropriately skilled staff members, even the lesser levels of support that were required in 1993 cannot be maintained over time, much less the expansion in both numbers and types/complexity of services that users will require by the end of the current planning period.

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<th>1997-98</th>
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<td>$250,000 (P)</td>
<td>$150,000 (P)</td>
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b. Maintenance and Life-cycle Costs for Building Electronics
As recommended by the Study Group's Report, $1 million in continuing funds was requested in 1996-97 to subsidize the ongoing costs of data communications services. Of that amount, $500,000 was allocated. That allocation has allowed us to reduce the cost-recovery rate for backbone services and the rate for the “new networking services” being installed as part of the $15.8 million information infrastructure program (see Appendix B for details).

Although there are many factors that will affect the number of these new networking service connections that will be made over the next few years, our current projections are that an allocation of the remaining $500,000 of the $1 million requested for 1996-97 should be sufficient to cover these costs for 1997-98. As deployment of these services moves ahead during the next two years, we expect an additional $500,000 will be needed to maintain these rates during 1998-99, and an additional $1 million in 1999-2000. Because of the delays incurred as part of the $15.8 million information infrastructure program, there is no basis upon which to project what percentage of current LAN users may opt to take advantage of these new networking services. Hence, it may be necessary, at some point, to adjust rates for network services based upon the actual adoption rate of the new networking services.

If the $500,000 allocation is not made in 1997-98, the rates for LAN connections will have to be readjusted upwards effective July 1, 1997 (see Appendix B for details). The rate reduction approach outlined above is expected to help encourage users to take advantage of the newer technology being installed as part of the $15.8 million information infrastructure program by minimizing the monthly fees. It also assists those who currently have 10MB LAN connections in upgrading their networks to 100MB services by defraying a large portion of the associated costs.

In addition, as was identified in the initial plan for this project, $1.5 million in one-time funds is required to pay for the installation of the electronics necessary to activate network installations at locations other than University Park. In 1995-96, $1 million of this request was provided. Given the delay in the University Park Infrastructure Upgrade, we are not requesting the remainder of these funds until 1998-99.

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<tr>
<th>Year</th>
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2. Improve University-wide Network

The demand for growth in network speeds provided to our faculty, students, and staff—within campuses, between campuses, and to the Internet—will continue to increase over the next five years. While it is difficult to predict, let alone cost, requirements for the year 2002, OTC has developed plans for the next two years. These are summarized in Figure 2 below. There will be significant additional costs involved in increasing bandwidth between campuses and to the Internet, and in providing redundant service to non-University Park locations.

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35The purpose of this funding was to ensure that when buildings were wired as part of the University Park Wiring Upgrade, faculty and staff would not be precluded from activating network connectivity because of lack of funds.

36These costs at University Park are covered by the $15.8 million Capital Funds allocation.

37Cost for increases in bandwidth to the Internet are covered in Item D of this Action Plan (see page 49).
<table>
<thead>
<tr>
<th>Date</th>
<th>UP LAN</th>
<th>UP to the Internet</th>
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*This will be in addition to the 100 MB FDDI backbone service but may be limited to specific locations.
**This will support Internet 2 services. An additional 20 MB of bandwidth may be provided to support commodity Internet service.
***For some campuses.

**Figure 2: Bandwidth Growth in the Penn State Network**

a. *Increase Bandwidth*

As the demand for service improvements between Penn State and the Internet increases, so also will the demand for expansion of telecommunications services between University Park and the other campuses. Today, even after taking advantage of rate reductions and service improvements provided by service vendors, the highest bandwidth OTC is able to provide to non-University Park campuses with current funding is slightly in excess of 1MB. This level of service is simply unacceptable to support the needs of our non-University Park users. Funds are needed so that the bandwidth to most campuses can increase to 4 MB in 1997-98 and to 34MB for those campuses requiring it in 1998-99. Funds are also required to support the expansion of campus LANs at non-University Park locations from 10MB to 100MB, a project that could be completed by 1999.

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b. *Intercampus Redundancy*

As dependency upon networked services increases, it is critical that a degree of communications circuit redundancy be provided to all campuses to allow continuation of critical tasks virtually 100 percent of the time. The approach recommended does that in a cost-effective manner that tolerates some degree of temporary performance degradation in order to limit costs. In order to further minimize costs, the approach chosen, while having a

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38At University Park, these costs are paid for by a combination of life-cycle funding and by a portion of the $15.8 million in Capital Funds. LAN connections at non-University Park campuses have no monthly charges that contribute to a life-cycle replacement fund. As a result, major upgrades to the backbone services at the non-University Park campuses currently depend entirely upon allocation of central funds.
fixed cost for equipment and service subscription, has a usage-dependent component\(^{39}\) that is only activated when situations requiring redundancy occur. If these funds are not provided, communication services at all campuses will continue to be disrupted by problems beyond our control (e.g., bad weather), and in many cases, campuses will be unable to do any work during periods of service disruption. In 1998-99, redundant services will need to be increased to accommodate the increase in bandwidth being provided to the campuses.

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3. Network Security

Network Security is fundamental to the types of services that Penn State will require in the future. To provide even minimum levels of Network Security support as more and more functions become distributed will require growth of our Network Security staff.

Faculty, students, and staff require a reasonable level of assurance that confidential information will not be revealed, that computing resources will be available when needed, and that neither institutional data nor their own electronic files will be subject to unauthorized modification or deletion. The complexity of providing this assurance has grown dramatically with the distribution of computing capability to the desktop. In the past, mainframes and “dumb” terminals could be secured centrally. However, the technology does not yet exist to effectively secure from a central point an environment of intelligent desktop computers of widely varied hardware/software configurations, operating systems, and multiple servers. Instead, each local area network (LAN) administrator must assume a high level of responsibility for the security of his/her network. The skills and security awareness of local system and network administrators must be enhanced.

Penn State’s network security program is at a major turning point. It is critically understaffed for the scope and range of its responsibilities, the ever-growing tide of incidents, and the expansion of both its user base and the level of computing being performed at the desktop. Penn State is well-positioned in this area in relation to its peer institutions, but without staff resources, we will quickly devolve from a position of leadership to one of “catch-up” at best. The investments below will provide an additional staff member for Network Security in each of the next two years.

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4. Space

C&IS first requested space relief through the Capital Budget process in our 1987-88 Strategic Plan. At that time, we stated that we would need additional space by 1997. An extension to the Computer Building was proposed as a solution. The demand for space in C&IS has been worse than we predicted in 1987. Only by renting space off-campus and more recently occupying the majority of the University Support Building II (USB II) have we been able to find sufficient space for the staff needed to fill the increased demands for C&IS services.

\(^{39}\)Estimates of the quantity and durations of these situations are based upon historical data compiled by OTC.
We are now at a critical juncture. We cannot “shoe-horn” additional employees into already over-crowded work areas. Yet the expansion of the University’s technology infrastructure requires a commensurate investment in the human infrastructure needed to manage it. These additional staff require adequate space to work in.

The consolidation of the OAS and CAC computing centers could provide economical space relief for the next two years. To take advantage of this consolidation will require renovating the space that the OAS Computing Center currently occupies. This would allow the OAS staff currently residing in USB II to relocate into the Shields Building, enabling OTC to reclaim USB II space for their data and communications engineering staff. The space this staff vacates in the Telecommunications Building can then be used for the Network Operations Center staff and the Network Security staff.

This action will only provide temporary relief. Additional space will be needed, possibly as early as the summer of 1999, for the projected growth of OTC and Network Security. Some combination of the following alternatives must be implemented to provide adequate space for future needs:

- Construct an addition to the Computer Building as recommended in 1987.
- Provide additional space in USB II, as well as construct an additional structure on that site.
- Acquire reprogrammed academic support space generated by the relocation of the College of Science or the College of Engineering.

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5. Life-Cycle Funding

Many of the University’s information technology assets continue to age with no visible hope of funding for their replacement. Given the University’s extremely tight fiscal environment, we are once again identifying the most pressing of these needs, but deferring most of the funding requests until 1998-99.

a. Technology Classrooms

C&IS, in collaboration with the University-wide Committee on Instructional Facilities, has been creating technology classrooms since 1991. Several years ago, the Facilities Resource Committee (FRC) established a policy that all new technology classrooms needed to have life-cycle funds identified as the facilities were funded. This has been extremely helpful in keeping technology classrooms up-to-date. In each of the past several years, permanent life-cycle funds have been provided to C&IS for the classrooms installed in the previous year.

This year, $360,000 in Student Computer Fee funds are being used for the development of five technology classrooms at University Park (three collaborative classrooms and two large auditoriums) and seven classrooms at non-University Park locations. The funds requested will address life-cycle needs for the classrooms being installed.

40These sites will be selected from proposals submitted by faculty later this year.
b. Satellite Uplink

When the University’s first satellite uplink (transmitter) was installed in 1987, a three-tier cost-recovery approach was put in place. Use of the facility by those offering credit courses was centrally funded, use by continuing education and other separately budgeted entities offering non-credit courses was cost-recovered (for out-of-pocket labor costs), and uses by commercial enterprises were recovered at a “full commercial” rate. The commercial rate included a component to be put toward eventual replacement of the equipment, for which no other life-cycle budget was supported. The balance accumulated through that fee structure is, as was expected, modest given the limited commercial use there has been.

The end of the equipment’s projected ten-year lifespan is now approaching. While much of the structure will continue to serve our needs for many years, many of the relatively expensive electronics are nearing the end of their actual lifespan. If reliable, quality satellite service is to be offered, funds will be needed to replace the current worn-out equipment and to provide future replacements when needed.

Funds to upgrade the internal and external antenna controllers and motors and to replace aging electronics with those needed to provide up-to-date digital services are being requested. In addition, it is strongly recommended that a permanent maintenance fund of $15,000 (P) be established, as well as a life-cycle fund of $35,000 (P) to ensure that funding for the next generation of upgrades for this service will be available when needed. If these funds are not provided, services will deteriorate until the cost of operation exceeds their value, at which time the equipment will be salvaged. This would have a significant negative impact on our Distance Education activities.

<table>
<thead>
<tr>
<th>Year</th>
<th>1997-98</th>
<th>1998-99</th>
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<tbody>
<tr>
<td></td>
<td>$140,000 (P)</td>
<td>$60,000 (P)</td>
</tr>
</tbody>
</table>

c. LIAS Workstations

Prior to 1996, LIAS workstations were low-cost “dumb” terminals connected to a powerful LIAS server. As the number and complexity of information resources increased along with student and faculty demands for information tools and accessibility, the “server-centric” model for delivering LIAS information became too limiting. To enable new types of information to be delivered to LIAS workstations (including image, video, and sound) as well as to enable access to additional information resources, the LIAS terminals were replaced with microcomputers. As pointed out in the 1993 Report of the Study Group on Information Infrastructure, funds need to be provided to upgrade these workstations as technology changes.

<table>
<thead>
<tr>
<th>Year</th>
<th>1997-98</th>
<th>1998-99</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$100,000 (P)</td>
</tr>
</tbody>
</table>
d. CAC Staff Equipment

Equipment for personnel in the CAC, who depend upon current computing equipment and emerging software to do their jobs, also needs to be frequently updated. Unless these funds are provided, the number of those who are able to do leading-edge work in course development and support of research computing will be reduced in an area where demand already outstrips availability. Funding is requested to replace staff equipment no longer capable of supporting leading-edge needs.

<table>
<thead>
<tr>
<th></th>
<th>1997-98</th>
<th>1998-99</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>$335,000 (P)</td>
</tr>
</tbody>
</table>

6. Diversity

In the area of diversity, C&IS will continue to sponsor and participate in programs that contribute directly to improving and enhancing diversity at the University, especially in the information technology field. Funding for all diversity programs over the next two years has already been reallocated within C&IS’ operating budget. Specific actions we plan to take include:

- Over the next two years we will continue our attempts to find additional business partners to fund participants in the Academic Computing Fellowship Program.

- We will continue our cooperation with the Office of Disability Services to provide access to adaptive technologies that enable students with disabilities to use information technology productively in their curriculums.

- Because we cannot absorb more than one graduate of the Professional Development Program (which currently has three participants) into a full-time standing position in C&IS each year, we will try to expand the number of program participants over the next two years by recruiting other University departments to cost-share a position. We did this last year with the Department of Student Affairs.

- We will continue to offer employees an opportunity to learn new skills through OAS’ Job Enrichment Program and a similar, less formal, program in the CAC. These programs enable us to provide the training necessary for employees to acquire the skills needed to move from the staff non-exempt ranks to an exempt position that holds more career promise. These efforts have already successfully moved a number of staff into positions that provide greater value both to themselves and the University.

- In 1997-98, we will provide at least two educational opportunities for all staff members to increase their diversity awareness as well as improve communication mechanisms throughout the organization.

- We will continue to contribute the costs for the rental of the Wagner Training Facility as part of our support for the Office of Human Resources’ Summer Staff Assistant Training Program.

7. Mandatory Administrative Software Increases
The baseline expenditures required by OAS to run their computers and information systems cover a variety of hardware and software maintenance and lease agreements that have been signed over the years. The greatest share of these costs are allocated to the substantial collection of operating system, data base management, programming, and workload scheduling systems software. These baseline expenditures are included in the permanent operating budget of OAS, but annual increases to cover inflationary costs are not. Just as the cost of doing business increases in every other area of the University, the cost of doing business in OAS also increases. These cost increases, which are necessary simply to “continue doing business” in OAS, are not covered in the OAS permanent budget and, therefore, are being requested as the highest priority permanent increase for C&IS for the next two years.\(^{41}\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-98</td>
<td>$75,000 (P)</td>
</tr>
<tr>
<td>1998-99</td>
<td>$25,000 (P)</td>
</tr>
</tbody>
</table>

**B. Continually Improve Information Services**

Because information technology is dynamic and ever-changing, services cannot be implemented once and be declared forever “done.” They must be constantly renewed, upgraded or replaced with newer, more cost-effective models. C&IS will be required to introduce new or improved services in a number of areas to meet ever-changing needs and growing demand. The following are examples of specific actions needed in the near-term:

1. **Administrative Information Systems (AIS)**

   OAS will be required to move its architecture to a more modern computing paradigm. Areas in which work is already underway and must continue include data warehousing, the CAAIS effort, and the overall transition of current mainframe applications to a client/server model. All of these enhancements will be achieved without any increase in budget.

   **Data Warehouses:** A key element of the transition from mainframe to client/server computing is expansion of the role of the data warehouse. This new service already provides frequent and easy access to millions of data records about faculty, staff, alumni, friends, courses, majors, campuses, budgets, expenses, gifts, and other critical information to support decision-making. In the next few years, the data will be re-structured to make it more appropriate for executive decision-making.

   **CAAIS:** One of the most exciting new services for students will be those provided by the Comprehensive Academic Advising Information System (CAAIS). This is a Web-based advising system that is readily accessible to students directly or to faculty on behalf of the students. CAAIS is an on-line expert system that will advise students through their most difficult academic decisions to help them obtain the greatest value that they can from their Penn State education. CAAIS is a direct response to student requests for improved advising services.

   **Transition to Client/Server Computing:** In a carefully crafted plan growing out of the Future Computing Environment (FCE) Committee, OAS will introduce client/server computing first to those areas that give the greatest process improvement payback such as CAAIS and the Financial Information Tool (FIT). OAS’ mainframe computer systems will evolve to an enterprise server with new open access capabilities that will shape administrative

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\(^{41}\)The CAC, which has some of the same problems, is not affected to the same extent as OAS because of vendor programs that protect “academic use” from large increases.
computing in the future. Moreover, the Distributed Computing Environment\textsuperscript{42} (DCE) will be installed on all computers (clients and servers) to simplify the management and security of the distributed client/server network.

2. **Access Project Enhancement**

CAC will continue to enhance the Access Project, which provides standards-based, distributed computing to over 100,000 faculty, staff, and students. During this five-year period, the CAC will consolidate the services and move them into the Distributed Computing Environment. The goal is to provide simple-to-use access to information and to facilitate collaboration in a way that is similar to “dial tone”—it is there when a person needs it.

New services include emerging capabilities such as “Personal Web Pages,” which provide individuals with a means of communicating to others what they are currently doing. This service is becoming the norm at most major universities. Students will increasingly use their “pages” to provide information to recruiters and others. Faculty will use this space to provide early results of their scholarly works.

Along with other C&IS units, CAC will aggressively explore ways to enhance the speed of connectivity of off-campus residences with the University’s network. This is fundamentally important to the national trend towards “telecommuting.”

3. **Parallel Computing**

One of the major changes in technology in the last five years is the use of “commodity” computer components in parallel to provide very high performance at much lower cost than can be provided by more esoteric serial computers. The CAC has been a leader in this area not only to support research, but also to support the Access Project and other non-research functions. The CAC will continue to aggressively explore the use of parallel computers to meet the explosive demands of faculty, students, and staff at reasonable cost. This activity is consistent with the vision expressed in the 1991 Strategic Plan for Academic Computing.

4. **Education Technology**

The CAC has provided leadership in the thoughtful use of technology in teaching and learning. The CAC will continue this function by exploring new technologies for suitability in the University’s curriculum and by training faculty and staff in their use. These activities will be increasingly important to Penn State’s competitiveness as other institutions begin to improve their efforts in this area.

5. **Student Services**

a. **Student Labs**

There are no funds available to open new student Microcomputer Labs at University Park in future years.\textsuperscript{43} Funding is only just sufficient to operate the existing Labs and keep

\textsuperscript{42}DCE includes all of the components necessary to link clients and servers together in a reliable, secure, and flexible manner: security services, directory services, time services, file services, threads, and remote procedure calls. DCE is often referred to as “middleware” because it operates “in the middle” between the client and server computers.

\textsuperscript{43}$250,000 in Student Computer Fee funds used for this purpose in 1996-97 will be reallocated to University Park colleges in 1997-98.
machines acceptably current. At the end of Spring ’96, there will be over 1,400 machines at University Park. CAC operates six labs twenty-four hours a day throughout most of the semester. Each semester, there are well over 1,000,000 individual sessions in University Park labs run by the CAC.

Demand, however, is still outstripping availability, a fact attested to by the lines of students waiting to use machines. We need at least 200 and probably 400 more computers to meet current needs.\(^{44}\) Without additional funding, there will be increasing student dissatisfaction with these labs and increasing limits on what faculty can do in the curriculum. Student Fee income must be supplemented by General Funds in order to meet this demand.

\[
\begin{array}{c|c|c}
 & 1997-98 & 1998-99 \\
\hline
\text{Student Fee} & \$250,000 (P) & \$50,000 (P) \\
\end{array}
\]

b. Technology Classrooms

Penn State has been building Technology Classrooms since 1991. Historically, funds from the Facilities Resource Committee (FRC) have supplemented Student Computer Fee funds for this purpose (see Figure 3 below).

\[
\begin{array}{c|c|c|c}
 & \text{Student Computer Fee} & \text{FRC} & \text{Other Sources} \\
\hline
1991-92 & $100,000 & $600,000 & $25,000 \\
1992-93 & $150,000 & $0 & $25,000 \\
1993-94 & $150,000 & $80,000 & $25,000 \\
1994-95 & $150,000 & $130,000 & $25,000 \\
1995-96 & $150,000 & $230,000 & $25,000 \\
1996-97 & $360,000 & $0 & $25,000 \\
\end{array}
\]

**Figure 3: Funding Sources for Technology Classrooms**

Demand for Technology Classrooms continues to grow, yet total University investment has decreased this year and will dramatically decrease beginning in 1997-98 without supplemental funding, as only $160,000 in Student Computer Fee funds will be available for Technology Classrooms in 1997-98.\(^{45}\) If Penn State is to continue to make the curricular changes required in the 21st century, Student Fee income must be supplemented by General Funds to meet this demand. Failure to do so will result in gradual deterioration in the current technology classrooms and will preclude installation of computers in the appropriate number of additional classrooms.

\[
\begin{array}{c|c|c}
 & 1997-98 & 1998-99 \\
\hline
\text{Student Fee} & & \\
\end{array}
\]

\(^{44}\)The use of machines changes so rapidly that it is hard to estimate actual needs.  
\(^{45}\)$200,000 in Student Computer Fee funds used for this purpose in 1996-97 will be reallocated to University Park Colleges in 1997-98.
6. Faculty/Staff Modems

Faculty and staff continue to do more of their work from off-campus locations. This extends the working day for many. In the case of faculty, it allows them to have irregular office hours via electronic mail and other means. For staff, it allows them to do work from home at night and on weekends.

Other organizations are finding that they can save significant funds by having staff work from their homes rather than provide them with offices. This is beginning to happen at Penn State as well. Both of these trends require additional connectivity for faculty and staff. The number of modems to support faculty/staff must be increased to avoid them consuming those funded by Student Fee income for student use.

<table>
<thead>
<tr>
<th>Year</th>
<th>Faculty/Staff Modems</th>
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<tbody>
<tr>
<td>1997-98</td>
<td>$30,000 (P)</td>
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<tr>
<td>1998-99</td>
<td>$30,000 (P)</td>
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<tr>
<td></td>
<td>$150,000 (T)</td>
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<td>$150,000 (T)</td>
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</table>

7. Wireless Communications

Wireless data communications is a technology that is rapidly maturing, especially cellular services and other services that provide coverage for metropolitan areas. OTC is developing a relationship with one of the leading vendors of these services to offer low-cost services at University Park. Trials have been developed to evaluate the viability of certain vendor products for various applications. OTC plans to continue to develop knowledge and experience with wireless services, and to make them available University-wide as soon as feasible.

8. Library Computing Services

Library faculty need support for research in digital library solutions. The University Libraries’ plan is to develop a process modeled after that used by Educational Technology Services in the CAC to provide core funding for courseware development for University faculty. A small pool of funds would be competitively offered to assist library faculty with hardware and software grants for digital library research, enabling the introduction of new digital library technologies for Penn State students and researchers as well as making the University more competitive for grants in this emerging research area. C&IS strongly supports this new initiative being requested by the University Libraries.

9. Pilot Projects

The use of pilot projects plays a key role in controlling risk while assessing the viability of new information technology opportunities. Although central support of pilot projects has been infrequent in the past, those projects supported have proven well worth the modest funds expended. They include developing a prototype of the University’s high-speed data backbone, trial of very early releases of interactive video equipment, and modeling of our statewide network prior to making long-term commitments for vendor services and products.

The relatively modest amount of funds spent on these undertakings have enabled us to confidently provide state-of-the-art services in Penn State’s specific environment with
minimal chance of regret. Funds for these purposes, however, have been notably absent from C&IS’ budget for some time—resulting in higher degrees of risk-taking than necessary, and in some cases preventing any experimentation with a new technology prior to implementation. Because of a lack of funds to test concepts, products, or services on a small scale prior to more widespread use, relatively large investments are now made on the basis of vendor claims and theoretical models, without the benefit of real-world evaluation in Penn State’s environment. Thus far we have been fortunate to have incurred only a few, relatively low-cost miscues due to lack of funds necessary to perform proper evaluations. However, the growing cost and rate of advancement of information technology will unnecessarily increase risks beyond what they would be if even a modest investment were made to support pilot projects. Even the modest amount of funds requested here will substantially lower risks.

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<tr>
<th></th>
<th>1997-98</th>
<th>1998-99</th>
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<tr>
<td></td>
<td>$100,000 (P)</td>
<td>$100,000 (P)</td>
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C. Enable the Cultural Transformation of the University

The “transformation” of the University to an environment that will enable Penn State to remain a leading university in the 21st century is, to a large extent, dependent on how effectively we exploit the opportunities provided by information technology. These opportunities lie not in the technologies themselves, but in the applications they enable. These applications can be developed by C&IS, but only if C&IS is able to invest in the staff necessary to do so. Additional applications staff are required in the areas of academic computing, library computing, and administrative computing if we wish to leverage technology to transform the University.

1. Applications Support Staff
   a. Transition of AIS to client/server computing

   A key ingredient in the cultural transformation of the University is the re-engineering of our current business processes. For example, the Departmental Accounting phase of IBIS offers significant opportunities for process improvements if the system users are poised to take advantage of them. Departmental Accounting includes a new set of client/server functionality that enables departments (budget administrators, principal investigators, project managers) to have more timely and accurate financial information when and where they need it. This new functionality should improve, update, and replace most of the financial processes that have been used by departments for the past 20 years.

   The transition from mainframe to client/server computing is requiring more staff than previously estimated because OAS must continuously improve its baseline operating systems while, at the same time, creating new client/server systems for accessing and analyzing administrative data. The emergence of the latter is not diminishing the requirement for the former. To sustain both areas requires a modest, but important, increase in staff. The staff increase is especially modest when considering that our peer institutions are making major investments ($60 to $80 million) to replace their obsolete student and business systems. Penn State will be able to escape these investments because of its decade-long investment in state-of-the-art administrative information systems.

   Altogether, OAS needs six additional development staff over the next two years (three each year). Four of these staff will be funded from the $417,000 central IBIS budget. The two remaining staff are being requested in this Plan.
b. Research Computing Support

As computer simulation and analysis have become fundamental tools for research in a wide range of disciplines, the demand for assistance has grown as well. This is because new technologies that are fundamental in many disciplines develop in short periods. For example, the use of high performance parallel computers that were lab curiosities in 1990 now are mainstream in a wide range of disciplines. To remain current, faculty need assistance in moving their software to these new machines. Similar patterns are true in graphics and visualization where new technologies are emerging.

Areas such as Simulated Environments and Data Mining will necessarily result in a need for more direct support of faculty and graduate students. Additional highly skilled staff are needed to perform this work. Without their assistance, the University may endanger its position as a leader in several strategically important disciplines in engineering and the physical sciences. Other areas such as business and the social sciences are likely to demand these skills as well.

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<tr>
<th></th>
<th>1997-98</th>
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<tr>
<td></td>
<td>$50,000 (P)</td>
<td>$50,000 (P)</td>
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c. Digital Library Research

The need for librarianship on the Internet to organize the information, authenticate its validity, provide search and navigation tools, assure long-term access, and provide an archive for preservation of important data and information has become obvious. The old card catalog and its electronic equivalents are insufficient for the new digital library. Library information is no longer bound to the acquisition budget of the institution, nor is it controlled as an institutional asset. The new digital library spans institutional buildings, university campuses, inter-institutional consortia, and national and international boundaries. New tools need to be developed to help people deal with the mass of information, search and navigate multimedia information, and insure access to information while maintaining intellectual property rights.

Penn State does not have the choice of waiting until someone else develops the standards, tools, and policies for the digital library. To survive as a best-in-class institution, Penn State and its consortia partners must take the lead in digital library research to produce the information tools and policies that will enable efficient use of the Internet as a teaching and learning information tool. This will require technology consultants who can be accessed by faculty when developing their research projects on digital library issues, and digital library experts to help faculty formulate research projects, apply for grants, recommend hardware and software solutions, assist in problem solving, and serve as a technology resource for digital library projects. One additional staff member is required in Library Computing Services in each of the next two years.

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<thead>
<tr>
<th></th>
<th>1997-98</th>
<th>1998-99</th>
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<tbody>
<tr>
<td></td>
<td>$50,000 (P)</td>
<td>$50,000 (P)</td>
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</table>
2. Consulting

The CAC has experienced explosive growth in the services that it provides. From less than 30,000 users four years ago, CAC now has over 100,000 active users of its services. This has placed a serious strain on the ability of CAC staff to answer questions and deal with problems that users cannot resolve themselves. Additional direct Faculty Consulting and Help Desk Consulting Staff are needed to adequately address user needs.

<table>
<thead>
<tr>
<th></th>
<th>1997-98</th>
<th>1998-99</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CAC Help Desk</td>
<td>$80,000  (P)</td>
<td>$0</td>
</tr>
<tr>
<td>b. Faculty Consulting</td>
<td>$0</td>
<td>$50,000 (P)</td>
</tr>
</tbody>
</table>

3. Desktop Services

As more and more computing responsibility and power is distributed to the desktop, it is critical that overall support to LAN administrators and system users be expanded. This includes support services such as training, software and hardware consulting, installation, and configuration assistance. It had been C&IS’ long-range plan to use the positions saved through the consolidation of the CAC and OAS computer centers to seed a new organization, Desktop Services, to begin to address these needs, but those funds are being used to cover our permanent budget reduction shares. Thus, any progress in developing a Desktop Services organization will be funded through cost-recovery.

D. Enable External Collaboration and Research Sharing

C&IS plays a key role in enabling external collaboration and research sharing for Penn State’s faculty and students. Of the examples highlighted below, only Internet 2 will require additional investments.

For the past decade, C&IS has facilitated the use of the National Supercomputing Centers to provide Penn State researchers with access to the very highest performance computing resources. The Cornell Theory Center and the Pittsburgh Supercomputing Center count Penn State faculty as major users of their facilities. The NSF-funded Supercomputing Centers program is being replaced by the Partnerships for Academic Computing Infrastructure (PACI). This new program leverages the use of parallel computers and networks to provide researchers with access to still greater computing power. Penn State is a partner in an alliance proposal headed by Cornell that combines researchers in the colleges of Science, Engineering, and Earth and Mineral Sciences with technical staff. Other partners include Brown, Maryland, UCLA, Berkeley, NYU, Stony Brook, Syracuse, Oregon State, and Iowa State. The announcement of the winning partnerships will be made by NSF in March 1997. If successful, this will greatly boost the academic use of very high performance parallel computers at Penn State.

The CIC Teaching and Learning Initiative and the National Learning Infrastructure Initiative seek to foster collaboration and resource sharing between institutions in the use of technology in the curriculum. As a national leader in the area, C&IS has important roles in these external collaborations. Staff from the CAC and faculty from several colleges are involved in these initiatives.

Universities have played a seminal role in the advance of computing technology. The move to collaboration between institutions requires that the systems at one institution be compatible with those at peer institutions. The Common Solutions Group is a consortium of
twenty-five institutions plus several major networks and related organizations that seek to ensure that collaboration is facilitated by common solutions to a wide range of technical problems. C&IS is an active member of this group, which includes other CIC institutions (Michigan, Wisconsin, Minnesota, Chicago) plus other information technology leaders such as MIT, Berkeley, Maryland, and Washington.

As the use of the Internet continues to grow and Penn State emerges as a leader in the development of its successor, Internet 2, numerous changes will be necessary to maintain service levels commensurate with Penn State’s needs, as well as to appropriately position us for the future. Connectivity will be even more essential than it is today. The applications that can use the Internet today are restricted by the small amount of bandwidth available. Internet 2 will enable a new set of applications by adding Quality of Service\(^{46}\) to provide bandwidth reservation from desktop to desktop. Using Quality of Service provisions in Internet 2, applications will be able to request a specific bandwidth allocation, end-to-end. This will enable video conferencing, remote control of experiments, and high performance data transfer. There are other requirements, such as multimedia, embedded voice services, and video and imagery, which can only be supported by the technology being implemented as part of Internet 2. Demand for our “commodity” Internet services, such as e-mail and World Wide Web service, will also continue to grow substantially.

In January 1997, the National Science Foundation awarded Penn State a two-year grant that will offset $350,000 of the costs associated with connection to the vBNS, the precursor of Internet 2. However, costs to obtain the nearly 100-fold increase in Internet connectivity will still be substantial. Estimates for 1998-99 are preliminary at best and can only be refined once the design and implementation of Internet 2 is further along and once the pricing of services currently not offered is defined.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-98</td>
<td>$425,000 (P)</td>
</tr>
<tr>
<td>1998-99</td>
<td>$950,000 (P)</td>
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</tbody>
</table>

\(^{46}\)Quality of Service (QOS) is a measure of performance for a transmission system that reflects differences in availability, delay, and classes of use in response to differing needs of video, data, and voice communications.
VIII. BUDGET PLAN

A. 1997-99 Budget Reduction Plan

The Office of Computer and Information Systems’ share of the University’s budget recycling plan is $267,468 for each of the next two fiscal years. We plan to meet this obligation through a combination of strategies.

We are in the process of combining the computer operations of the Center for Academic Computing and the Office of Administrative Systems. This consolidation of operations will enable us to eliminate ten computer operations staff positions over a two-year period. In addition, we will have some reduction in operating costs. Because we will need to carefully synchronize the consolidation with the elimination of positions, equipment replacement, data file transfer services, and cross-training the remaining staff, the savings must be applied over two years.

The transition of the SNA communications network to a “fee-for-service” basis will also provide funds for recycling.\textsuperscript{47} In addition, DCA services\textsuperscript{48} will be eliminated in the second year.

<table>
<thead>
<tr>
<th>Budget Reduction 1997-98</th>
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<tbody>
<tr>
<td>Consolidation of CAC and OAS computer centers</td>
<td>$202,468</td>
</tr>
<tr>
<td>Reduction of SNA communications services</td>
<td>$65,000</td>
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</table>

<table>
<thead>
<tr>
<th>Budget Reduction 1998-99</th>
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</thead>
<tbody>
<tr>
<td>Consolidation of CAC and OAS computer centers</td>
<td>$145,468</td>
</tr>
<tr>
<td>Elimination of central funding for SNA</td>
<td>$102,000</td>
</tr>
<tr>
<td>Elimination of DCA services</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

B. Budget Enhancement

The items below detail how C&IS plans to use the 0.6 percent budget enhancement in each of the first two years of this Plan.

1. Mandatory Administrative Software Increases

OAS spends more than $1 million each year in mandatory payments to hardware and software vendors that provide its computers and operating systems. These are operational expenses required to keep OAS computer services running 24 hours a day, 7 days a week. Each year, these costs increase. These increases are non-discretionary (much like increases in utility rates)—OAS has to pay them. These cost-of-service increases are not in OAS’ standing permanent budgets. Thus, C&IS must use its reallocation funds to cover these non-discretionary increases.

\[
\begin{array}{ll}
1997-98 & 1998-99 \\
75,000 (P) & 25,000 (P)
\end{array}
\]

\textsuperscript{47}Users will be charged $100/month per connection for SNA services during 1997-98. Charges may rise somewhat in 1998-99, depending upon the number of users who continue to use this service.

\textsuperscript{48}Outmoded asynchronous communication services over the backbone.
2. Network Security

As more and more functions transition to being network-based, Network Security becomes proportionately more critical. Increases in staff to support network security functions are mandatory if C&IS is to provide even minimal levels of support in this key area.

<table>
<thead>
<tr>
<th></th>
<th>1997-98</th>
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<tr>
<td></td>
<td>$32,000 (P)</td>
<td>$32,000 (P)</td>
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3. Faculty Consultants

The CAC provides consulting to faculty, students, and staff on a wide range of topics. The increased use of technology in all areas of the University has seriously strained CAC’s ability to provide even modest amounts of assistance. This is especially true for faculty who are using technology in both their research and teaching. To continue to provide even minimal levels of assistance to faculty, additional staff will be required.

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<th></th>
<th>1997-98</th>
<th>1998-99</th>
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<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$50,000 (P)</td>
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C. Other Budget Needs

Understanding the University-wide pressures for enhancements to the University’s information infrastructure and the services provided by C&IS, the University Planning Committee, at its May 22, 1996 meeting, requested that C&IS include in its Strategic Plan a request for funding for critical information infrastructure items. It was understood that these requests would exceed the guidelines of limiting funding increases to 0.6 percent of the current budget base. We were requested to separately identify these requests. They are listed, in priority order, in this section.

The additional funds requested total $2.525 million in continuing funds and $1.033 million in one-time funds for 1997-98. All of the initiatives supported by these funds were identified as priority requirements in the December 1993 Report of the Study Group on Information Infrastructure, with the exception of space (which was identified as a need a decade ago) and staff for administrative computing, library computing, and computer security (areas not addressed by that Report). A significant portion of these funds ($1.905 million) are part of the $4.5 million required to provide ongoing support for services installed as part of the $15.8 million Capital funding project. The Commonwealth’s inability to provide these funds is discouraging, but it does not eliminate the need for them as we move forward on this project. We continue to request these funds only as they are actually needed.

The items presented below reflect measured, conservative approaches to meeting the high degree of increased demand being experienced in the area of information technology at Penn State. Although the funds involved in maintaining required levels of performance are substantial, the value of these investments is undeniable if Penn State wishes to remain competitive in “the race for excellence.”

<table>
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<tr>
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<th>1997-98</th>
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<tbody>
<tr>
<td>1. Space for C&amp;IS Staff (p. 37)</td>
<td>$433,000 (T)</td>
<td>$0</td>
</tr>
</tbody>
</table>
2. Telecommunications Infrastructure 49 (p. 33)
   a. University Park Infrastructure Upgrade
      $750,000 (P) $650,000 (P)
      $0 $500,000 (T)
   b. Improve University-wide Network
      Increase Bandwidth $350,000 (P) $500,000 (P)
      $200,000 (T) $900,000 (T)
      Intercampus Redundancy $50,000 (P) $200,000 (P)
      $130,000 (T) $300,000 (T)
   c. Enhance Internet Connectivity
      $425,000 (P) $950,000 (P)

3. Student Services (p. 43)
   a. Student Labs $250,000 (P) $50,000 (P)
   b. Technology Classrooms $200,000 (P) $20,000 (P)

4. Applications Support Staff (p. 47) $150,000 (P) $200,000 (P)

5. Consulting Staff (p. 48) $80,000 (P) $0

6. Faculty/Staff Modems (p. 45) $30,000 (P) $30,000 (P)
   $150,000 (T) $150,000 (T)

7. Pilot Projects (p. 46) $100,000 (P) $100,000 (P)

8. Life-Cycle Funding (p. 38)
   a. Technology Classrooms $140,000 (P) $60,000 (P)
   b. Satellite Uplink $0 $50,000 (P)
      $120,000 (T) $200,000 (T)
   c. LIAS Workstations $0 $100,000 (P)
   d. CAC Staff Equipment $0 $335,000 (P)

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49This is part of the $4.5 million in continuing funds required to support the $15.8 million Commonwealth-funded University Park information infrastructure program. Thus far, $1.28 million of the $4.5 million has been allocated on a permanent basis: $380,000 starting in 95-96 for Internet connections; $400,000 starting in 96-97 for OTC staff; and $500,000 of $1 million requested starting in 96-97 for network electronics maintenance and life-cycle funding. Another $300,000 has been made available on a continuing temporary basis for design work associated with the $15.8 million program.