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Technology

Sharing the Supercomputers

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Computer scientists and Government officials are urging the creation of a nationwide "data superhighway" that they believe would have a dramatic economic impact, rivaling that of the nation's interstate highway system.

This highway would consist of a high-speed fiber-optic data network joining dozens of supercomputers at national laboratories and making them available to thousands of academic and industry researchers around the country. Vital Competitive Tool

A national research network is vital, backers of the concept say, because it will help protect an important area where the United States now has a clear technological advantage over Japan and Europe.

America's lead in computer networking is largely a result of Pentagon financing in the mid-1970's for Arpanet, a system that linked universities, corporate research centers and military laboratories.

The new network would cost about $400 million and could be in place by the mid-1990's, its proponents say. Many existing high-speed networks can send 1.5 million bits of data a second, equivalent to one good-sized novel every five seconds. Each second the new network could carry 3 billion bits of data, or 3 gigabits -about 500 copies of that hefty novel. New Kind of Research

Legislation introduced in October by Senator Albert Gore, Democrat of Tennessee, included initial financing for development and construction of a National Research Network. Backers of the measure say that Federal financing for the project is necessary to develop the technology and convince industry that vastly speedier computer networks are commercially viable.

The network would pave the way for a new kind of scientific research in which thousands of scientists around the country could use the most complex and expensive equipment as if they were seated right in front of it.

Officials at the National Science Foundation envision computerized "collabatories" in which scientists using computer work stations could directly view and control the output of complex machines, such as particle accelerators, wind tunnels, telescopes and nuclear reactors, even though they were thousands of miles from the actual apparatus.

"I believe we can make an electronic laboratory in which people can collaborate and access information, effectively independent of location," said William Wulf, an assistant director of the National Science Foundation. "You'll never replace eyeball-to-eyeball communication, but you can substitute a lot." Remote Control

For example, a fiber-optic computer network would permit astronomers using a radiotelescope array in California to process the images on a Cray supercomputer in Illinois and then view pictures instantly, while at the same time controlling the telescope remotely from locations in both California and Maryland.

However, proponents of the idea note that putting it in place requires development of new fiber-optic communication links that are thousands of times faster than today's commercially available networks. All this could take as long as five years.

Fiber-optic networks, based on glass strands roughly the size of a human hair, use pulses of laser light instead of electricity to send computer data. They permit hundreds or thousands of simultaneous computer conversations by packaging each message into small packets consisting of 1's and 0's.

Because messages are broken up into packets, many of them can be simultaneously interwoven onto a single fiber cable and then recombined as separate messages at the other end. High-speed fiber-optic cable is already used widely for voice and video applications, but data applications have lagged until now because further technological developments are still necessary. Electronic 'Handshakes'

Researchers say they still need to develop special computer switches capable of handling the high rates of data and perfect the necessary high-speed electronic "handshakes" that one computer must make with another when data are exchanged. But the experts believe these tasks will not be difficult to accomplish within five years.

When the Pentagon's Defense Advanced Research Projects Agency built the Arpanet network, it paved the way for the industry that links commercial computers.

However, many researchers point to big government-financed high-speed computer networking projects now under way in both Japan and Europe. They are concerned that without a coordinated response United States industry will be in danger of losing its lead in developing the next generation of technology.

"It's possible that if we simply let a completely self-motivated marketplace develop our data communications infrastructure for the future it will be either inferior to what is being developed in Japan or Europe or owned by companies in Japan and Europe," said Russell Neuman, a political scientist at the Massachusetts Institute of Technology Media Lab. Difficult to Put to Use

One continuing problem that worries researchers is that in the past it has proved difficult to put the technology to use.

"Many times the technology has been there but there doesn't seem to be a path for transferring it from the research laboratories to the commercial market," said David Farber, a computer scientist at the University of Pennsylvania. "We want to show the commercial side that there is a use for this technology."

The proposed network would serve as a demonstration project to encourage private industry to develop similar super-fast commercial data links.

"The infrastructure we will need in the 21st century goes beyond traditional public works projects," Senator Gore said. "I envision a national computer network linking academic researchers and industry, using the nation's vast data banks as the raw material for increasing industrial productivity and creating new products."

Until now, supercomputers -which are increasingly essential for scientific and technical progress -have largely functioned as computing oases, isolated from thousands of potential users. The idea underlying the construction of a high-speed network is based on what economists refer to as the "turnpike factor." Modern highway interchanges have been found to attract traffic simply by their existence. Distance Is No Object

"We want to eliminate distance as a factor," said Robert Haber, a mechanical engineer who directs a high-speed networking project at the National Center for Supercomputer Applications at the University of Illinois at Urbana-Champaign. "You can compare this to the kind of things that happened in the 50's in the United States. We need a project of the scale of a National Highway Project for computer information."

Researchers also believe that an initiative to build a national system is essential because existing networks are badly overloaded, causing the equivalent of computer traffic jams.

"We have 2,000 users who need to transfer huge amounts of data, and the current networks aren't set up for that," said Steven Christensen, an astrophysicist at the National Center for Supercomputing Applications. "There is already a large bottleneck for many of those who want to use our machines from remote cities."

During the last two years the National Science Foundation has attempted to alleviate some of the worst overcrowding by establishing a new research network known as Nsfnet. In July, a 1.5-megabit-per-second expansion of that network, which links the five national supercomputing centers with about 200 universities, was installed. Stopgap Measures

However, such incremental increases in speed are viewed as only stopgap measures. Senator Gore's bill provided for a network that sat at the top of a hierarchy of existing networks now operated by different Government agencies, like the Energy Department, the Defense Department and the National Aeronautics and Space Administration. The smaller branches would feed into the faster N.S.F. network just as smaller streams feed into a large river.

Once the gigabit network is in place, researchers will be able to begin developing new applications.

For example, Hellmut Golde, a computer scientist at the University of Washington, is beginning to work out a way to control complex instruments over a high-speed network. He is working with a nuclear physicist at the University of Washington who is interested in permitting students at different campuses to share a training reactor. These training systems are scarce, and Mr. Golde's idea is to re-create the control room for such a system at several locations.

He acknowledged that advances in computer security would have to be made before a nuclear reactor would be accessible on a computer network.

Researchers at campuses around the country have already begun planning regional high-speed networks that will offer a preview of some of the services of the future gigabit network. Scientists at the University of Pennsylvania and Princeton and researchers at I.B.M.'s Watson Research Laboratories have proposed a fiber-optic network to link the three research centers. Named the Hourglass Project, the network would permit medical specialists at Princeton and Penn to share high-resolution X-rays or other radiological images. 'Video Wall'

The network would also make possible a "video wall," a video conference system with extraordinary resolution. Such a system would in many ways permit researchers to interact as if they were seated in the same room even though they were actually separated by hundreds of miles.

Another proposal by the Corporation for National Research Initiatives in Reston, Va., calls for the creation of a digital library, a computer data base that would permit vastly improved access to information for researchers and students. "From any work station you should be able to specify a document if it exists anywhere in the country and then view it directly," said Robert Kahn, president of the corporation. Mr. Kahn, a former director of the Defense Advanced Research Projects Agency, has been a key sponsor of the idea of creating a gigabit network to link research centers and universities.

Technology for creating such a national library is one area where Japan may be ahead of the United States. Researchers at Japan's National Center for Science Information Systems are well on their way toward putting the entire scientific literature of the country on-line.