A Great Transition: An Analysis of the Privatized Internet as a Two-Year-Old

by E. Michael Staman

Within the past year we have seen a steadily declining level of performance of the Internet, and many wonder when, or whether, we might expect to see characteristics more typical of the network during the last year of the NSFNET program. As with any two-year-old, there seem to be days when the Internet behaves well and days when one wonders whether the atrocious behavior that it exhibits is somehow deliberate, designed to test the patience of its higher education creators, and determined to be forever incorrigible.

Privatization of a service is typically expected to yield advantages such as lower costs (or better cost performance), improved functionality, and rapid deployment of advanced technologies. Such advantages have not been realized following the privatization of the NSFNET, and many factors have combined to slow their realization. We are witnessing an unprecedented explosive behavior being driven by millions of new users, significant increases in use by the commercial sector, and the impact of browser technology that was not in existence twenty-four months ago. This evolution encompasses education, the private sector, and society as we create an infrastructure destined to become as pervasive as the electrical grid, telephones, and our system of roads. These developments are transforming the way we think, conduct commerce, communicate, and interact with each other. At the moment our demand for bandwidth appears insatiable, and a real question is which parts of the commercial sector will step forward to meet the need, not whether the need will be met.

The above is not exactly breaking news. The following comment is from a 1994 hearing of the U.S. House of Representatives Subcommittee on Science:

The growth of both the number of users and the applications of the Internet (that element of the NII which is available and working effectively today) has astounded even those of us who have been its most optimistic proponents for many years. It has grown from a resource used primarily by the research and education sector as recently as five years ago to a significant force within the nation's business sector today. It will become a major element of our global competitive posture within the decade.1

The intent of this article is to reflect on why there are problems today and to discuss a number of efforts focused on fixing them. I will begin with a discussion of why the Internet appears to be broken, including some observations about both commercial and higher education use of the network, and conclude with a brief report on initiatives currently under way within the higher education community that are focused on creating the next generation of Internet applications, services, and technologies.

Why are there problems?

To begin, a great many of the “quality-of-service” problems that Internet Service Providers (ISPs) have been quietly trying to keep under control since the beginning days of the NSFNET privatization have become unmanageable, and most recently in ways visible to the user community. Most discussions about the why and what to do range from “higher education needs infrastructure devoted solely to its needs” to “the commercial marketplace is the only solution, and once the money formula is right all will be solved.” Discussions about the former are currently tending to focus on the needs of the Research Universities, while discussions about the latter (within the higher education community) tend to reject the thesis of a fully privatized solution but increasingly understand that money is part of the problem. One key conclusion is that for the majority of higher education there is real risk of continued problems, but that should not be translated into “it will come crashing down around our ears.”

Many elements are in rapid evolution, and these will continue to contribute to the turmoil that seems to be the norm today. Discussions in several areas follow.
The technology

The following is typical of the way the private sector views today’s Internet:

The Internet is a collection of cooperating interconnected TCP/IP networks. With no centralized management or administration function, troubleshooting and administration are complex and time consuming. In addition, performance is unpredictable, reliability varies greatly among Internet Service Providers (ISPs) and there is (are) no mature or common security standard(s) for virtual private networks.2

First, recognize the nature and maturity of the technology. In a limited defense of the ISPs, ranging from large interexchange carriers to some of our smallest providers, the fact that the Internet works at all is somewhat amazing. There has been no other technological evolution that has grown at the rate of the Internet, and I can think of no other infrastructure, of any kind, that could withstand the pressures inherent in that growth and still be functioning. During the last months of the NSFNET we experienced growth rates of 10 percent per month, astronomical by any standard, and current estimates are that traffic now doubles on today’s Internet at a rate more than twice that of the NSFNET days.

Remember that the “privatized” net is less than two years old, and that we are in the midst of a very difficult transition. We can expect turmoil for some period to come. Not only are there now in excess of 5,000 Internet Service Providers in this highly immature industry, with its equally immature technology, no one-repeat, no one—predicted things such as real-time applications on the Internet becoming popular and commercial so quickly. Examples of these include packetized audio, video, electronic commerce, computer telephony, World Wide Web searching, and other Web-based applications. These are only beginnings as the entrepreneurial capabilities within the nation become unleashed. Note that the continued rapid change in all areas of technology (networking, hardware, software) makes any planning short-range at best. Recall that Mosaic was introduced about three years ago.

The commercial marketplace

Even so, evidence of commercial adoption of the Internet as a place to do business accumulates every day. Ghosh writes that for most businesses, the two most important benefits of the Internet are cost reduction and enhanced customer service and convenience.3 He goes on to discuss a range of problems that need to be solved before doing business on the Internet becomes truly routine, but the very fact that there is so much effort being invested in their resolution is testimony that we can expect the current level of commercial growth to continue. The private sector is not inclined to invest heavily if the right return on that investment is not in the offing.

The question of payment and electronic transactions is a typical problem and a good example of the above. We tend to think of typing in a credit card number as the mechanism for payment on the Internet, and we often hear that until the “security” problem is solved there will be no serious commerce conducted on the Net. However, not only does society appear generally quite willing to enter credit card numbers onto a Web page (indeed, there are some who argue that such a mechanism is at least as secure as providing the number to an unknown telephone solicitor), there are now many Internet payment mechanisms in varying stages of development or existence (for example, First Virtual, NetBill, Ecash, and CyberCash).4 Entrepreneurs quickly rush to fill voids if there is money to be made; if none of the existing schemes works satisfactorily, then there is little doubt that someone will invent one that will.

The regulatory and legislative arena

Legislative uncertainty and continued evolution add to the turmoil. One key issue is best embodied in the following argument: “No form of electronic media has grown as fast as the Internet, and [it] has grown precisely because it isn’t regulated” versus “The Internet will not achieve its commercial potential if this new frontier becomes the Wild West of fraudulent schemes.”5 The first quote is from Larry Irving of the Commerce Department, and the second from Jodie Bernstein of the Federal Trade Commission. We should not expect these issues to be resolved soon. Nor should we expect a quick resolution to other tough issues such as digital copyrights, usage policies (the Communications Decency Act, for example), cryptography, export regulation, and taxation. All will shape the nature of commerce on the Net, and we should expect continued uncertainty as these and related issues (telecommunications rates, bandwidth licensing, international selling of software or information) work themselves into some sort of stable legal and legislative fabric.

Changes in higher education’s regional networking infrastructure

The explosive growth of the commercial marketplace, then, is a real part of the problem. CICNet, my organization, has certainly felt such pressures. And while we have had fewer problems than many, we have not been immune from

2 From a description of the purpose and activities of the Automotive Exchange (AIX) project, currently available at http://www.aiag.org/anx/usa/transportation/.


either internally generated problems or failures within the larger Internet. We remain as the last large, not-for-profit, multi-state networking organization owned by a higher education consortium. We are increasingly finding that our commercial traffic is becoming such a significant part of the total that we will soon need to find a way to solve infrastructure problems and related organizational structure issues to protect both our commercial customers and our owners. We are owned by the CIC universities, a.k.a. the “Big Ten plus Chicago.” And while our not-for-profit and R&E focus will likely not change, what will change is that our services solutions will expand into areas involving inter-university project support.

I should note that the CICNet network, as a second-tier provider (one provider away from the Network Access Points), also has been adversely affected by many of the same external problems that universities see—large packet loss, congested paths through the Net, provider outages, hackers attempting to cause network nodal failures, and the like. Our backbone provider’s network (and we think our provider is the best in the business) continues to show congestion at the edges, even though they have made remarkable progress in the interior of their network. Many of the low(er)-end providers oversell their trunk lines by ridiculous amounts so it is hard to feel sorry for them when these trunks fill up.

It is also important to understand that the solutions of the past are generally not available. For example, the original R&E mission of many of the old NSF-sponsored regional networks (SURANET, in the southeastern United States, for example) is no longer relevant, either because the network is gone, sold by higher education to for-profit organizations, or because the network has become for-profit in its own right, or because the network has not been able to sustain itself financially and is now out of existence. The focus of the new incarnation of most of these organizations tends to be in areas other than higher education. Not all, but many, have this problem.

Changes in higher education’s needs
and applications set

Finally, higher education itself is in a period of transition. To begin, we are just beginning to understand and realize the potential of the Internet. In the process of gaining this understanding, the true nature of the problem and its magnitude are becoming increasingly clear.

We need access to a next-generation network supportive of research and education. Applications abound, and include things such as:

• virtual teleconferencing, where we can mix virtual reality or interactive three-dimensional graphics with teleconferencing activities;
• virtual prototyping, through which we can engage in shared visualization of three-dimensional computer-aided design models over the network in real time on a global scale, because engineering collaborations are not necessarily restricted to locations in close geographical proximity to their participants;
• solutions in which we immerse humans in virtual environments to capture best practices or to train them in the use of unstable chemical elements or in working in hazardous conditions anywhere on earth or in space, providing training-on-demand in the process;
• projects where we can shorten product development life cycles through simulation, three-dimensional, real-time visualization, group modeling, and the like;
• simulations of new architectural, automobile, or other expensive-to-prototype design activities in ways which improve quality, decrease costs, and increase the probability that projects and products that come to market are better, safer, more reliable, or whatever the value of the moment might be.

Serious stuff, and beyond our capability today. Indeed, there is reason to anticipate that such requirements, or their counterparts next year or in the next decade, will be forever beyond the ability of the commercial sector to provide at an affordable price. As Douglas Van Houweling said recently in a presentation at the University of Michigan on visualization and virtual reality, “If a picture is worth 1,000 words, then a moving picture is worth 100,000 words, and a virtual environment worth 100,000,000 words.”

For the sake of completeness, it is important to note two very important activities directly related to the applications space. Most readers are probably very aware of the excellent work being accomplished by the Coalition for Networked Information (CNI) and the National Learning Infrastructure Initiative (NLII), the former focused on intellectual property issues and the latter on the evolution of an applications set which realizes the potential of multimedia in a networked teaching and learning environment.

6 See http://www.cni.org/and http://www.educom.edu/program/nlli/nlliHome.html

What’s happening at the national level?

The NSF has indicated that the acceptable use policy (AUP) for the vBNS (its national high-
speed backbone) will be relaxed to become something like from .edu to .edu, and approved universities and their partners will be able to use it for any such traffic. That’s good, and moves us in the right direction. So, too, are the discussions which are likely to result in good solutions for the ninety or so Research I universities. These beginnings also move us in the right direction. The current discussions about Internet II, gigapops, private sector partnerships, and the like are equally important, and we need to encourage and support such initiatives.

One of the most important initiatives on the national level is the Internet II effort. While a number of people began working on the idea of a new network for higher education shortly after the privatization of the NSFNET, initiatives to create national consensus really began at a conference held in Monterey, California, in September 1995. Immediately following that meeting a group of individuals formed an ad hoc group called the Monterey Futures Group (MFuG) to begin the effort of specifying both technical and application requirements for such a network. The work of the MFuG group included both an initial discussion of the future application space needed by higher education and a first cut at the technical requirements for its support.7

The work of the MFuG group was transitioned to the Networking and Telecommunications Task Force (NTTF) during a FARNET/NTTF-sponsored meeting in Washington this past April. As follow-up, FARNET then obtained funding for a nationally attended workshop held in Colorado Springs this past August and which was again jointly sponsored by a number of professional societies and organizations.8 Key outcomes of the meeting were a national discussion on the next steps and an accelerated effort by the leadership within the nation’s Research I universities to launch the Internet II initiative.

Where do things stand today?

First, as of November 1996, approximately forty of the Research I universities concluded that the time has come to launch a project targeted at creating a new, high-performance Intranet for their needs. This effort, now known as Internet II, is gaining momentum. Six subcommittees are working on the initiative, each of the charter members has contributed $25,000 to support the effort, and each has pledged $500,000 for its participation in the outcomes of this initiative. Internet II is not about bandwidth; it is about enabling applications. This effort can best be defined by the academy, and it is through the academy that such advanced technologies can best be understood, advanced, commoditized, and transferred to the private sector. This is a vitally important effort, and we need to support and encourage the participants to continue.

That said, there is little in the above initiative that helps the rest of the college and university sector, community colleges, K-12, libraries, and the like. It is here that I think we need to quickly turn our attention. We have a very difficult problem. At the least we need a forum to discuss the problems of the larger community so that some common understandings might evolve into proposals for solutions.

The challenge to be addressed might be stated as “Internetting for the rest of us.” Now that the Research I universities have launched the Internet II initiatives, how should the remainder of the academic community best position itself to participate, while realizing the fullest potential of current and evolving Internet technologies and services? I am sure that CAUSE would be amenable to working something into its general agenda if there is sufficient interest. So, too, would FARNET—the Federation of American Research Networks. Perhaps some kind of joint forum would be appropriate, and, as a point of reference, FARNET issued a press release outlining its “… plans to focus on a broad range of initiatives in 1997 that will extend the next generation Internet and its technologies, applications and services to the broader education, research and public services communities.”9

The privatized Internet as a two-year-old? It is behaving exactly as one would expect, and, as we tend to view most two-year-olds, we look forward not only to passage of the phase, but to the unlimited future that harbors our most optimistic hopes and aspirations for any of our children. We are increasingly seeing an analogy, initially prepared by Ivan Campos for the Colorado Springs meeting,10 as explanation of where things stand today. His claim is that we have evolved the Internet from an advanced research project to today’s commercial service, and that we are beginning a second cycle to create the next generation, this one capable of supporting applications which are now quickly evolving within higher education and which cannot be accomplished on today’s infrastructure. Stay tuned.

7 MFuG’s work is documented at http://www.farnet.org/
8 FARNET’s co-sponsors for the Colorado Springs meeting were the Resource Allocation Committee (RAC), Advanced Network and Services (ANS), NTTF, NYSER-NET Inc., the Coalition for Networked Information, and the National Science Foundation.
9 See http://www.farnet.org/releases/ for the full text of the press release.

“Internet II is not about bandwidth. It is about enabling applications.”