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COLLABORATION

The Time Is Now: Bust Up the Box!

By John Markoff
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San Diego - COMPUTING is breaking out of the beige box. Millions of miles of fiber-optic cables are weaving together software that lives on the Internet and data moving at the speed of light into a single global fabric.

It has been almost two decades since Sun Microsystems pioneered the slogan "the network is the computer." Today, after many false starts, that idea is a reality.

Along with relentless technical advances, one force behind this change has been the billions of dollars spent by telecom companies on fiber-optic lines before the end of the tech boom. That splurge was a factor in driving many of those companies into bankruptcy, but also helped reduce the cost of transmitting data.

For decades increases in the speeds of computer networks trailed the exponentially accelerating speed of microprocessor chips. Now the balance between the power of computer processing and networking has fundamentally reversed, and the rapid rise of transmission speeds is beginning to have a revolutionary impact on how computers are used and what they can do.

"That box of things that used to be contained inside of your PC now gets spread out literally on a global basis," said Mike Volpi, a senior vice president at Cisco Systems, the largest networking company in the world. The changes are taking place both at the highest end of the supercomputing world and just as swiftly in the consumer World Wide Web.

Where software applications like Microsoft Word or Autodesk's AutoCAD were once standalone monoliths that functioned in just a single machine, the new distributed applications are now remarkably adaptable. They are frequently spread across large and small computer systems in order to harness more processing power, and programs now dart about through the networks, relocating themselves to save power or to use resources more efficiently.

Google is perhaps the most extreme example of the future of networked computing.

Today the company is a major buyer of fiber-optic network capacity to interconnect a computing system that is spread over more than 100,000 processors in over a dozen data centers around the world.

Moreover, for everyday Web surfers, an exploding array of services is being built by using the software equivalent of Lego blocks, as companies like Google, Yahoo and Microsoft begin to make software components available to "mash-up," that is, to link programs running on different servers in different places, in new distributed applications on multiple computers and frequently available free.

Earlier this year a classic mash-up was created by Paul Rademacher, a Silicon Valley programmer who connected apartment rentals on the Craigslist Web site with Google Maps, in the process creating a new Web service, a program that resides simultaneously in many places on the Internet.

That model has initiated a growing array of applications involving so-called distributed computing for corporations, consumers and scientists. "Today we are Google-mashing everything," said Bill St. Arnaud, senior director of advanced networks for Canarie, a government-sponsored high-speed network based in Ottawa that links research laboratories.

It is now possible to connect computers on opposite sides of the world by an optical fiber capable of carrying 10 billion bits of information a second.

Known as "lambdas" -- an industry term for optical circuits that carry data -- these data superhighways are making it possible to create a new class of supercomputers that have no geographical boundaries.

Such virtual computers are possible to create today because the new optical networks have delays of only the time it takes the speed of light to travel from one point to another. They offer a bridge to a new era of computing.

"People have spoken about how computer networks have flattened the world," said Larry Smarr, an astrophysicist who is director of the California Institute for Telecommunications and Information Technology, known as Calit2, an interdisciplinary research laboratory which will officially open this month at the University of California, San Diego, in La Jolla, and the University of California, Irvine. "But it's more than that, distance is vanishing and the world is now shrinking to a single point."

The implications of ultrafast computer networks composed of optical fibers that stretch around the globe could be seen clearly last month at a supercomputer network workshop, iGrid 2005, held at Calit2's La Jolla building.

This is the fourth such workshop since 1998. They have been held irregularly by scientists and engineers to help master new network and computing technologies, and to build prototypes of computing applications that can span the globe.

Mr. Smarr envisions the new laboratory as the model for the scientific research center of the future. He is bringing together scientific and engineering disciplines and providing them with a range of laboratories that include nanofabrication clean rooms and facilities for visualizing scientific information.

Multimedia artists will be an integral part of the research center and will explore new art forms made possible by high-speed networking.

For example, at the building dedication later this month, Adriene Jenik, an associate professor of computer and media arts at the University of California, San Diego, will preview Specflic 2.0, what she describes as an example of "speculative distributed cinema." This next-generation style movie will appear on a cluster of networked displays in the courtyard of the new building. Each display will be a window into a different part of the narrative, which will be taking place with both live and filmed actors.

"The story isn't just told, it's experienced," she said.

At iGrid last month a network capacity of 100 billion bits per second was connected to the new Calit2 building, allowing prototypes of scientific visualization applications that have not previously been possible.

There were demonstrations of brute networking power: using networks capable of carrying more than a billion bits of data a second to carry a super high-definition video conference over 9,000 miles between Tokyo and La Jolla, accompanied by a separate stream of hi-fidelity digital sound produced by musicians at LucasArts in Northern California.

There were also the first demonstrations of a new generation of supercomputing power made possible by emerging optical networks like the Global Lambda Integrated Facility, the National Lambda Rail and Teragrid.

These networks not only make it possible to harness the power of multiple supercomputers, but they also allow scientists to create a new class of instruments, in which huge volumes of scientific data are easily available to researchers around the globe.

For example, at the iGrid symposium scientists showed the first high-definition digital video broadcast from an undersea volcanic vent more than a mile beneath the ocean off

the northwest coast of the United States.

The video comes from a new undersea observatory being constructed by a United States-Canadian partnership. The system will consist of a web of computers interconnected by fiber-optic sensors on the sea floor intended to monitor everything from geological to climate changes.

The distributed computing system will collect data from thousands of sensors of different types that allow the researchers to build a complete picture of the undersea world.

"This is the new computational science," said Edward Lazowska, a computer scientist at the University of Washington in Seattle and one of the project investigators. In the future, he said, science will be based on data flowing across computer networks that can then be visualized and mined.

For Mr. Smarr, the power of visualization and the need for very high-speed networks was underscored when a team of researchers at the TelaScience Laboratory at San Diego State University worked to assist rescue teams responding to the Indian Ocean tsunami and to Hurricanes Katrina and Rita.

By quickly processing digital satellite image data, the researchers at the university were able to support rescuers with detailed visual maps.

By processing satellite imagery of the Gulf Coast in the wake of Katrina, the researchers correlated satellite imagery with address information, permitting individuals and rescuers to see the impact of the flooding on homes.

The researchers were slowed, Mr. Smarr said, when it took 10 days to transfer the digital data from a United States Geological Survey computer because of a slow computer network.

In commercial data centers, thousands or tens of thousands of server computers can be more rationally used as workloads are moved around to mirror changing needs.

While the United States has been relatively slow in deploying fiber optics directly to homes, that is not true of a growing number of countries in Asia and Europe.

In Japan, for example, there are now three million homes connected directly to the Internet via fiber-optic cables. Compared with typical United States home bandwidth data rates of 500,000 to 1.5 million bits per second, Japan has bandwidth of 100 million bits a second for $30 to $55 a month, according to Osamu Ishida, an engineer at the NTT Network Innovation Laboratories, an advanced development laboratory in near Tokyo.

Although a new computing era is clearly dawning, it does not have a consensus label as was the case with each of the previous eras: mainframe, mini and personal computing.

So far, the new epoch of computing has been described as grid computing, on-demand computing, utility computing, the planetary computer and Web 2.0.

Although the titles are different, they are all efforts to describe an age that will be a fundamental break from earlier computing generations.

"Can you blow up the computer machine room and spread it over the surface of the planet?" Mr. Smarr said. "This is really happening."

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