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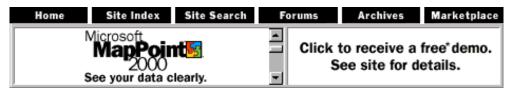**October 7, 1999**

As Net Turns 30, the Sequel Is Still in Previews

Internet2, a Project to Link Universities With Fast Connections, Gets Mixed Reviews So Far

By KATIE HAFNER

THIRTY years ago this fall, the Internet got its start as the Arpanet, a Government-financed computer network for universities and military sites. That network has gradually morphed into today's Internet, which 200 million people around the world use, misuse, cherish and curse.

About three years ago, a project called Internet2 began. It involves a a new high-speed data backbone connecting universities, much like the way they were connected in the original Arpanet. It is one of several attempts to steer a future course for the connected world, a reinvention of the Net meant to feed new technologies to the public eventually. But opinion is divided on whether it is the bridge to the 21st century or an expensive dead end.

Proponents of the Internet2 project, whose users are almost exclusively at universities, say it is a unique sandbox in which researchers can conduct experiments in areas like advanced videoconference techniques, virtual reality and telemedicine. They say the technological innovations to emerge from the project will quickly filter down to the "commodity" Internet, as the general Internet is sometimes called.

Peter Yates for The New York Times

Douglas Van Houweling is president of the group that oversees Internet2.

Critics, on the other hand, say the project is falling short of its original goals, that it has little technical innovation to show for three years of work and that much of Internet2's prodigious capacity often stands idle. Further, they say, the expense to universities outweighs the project's usefulness to faculty and students.

Internet2 started with much fanfare in 1996 as a high-capacity private network for researchers at universities to use for developing and testing futuristic applications that require a lot of bandwidth.

"The people who started Internet2 were looking back on this kind of nostalgically as the days when universities had the Net to themselves and now they don't," said Vinton G. Cerf, an Internet leader who is senior vice president for Internet architecture and technology at MCI Worldcom, which supplies part of the high-speed backbone for Internet2. "And now they were all going to get together and build their own backbone. They seemed to be moving back to the stage where they had a Net to themselves."

The promise surrounding the new network held a definite appeal for those who joined. "Internet2 was built largely on a field of dreams -- if you build it, they will come," said Ira Fuchs, the vice president for computing and information technology at Princeton University, an Internet2 member. "The hope was that you build the infrastructure, make it available, and there will be applications."

Since its inception, Internet2 has grown to include 163 member institutions; it has the backing of 20 corporate partners. Astronomers use the network to send huge data sets from telescopes and to manipulate those faraway telescopes.

Medical researchers use it to view complex anatomical models from many miles away. Successful demonstrations of high-definition television transmissions have taken place over the network. And network specialists at several universities are using the Internet2 project to conduct experiments in computer networking itself.

Internet2 is similar to the Internet in its earlier days in that its use is limited to those universities and a handful of corporate research centers that pay for the high-speed connection. If a researcher at an institution wants to send data to a researcher elsewhere over Internet2, both institutions must belong to the network.

The cost to universities is high. Helped by subsidies from the National Science Foundation, each campus pays $500,000 to $1 million or more a year to gain local access to the high-speed Internet2 backbone and upgrade its campus network so the network can deliver data to campus desktops at a guaranteed speed of at least 10 megabits per second, which is 10 million bits per second. That is nearly 200 times as fast as a modem handling 56,000 bits per second.

But the foundation is scheduled to discontinue its subsidies next April, and some Internet2 members are beginning to view the cost as an unwelcome burden. "Someone forgot to tell the universities how expensive Internet2 will be when the subsidies go away," said David J. Farber, a professor of computer science at the University of Pennsylvania. At most universities, Dr. Farber said, faculty involvement in Internet2-related projects is minimal, at best.

Fuchs of Princeton said he knew of no universities that are seriously considering withdrawing from the project. But Fuchs, Dr. Farber and others agreed that additional funds generated by faculty research grants were crucial to help defray the cost of the network.

"Without campuswide support, the bill will be more than the administrator will be willing to pay," Dr. Farber said.

Applications that require a high-capacity network are at the center of the project's charter. One project, still in the formative phase, is called Gumbo,

which stands for Grand Unified Modeling of Biological Organisms. Led by researchers at the California Institute of Technology, the project will create highly ambitious computer models of biological systems by having computers at many places on the network work on pieces of the problem, a strategy called distributed computing.

Another project, perhaps the one best suited to Internet2, is called tele-immersion; it is under the direction of Jaron Lanier, who is known for his work with virtual reality and is also the co-director of the Gumbo project. Tele-immersion, an advanced form of virtual reality, lets users in different places interact in real time in a shared simulated environment, making them feel as if they were in the same room. Instead of the gear often associated with virtual reality -- body suits, goggles, gloves -- tele-immersion uses a "tele-cubicle," which is equipped with large screens, scanners, sensors and cameras.

"With prior forms of virtual reality, you're in an entirely synthetic environment so that people end up looking like cartoons," Lanier said. "With tele-immersion, the goal is complete realism so that people look real, they feel real and the environment they're in, such as their office, feels real and you feel like you're really there." Lanier said he hoped that the project would be ready for a full working demonstration by April.

Campuses are learning to exploit all the power of a high-bandwidth system.

"You'll be able to see me just as if I was right in front of you, in three dimensions," said Allan H. Weis, chief executive of Advanced Network and Services, a nonprofit organization based in Armonk, N.Y., that is an Internet2 corporate partner and is sponsoring the tele-immersion project.

"You can touch me on a shoulder, and I'll feel it."

Tele-immersion is ideal for Internet2, Lanier said. "The goal is to stress the network," he said. "We're really trying to push Internet2 to its limit.

Applications like tele-immersion require what network researchers call quality of service, the ability to assign priorities and types of service to different types of data.

"If you're transmitting an X-ray of someone's lung, you can't afford losses of data, said Lawrence Landweber, a professor of computer science at the University of Wisconsin at Madison. "You've got to get it all because you don't want to miss that spot on the lung. But you can have it be delayed.

If you're looking at a real-time video of somebody, on the other hand, and you're interacting with them, you can't afford to have a delay, but you can lose some data."

Greg Wood, an Internet2 spokesman, said a plan for

introducing quality of service over Internet2 would be tested in the next six months.

Skeptics say Internet2 suffers from a dearth of highly demanding applications. Projects like tele-immersion, Dr. Landweber said, are the exception, not the rule.

THE FUTURE - Jaron Lanier runs a virtual reality project that takes advantage of Internet2's high speed.

As a result, the actual utilization of the network is far below its capacity. Aside from an occasional burst of activity, which can make parts of the network run at as much as 100 percent of capacity, the usual utilization figure hovers around 1 percent.

Douglas Van Houweling, president of the University Corporation for Advanced Internet Development, a nonprofit organization that oversees the Internet2 project, sees it differently. As long as people are using the new system to run applications that do not take full advantage of its capacity, the network will be underutilized. "The key is to raise people's eyes to see a new horizon of advanced Internet applications," he said, "and I think that's clearly happening, but it's not happening overnight."

The job of drumming up interest among faculty members has fallen to Ted Hanss, Internet2's self-described evangelist -- his official title is director of applications development. He is frequently on the road, visiting campuses to raise awareness among faculty members.

"To engage faculty, you need to give them confidence that there's a long-term commitment on the part of university administrators to keep the infrastructure," Hanss said. "They don't want to be told it's going away."

The group of companies providing the Internet2 backbone has made a firm commitment to keep it in service until 2003. What might happen after that is unclear. "We'll work to insure high-performance network capabilities among universities beyond 2003," Wood said. "That's part of our mission."

Unlike the original Internet, which gradually metamorphosed into a network for the general public, Internet2 will most likely remain, in some form, in the academic domain.

"It's not our intention to take the Internet2 backbone and make it a public thing, but to make what we learn in the project a public thing," Dr. Van Houweling said. "I don't know that we'll ever name it Internet 3 or 4. But the whole objective is that the things we do become a part of the Internet that everyone is able to use."

Part of that technology transfer will take place through the project's corporate partners, Dr. Van Houweling said. "Let's say we figure out a way of doing quality of service," he said. "Then Cisco and others will adopt those standards in their products and ship them out to commodity consumers."

It is precisely such companies that are stealing a march on Internet2, the project's critics say. "I'm not sure what Internet2 has taught us about building the next-generation network," Dr. Landweber said. "The reality today is there's a lot of interesting work, but it's mostly being done in the bowels of companies like Cisco, AT&T and Lucent."

At 2.4 gigabits per second, Internet2 may be fast, but, some of its critics say, not fast enough. "If you said you'd supply a network with a bandwidth of 5 gigabits

to my department, I'd say, 'Hey that's an interesting field of dreams,' " Dr. Farber said. "But Internet2 is nowhere near that." Dr. Cerf of MCI Worldcom agreed. "My sense is that it isn't far enough ahead of where industry is," he said.

Dr. Van Houweling, however, said the capacity of Abilene, part of the Internet2 backbone, would quadruple in the next year, to nearly 10 megabits per second. "All of our forward thinking is based on the assumption that we're going to have a hard time keeping up with the demands of the applications," he said.

Membership in Internet2 is not a requirement for high-speed data transmission. MCI Worldcom recently announced vBNS+, a commercial service that is similar to one the company already provides for a portion of Internet2 traffic. The new vBNS+ service is now available to all college campuses as well as to corporate research laboratories.

That announcement caught the eye of Michael Ribaudo, who is university dean for instructional technology and information services at the City University of New York. Ribaudo, who oversees his university's technology purchases, held his university back from joining Internet2, and all of the peripheral expenses that go with it, when it started, and now he considers himself vindicated.

"I think I've been proven correct to buy the bandwidth as a commodity item from a provider such as MCI," he said. "It's a smarter way to go."

Ribaudo hastened to add that he was not speaking for all universities. "I'm just saying that Internet2 isn't for everyone."

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