

Keynote Address
Autumn 2004 Meeting of the
Corporación Universitaria para Desarrollo de Internet (CUDI)

Larry R. Faulkner
President, The University of Texas at Austin
Chair, Internet2 Board of Trustees

Acapulco, Mexico
October 15, 2004

Please let me begin by expressing thanks to Carlos Casasús, Director General of CUDI, for inviting me to participate in this conference. On many occasions, I have enjoyed the hospitality of Mexico, and I am very pleased to be here today.

This morning I appear before you in two capacities: as Chair of the Internet2 Board of Trustees, and as President of The University of Texas at Austin. We say in our culture that "I wear two hats."

Wearing the first hat – as Chair of the Internet2 Board – I have a close view of the rich possibilities for progress in research and education that are being enabled by high-performance networking, and I have a hand in the process that is shaping the next generation of networking. In a while, I will speak more about all of that and why it has value to all of you. After all, the main reason for this meeting is to give you an opportunity to learn more about the usefulness for you and for your colleagues at home.

But let me begin by speaking apart from the technology – just about the importance of contact and collaboration – an age-old topic for leaders of educational and research institutions, but one with growing importance in a world where institutional libraries can no longer capture the reference needs of scholars, where research is increasingly carried out in teams of experts with differing skills, where institutions like ours are asked to address complex problems of all kinds – many of them global, where our graduates will be much more likely than those of earlier generations to work across political and cultural boundaries. Every institutional leader here knows about these things and must wonder how to succeed with the demands and how to seize the opportunities.

I, too, am mainly in the position of coping with matters like these as the president of a large public research university in the United States. I must see that The University of Texas at Austin remains well connected to leading institutions worldwide and that it supports the best educational and research opportunities for its faculty, staff, and students. We also have the responsibility to foster a superior research and teaching environment that offers up-to-the-moment technical support for higher education in the State of Texas. Moreover, it is a public duty of our university to promote the general health of Texas and the larger world in practical ways built upon our capabilities in education and research.

The favorable mutual development of Mexico and Texas is of very great importance to people in our state; therefore we in the University are placing a special priority on our ties to Mexico and the remainder of Latin America. This has been one of my major themes since 1998, when I began as president of UT. We are emphasizing the development of our programs relating to Mexico and to Latin America generally. We are adding to our faculty, to our library holdings, and to our collections of art and artifacts. We are promoting conferences, joint research

programs, joint degree programs, and exchanges of students and members of our faculties. All of this rests, of course, on contact and collaboration.

There are countless facets to the effort. We are proud of our Mexican Center, on whose advisory board Carlos Casasús serves. That center is a part of the distinguished Lozano Long Institute for Latin American Studies, which engages hundreds of scholars. We are glad to offer students and researchers everywhere access to the Benson Latin American Collection, the largest Latin American library in the North American academic world. We are also enriched by the Latin American paintings in our Blanton Museum of Art, the largest and most prominent such collection in a North American university museum. We are proud of our joint Executive MBA degree program with the Tec de Monterrey in Mexico City, and with our exchange programs with many leading institutions of Mexico, including UNAM and the Colegio de Mexico. We believe that much joint benefit arises from the extensive collaboration between Pemex and our Bureau of Economic Geology. We are energized by our agreements with CONACYT to undertake joint research, the latest relating to nanoscience and nanotechnology.

As president of UT Austin, I have had the honor of hosting Mexican educators, scholars, students, researchers, business and political leaders, and other distinguished visitors to the city of Austin, including President Vicente Fox, who has spoken twice at our university. *México* and *Téjas* have had a long and dramatic history together. Today we are interconnected by culture and language. We are partners in education, in commerce, and in the arts. For many years, The University of Texas has benefited from a vibrant cultural exchange with Mexico. And we are committed to making this special relationship even stronger.

But we at The University of Texas are not alone in our desire to build relationships with Mexico, and I am certain that institutions here are looking to strengthen partnerships across North America and around the world.

When we exchange ideas and resources – when we cross borders to learn from one another and to experience all that our neighbors have to offer – then our lives are enriched, our institutions are strengthened, our people benefit in tangible ways. And in the process, we experience the respect and understanding that should always guide the spirit of cooperation between countries.

Historically there have been enormous barriers to such efforts: the cost of travel and the practical frequency with which it can be undertaken, the impracticality of having a whole team travel very often to a single meeting place, the speed of interchanging letters, practical limits to the volume or character of material that can be shipped, rare access to good libraries or special collections.

But now, thanks to the technological advances of the past decade, our institutions – our scholars, our students – our libraries, our laboratories – can become more easily interconnected than ever before in history. We no longer need to cross rivers to communicate with each other or even to collaborate closely. We no longer need to exchange correspondence or research findings that take days or weeks to arrive. Today, knowledge and discovery travel at the speed of light, in a volume and with a texture that were never possible to convey by mail or shipment. Information is as close as our fingertips on a keyboard. The complex visual components that are essential to research and teaching – color slides, raw spectrometric data, high-resolution medical images, tables, charts, graphs, sketches, video, sound clips – can be rendered instantly and more accurately, and shared with colleagues around the globe at the click of a mouse.

This new technology draws us together, places us in the same room at the same time, without leaving our home institutions. It gives a radical new meaning to the age-old welcome: "*Mi casa es su casa.*" The cultural exchange that has enriched us for decades can take place in a moment's notice, but can still be as personal as the human voice or a handwritten note. By taking advantage of these advances, we reduce travel, save costs, and economize our time. To those of us who lead full lives teaching, researching, and running institutions – and that includes everyone attending this conference – the new technology is a remarkable gift.

It no longer takes a pair of heroes to sustain a distant collaboration.

What makes all of this possible is the ability to direct a lot of information, practically instantaneously, to practically any scholar or student in a nation or in the world. *Networking* is the key to reaching the individuals on demand. *Bandwidth* is the key to being able to send a lot of information quickly. Actually, *bandwidth* is the measure of how much information can be conveyed in how little time. In this new world, universities and other research organizations have a compelling, mutual interest in establishing and sustaining networks that link our people comprehensively with the greatest achievable bandwidth.

And that point leads to CUDI and to its U. S. counterpart, Internet2.

Internet2 is a collaborative enterprise among more than 200 U. S. universities, plus our national laboratories and many research laboratories in U. S. corporations. The organizations are the members of Internet2, and they govern it through a Board of Trustees and a set of councils. About two-thirds of the Trustees are elected presidents from member universities, like me. Internet2 is separately incorporated and has an official name very similar to CUDI's, *University Corporation for Advanced Internet Development*. It is sometimes called by its abbreviation, UCAID. Actually, Internet2 is a registered trademark, not an official name, but it is the name by which most people now know us.

Internet2 has built and does operate a major physical network called "Abilene," which is the backbone linking our members at the national level. It makes a large crisscrossed loop around the U. S. with hubs in major cities and with nearly all segments now operating at 10 gigabits per second. Each member institution is responsible for making its connection with one of the hubs by using resources not operated by Internet2, typically via a commercial carrier. Also connecting at Abilene's hubs are links to international networks, such as CUDI's here in Mexico. Abilene is as advanced a large-area network as exists in the world, and Internet2 is justifiably proud of its success in building and upgrading it, operating it with extremely high reliability, and developing a sound financial model for sustaining it.

But Internet2 has a broader charge for "advanced internet development," and succeeding with that goal requires more than operating a national backbone. First, the organization actively encourages member institutions to upgrade the bandwidth of the local connections to offices and laboratories, because the use of the network by any scholar or any student is limited by the narrowest bandwidth on any part of the path from his or her computer to the computer with which he or she is communicating. We call this "end-to-end performance," and we give it a lot of attention.

We also work on specialized software, called "middleware," that helps advanced networking to be more effective or more useful.

We foster applications, such as videoconferencing tools.

And, of course, we work on the technology required to achieve the next generation of networking with still better bandwidth.

Mostly, progress in these latter areas is pursued by active volunteers from member institutions. Much of Internet2's value comes from its convening power – its capacity for bringing people together to work on a problem in the business.

Internet2 is striving to enable the full potential of such applications as telemedicine, digital libraries, distance education, and virtual laboratories – areas that tend to overload today's regular Internet. Some of them even overload Abilene. Greater bandwidth means better texture and greater power in collaborations, so it is always a goal. Pursuit of it leads inevitably to plans for improved networks, so let me now turn briefly to the future just ahead.

In the United States, there is now great momentum behind a concept for the next generation of research and education networking – the one that will succeed Abilene. It actually is a convergence of three separate visions for new forms of networking of national scope, each intended to address different needs and each requiring very different technical properties. The three visions are:

- the next-generation broadband network for intensive, general, research and education traffic.
- a network that can support active research and experimentation on advanced networking.
- a network to support very large scale national and global scientific efforts in which the network becomes part of the apparatus, like the Extensible Terascale Facility – a nationwide, coordinated multi-site computing system – or the radio astronomers' Very Long Baseline Interferometry consortia, which establish planet-spanning radio telescopes.

Remarkably, these visions have converged over the past couple of years to the point that all appear to be realizable on the basis of a common physical infrastructure. The core would be an optical fiber network owned by the research and education community and maintained by regional and national organizations spanning nearly all major players in research and education nationwide. The enterprise is being developed under the name National LambdaRail, and it involves a grand partnership of many local and national networking organizations in the U. S., including Internet2. By the middle of next year, we expect it to be delivering services.

In the U. S., we are in an age of convergence at the state and regional level, too. Institutions everywhere are recognizing common interests in achieving the best possible national connectivity, in anticipation of the more powerful, but more demanding, national vision. They want to be ready; they want to take full advantage; and they see a chance to achieve the results they need at lower cost through collaboration.

In state after state, the chosen path is to translate the national vision to the regional level: A membership organization is being formed to establish and to operate an owned, multi-lambda fiber optic network, covering the state and embedding the regional connection points to the

emerging national fiber optic backbone. Good examples are found in Florida, Louisiana, Michigan, and Texas.

The Texas story illustrates the way in which a number of regional interests can be brought together. In our Lonestar Education and Research Network (or LEARN, for short), essentially the entire population of Texas research-active universities (26 of them), all nine academic medical centers, and the entire Texas Association of Community Colleges have come together to create LEARN as a newly incorporated not-for-profit organization. It will hold the physical assets – optical fiber and associated hardware – needed to support a multi-lambda network offering optimal global connectivity; and it will operate that network statewide. It will support the needs of both the National LambdaRail project and the Extensible Terascale Facility.

LEARN will also help us to remedy the fragmentation that has characterized networking for education and research in Texas. It has already become the main collaborative forum for developing statewide policies; and it will become an important voice for representation of Texas institutions nationally.

In Texas, as in other regions of the U. S., regional convergence has been helped by connecting the vision of the regional network to public interests beyond higher education and research, such as delivery of services for education, networking needs of governmental agencies, and broad economic development. The larger picture is attractive to political leaders, and the governors and legislatures of several states have fostered regional networks through major financial support.

Finally, let me shift focus to the international level, where there is also a convergence of interest and effort, particularly toward settling and implementing standards for operation and global connectivity. A worldwide interest in cyberinfrastructure has emerged, and the establishment of competitive assets has become a priority for developed and developing nations. In many countries, this interest extends to high-performance networking for research and education. Timely efforts are now in motion to ensure ongoing compatibility and improved performance across national borders and under the oceans. CUDI and CLARA are important in these developments. Internet2's leadership, several of our member institutions, and many individuals active in Internet2 have taken a strong interest in these issues and are committed to progress.

Now let me close with a nice little story about music.

The University of Texas at Austin is home to the Miró Quartet – a superb string group with a worldwide reputation. Its four members teach in our School of Music, and they perform together internationally using UT Austin as their base.

About two weeks ago, when the Internet2 Member Meeting was held in Austin, the University hosted an evening event for all 700 participants at that meeting, plus other guests from the University and the city. The Miró Quartet performed, but they did so under unusual circumstances.

All of the audience experienced the performance in two settings. Before intermission, half were in a recital hall with the Quartet, and the other half were in an opera theatre, listening to multi-channel immersive audio and viewing live high-resolution images of the performers. At intermission, everyone switched halls, so that each person could compare the real concert experience with the immersive one. Was it live, or was it Internet2? A goal was to test the

prospects for delivering network-mediated concerts or teaching in the performing arts over large distances.

It was a masterful performance by the Quartet. It was a masterful performance by Internet2. The Quartet captured the audience with the beauty of their playing. The Internet2 techies were impressive in getting four high-resolution video streams and fourteen high fidelity audio streams, all synchronized, over a packet-switched network.

Most interesting to me was the audience reaction in the remote site. When each piece ended, there was full and genuine applause for the players, even though they were not in the hall. When they completed their performance and took their bows, there was again full applause – in waves, as at a normal concert. Still more fascinating was that after the Quartet left the stage, then returned for a second round of bows, the audience in the remote hall renewed its applause, just as if the players could hear it. There is no doubt that the experience was much more real for the remote audience than they expected.

But it was not real. It was Internet2, as one could tell by some of the shortcomings. The video frame speed was just too slow to capture the rapid bowing of the strings. More bandwidth is needed. No, the technology is not ready for the delivery of concerts for which patrons would actually buy tickets. But it was quite clear that master-level teaching can be given readily over the network over any distance using tools now available.

If we can do it at the master-level in music, we can also do a great many other things that matter in universities. For most possibilities, the real limits are in our imagination.

Thank you so much for listening. It was indeed a pleasure to have been a part of this conference here at its beginning, and I wish each of you a great adventure during the remainder.