Internet2
The current Internet was built for a world of a few million users, utilizing relatively low-speed communications links with limited functions (such as the World Wide Web and Web browsers). Accommodating the traffic generated by anticipated billions of users and trillions of digital devices necessitates significant technological evolution. Higher education is playing a pivotal role in this evolution through the Internet2 project. Internet2 is a consortium of more than 200 research universities, 70 corporations, and 30 government laboratories, with linkages to more than 30 nations. Further, nearly 10,000 colleges and universities, schools, libraries, and museums around the United States have access to Internet2’s backbone network, Abilene, through sponsored memberships.

Much as the early DARPA network served as the precursor to the first Internet, Internet2 had as its original goal the creation of the next-generation Internet, with a focus on addressing the needs of the research community. For many applications, particularly those in emerging areas of e-science, the commercial Internet is simply not evolving rapidly enough in terms of available bandwidth. Hence, the Internet2 network infrastructure is designed to be a closed-system test bed for developing and deploying advanced network applications and technologies, accelerating the creation of tomorrow’s Internet. Its purpose is threefold: to create a leading-edge network capability for the national higher education and research community, to enable revolutionary Internet applications, and to ensure the rapid transfer of new network services and applications to the broader Internet community.

Through efforts such as Internet2, higher educa-

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tion has the only scalable platform capable of truly collaborative efforts to create and capture evolving technology—because, unlike business and government, Internet2 is not hindered by fire walls or unnecessary regulation. Internet2 currently supports the efforts of several million faculty members, students, and staff in incubating new and sometimes disruptive technologies.

Technology’s Promise

Just four decades ago, one of the earliest computers, ENIAC, stood 10 feet tall, stretched 80 feet wide, and weighed about 30 tons. Today, $2 will buy a musical greeting card with a silicon chip more powerful than the ENIAC. Already, a modern $1,000 notebook computer has more computing horsepower than a $20 million supercomputer of the early 1990s. Digital technology’s extraordinary pace of exponential evolution is astounding. Characteristics such as computing speed, memory, and network transmission speeds for a given price increase by a factor of 100 to 1,000 every decade.

Software algorithm development is moving ahead at an even faster pace. With open source software development—in which the software code is shared in the public domain so that a large user community can participate in its development (such as the Linux operating system)—application software is also advancing rapidly.

The most dramatic impact of information technology on our world today, however, does not stem from continued increases in computing power. It comes from the increase in network capabilities—specifically, bandwidth, or the rate at which we can transmit digital information. In this regard, one of the most important advances in information technology and telecommunications has been the Internet. The key to the successful evolution of the Internet was the use of low-cost, open standards for its development, in contrast to earlier networks using proprietary technology. No one firm or government agency owns or controls Internet protocols or the rules governing connection or use.

As more and more people linked to the Internet, its value increased at an exponential rate. The Internet’s open, distributed organization enabled any user to innovate a new service for the whole network. We have never before had a communications medium that allows that sort of evolution; anyone who has a strong enough connection to the Internet can deliver a new application to everyone else on the network. These democratic values, whereby standards are developed in a collegial way, have led to an explosion of distributed innovation—lending credence to the notion that great things happen when no one is in charge. That notion prevails on university campuses as well, and because the Internet essentially emerged from higher education, the cultures of the Internet and higher education became mutually reinforcing. Key innovations flowed from higher education to the Internet, and many applications had their first large-scale tests in the university community. Today, that community has woven Internet applications into its fabric. Research came first, and now the Internet is becoming an increasingly important part not only of how we create knowledge but also of how we preserve, integrate, transmit, and apply knowledge.

The explosion of innovation spurred by the Internet was accompanied by an equal explosion of capital investment from all levels—venture capital, the information technology industry, the federal government, and many state governments, which often depended on their universities to put the technology in place. Voluntary organizations pitched in too: museums, foundations, and individuals all added contributions to the mix. Broad partnerships formed, such as the National Science Foundation’s NSFnet and Internet2. Although the United States led the way, this infusion of investment and commitment wasn’t just an American phenomenon; it occurred around the world, on a global scale. As a result, the technology raced ahead so quickly that the legal and regulatory environment could not possibly keep pace with it. Forces
threatened by the new capabilities worked hard to maintain the status quo but were unable to restrain the tremendous momentum for change in any significant way.

Today's Reality
The headlong growth of the 1990s has fallen victim to today's economic realities. Federal and industry research and development investment has experienced dramatic cuts. This shortage of capital is starving the system and preventing or delaying commercial deployment of even the best ideas and the most exciting capabilities on the technological front. Despite myriad possibilities, today's economic environment has made large companies willing to invest only minimal amounts in anything that has to do with the future, so these opportunities are not being exploited—except, interestingly enough, within our colleges and universities. Yet higher education, too, is increasingly focused on constraining expenses. One university after another, for example, is restricting the amount of bandwidth available to students from their residence halls, thereby reducing the chances that the next big innovation will come from the student body and the university.

Meanwhile, the forces trying to gain control of the Internet have begun to assert themselves as the rush forward has slowed. Increasingly, the focus is on centralized solutions and other approaches that compromise the principles behind the open architecture of the network. Traditional industries are moving to protect their interests, which is to be expected, but the same holds true in the realm of scholarly communication as well.

Perhaps most worrisome is the dominance of security and safety issues, where the easy solutions are centralized ones. The currently unstable climate, in which security concerns prevail, is leading to core changes in the balance point between openness and security and thus is fundamentally altering the Internet's open, democratic, and dynamic culture.

At some point along the way, within the past five years or so, the values that supported Internet development shifted. The focus no longer lies in creating something with extraordinary potential to build a better world for all its citizens; instead, the focus now stems from a dominant corporate ethic and commercial influences threaten to bury the promise of the Internet. The value conflicts between the higher education and corporate communities have broadened and intensified, making partnership opportunities between universities and corporate initiatives harder to accomplish.

Higher education, which played a critical role in the early days of the Internet, is less influential now, and a general lack of overall leadership exists on the important issues surrounding the future of the Internet. On a global scale, the United States' leadership position with regard to technological advances and applications has diminished substantially in recent years.

Higher Education's Role
The collective challenge we face as scholars, educators, and academic leaders is to develop a strategic framework that aids us in understanding and shaping the impact that extraordinary new technologies will have on our institutions. Strategic planning ought not to assume that we will simply respond to our changed environment but rather should propose that we can occasionally change it. Indeed, higher education profoundly changed its environment by inventing and deploying the Internet.

To guide development of a strategic framework, a concerted effort to raise awareness of the issues before us is necessary. Key policy issues include the following:

- How do we respond to the diverse educational needs of a knowledge-driven society?
- How do we take advantage of the opportunities offered by emerging information technology, such as freedom from the constraints of space and time, while facing its challenges, such as the radical changes that will likely be required in both pedagogy and scholarship?
- How do we balance the roles of market forces and public purpose in determining the future of higher education in America?

Conversations should begin on campuses to identify those key roles and values that should be preserved during a time of transformation. It is important, too, that the academy be prepared for change. The prevailing culture of
consensus in higher education too often thwarts action. Colleges and universities will need to develop a tolerance for strong leadership so they can respond to the changing needs of society rather than defend an obsolete past.

It is increasingly clear, too, that colleges and universities will need to develop new financial models if they hope to thrive in the digital age. Robust, high-speed networks are absolutely essential for knowledge-driven enterprises such as universities. It is worth noting that 40 percent of all new investment in capital facilities in our society today goes toward acquisition and support of such technology.

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As a rule of thumb, many organizations have found that staying abreast of technology requires an annual investment of 10 percent or more of their operating budget. For a very large campus, this can amount to hundreds of millions of dollars per year. Yet, this investment represents the stakes for survival in the age of knowledge. If institutions are unwilling to invest in technology, they may as well accept being confined to a backwater in the knowledge economy, if they survive at all.

Many promising initiatives are under way to both develop and deploy advanced networks and to establish and maintain the values and standards important to higher education in their operation. Groups such as the Higher Education Information Technology Alliance, EDUCAUSE, the Coalition for Networked Information, Association of Research Libraries, and Internet2 all focus on various key aspects of the issues we face. Additionally, the National Science Foundation’s cyberinfrastructure and middleware initiatives and The Andrew W. Mellon Foundation’s JSTOR, ArtSTOR, and other related efforts are making valuable contributions to our progress.

Given the importance of technological capabilities to our enterprise, however, higher education’s leaders need to coordinate their efforts to adequately address the complex philosophical, legal, and economic management issues before us. Decisions about how we will use technology and the legal and policy frameworks within which we will operate are being made now. The higher education community can wield substantial leverage in these discussions if it chooses to invest its resources and act in concert.

Conclusion

It is ironic that the very institutions that have played such a profound role in developing the digital technology now reshaping our world are seemingly the most resistant to reshaping their activities to enable its effective use. It is not unreasonable to ask, as the constraints of time and space—and perhaps even reality itself—are broken by information technology, whether the university as a physical place will continue to hold its relevance. Clearly, higher education must define its relationship with these emerging possibilities to create a compelling vision for its future. In the face of rapid and profound technology-driven change, indecision and inaction are perhaps the most dangerous courses of all.

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