RETHINKING THE COMPUTER

With Superchips, the Network Is the Computer

In 1979, Steve Jobs, co-founder of Apple Computer Inc., made a now-legendary visit to a neighbor. Xerox Corp. gave him a rare tour of its secretive Palo Alto (Calif.) Research Center (PARC). There, Jobs later recalled, he fell for a computer called Alto. Unlike the personal computers that Apple was then building, Alto had the power of a minicomputer, and its software painted crisp text and graphics on a big, bright screen. Jobs soon had a team of Apple engineers hard at work trying to duplicate Alto's user-friendliness. Their first attempt, Lisa, didn't sell. But then came Macintosh. And the rest, as they say, is history.

Yet the Alto's graphical "look and feel," which made the Mac such a hit and is so widely aped these days, was just the friendly face of a much larger, more profound body of thought coming to life in the Xerox labs back then. PARC was cooking up a radically new way of building and using computers.

The central idea: Slice and dice the mainframe. Carve up the power and functions normally trapped inside that costly behemoth and parcel them out to a network of dozens or even hundreds of small computers. First, put an Alto on every desk. Then, connect them together on a network and add specialized "server" computers to do particular jobs such as managing data bases, printers, or electronic-mail systems. Add the right software, and the network itself becomes "the computer" -- and a far more responsive and flexible one at that. By attaching new workstations and servers, it can easily expand and adapt to a business' changing needs. And all for less money than a mainframe.

SLOW START. PARC demonstrated all that with its own network, which, some people reckoned, harnessed more computing power than any mainframe data center in the world. But history overtook Xerox. Just when the copier company was trying to get a commercial version of Alto off the ground, the IBM PC grabbed everyone's attention. The PC was relatively crude, but it became a near-universal standard, shoving aside almost every other desktop computer design. Along with it went Xerox' vision of the network as computer. "In the IBM PC world, PARC's whole idea of networking has been completely lost," says one PARC veteran.

Jump to the present, though, and you see network computing at last catching on -- and not just the rudimentary PC links that for the past few years have delivered electronic mail to small groups of workers. Microcomputer networks are finally approaching PARC's more complex concept, in which computers on a network begin to work together intimately -- as intimately as if they were all one machine. In computerese, it's known as the client-server model. With it, a client computer -- a PC or workstation -- becomes a window into an almost limitless array of computing resources dished up by server computers on the network. Those machines deliver information or perform special jobs that an ordinary PC can't.

The beauty of this setup is that, to the worker, it seems as if everything is happening right on his desktop. For example, when a Wall Street trader updates the spreadsheet on his client computer, several different servers -- perhaps in other cities -- are doing his bidding. Some collect reams of market data from different exchanges. A supercomputer might analyze them for arbitrage opportunities. Another would scan historical data bases, and yet another would pass the results back to the trader's desktop PC. This is managed automatically so the computer user doesn't have to think about where any of the work gets done.

That kind of cooperative processing has long flourished in corporate engineering departments, where networks of Alto-like workstations have practically made minicomputers obsolete. Now, the same technology is poised to thoroughly reshape business computing, the last bastion of mainframes. Desktop computers are nearly ubiquitous in business, and many are more powerful than the Alto -- workstations from Sun Microsystems, Hewlett-Packard, and Digital Equipment, for instance, and high-end personal computers from IBM, Compaq, and Apple. And networking software is finally getting robust enough for client-server setups.What finally makes these networks possible are the new mainframe-caliber microprocessor chips such as Intel Corp.'s 80486, Motorola Inc.'s 68040, and the so-called RISC (reduced instruction-set computing) chips used in workstations. These megachips are the building blocks for a new class of servers -- sometimes called "superservers" -- that, along with new software, finally complete the network-computing puzzle. With mainframe speeds and enormous disk-drive capacity, they can store information for an entire company to share -- and dole it out as needed to PCs in the factory, the warehouse, or the executive suite.

'IRRESISTIBLE FORCE.' In these servers, the microprocessor at last delivers on its astounding promise: to handle virtually every job that minis and mainframes do. And not just because of their enormous power and low cost. Since they are specialized, each microcomputer-based server can be tuned to excel at its assigned task -- and to outdo a mainframe, which must do it all (illustration). "We're on the brink of a major crossover between micros and mainframes," says Charles E. Exley Jr., CEO and chairman of NCR Corp. "The microprocessor revolution is becoming an irresistible force. Ultimately, every business will want to move from their mainframes to microprocessor-based systems."

So convinced is Exley that he has made that proposition the basis for NCR's entire strategy. Within a few years, every computer in the NCR line -- from PCs on up -- will be based on one or more Intel microchips. Gone will be NCR's proprietary mainframe designs and any other machine that cannot run standard software and therefore plug easily into networks. The Dayton-based company is working closely with a small West Coast company, Teradata Corp., to build a new kind of computer from hundreds of Intel chips (p. 124). NCR's commitment to the Intel-based strategy, analysts say, makes it a good fit with American Telephone & Telegraph Co., which has taken almost the same route. Although neither company will comment, industry-watchers say the two companies have been talking for several weeks about a possible acquisition, merger, or joint venture.

Both companies are in a position to do what IBM or DEC can't: totally overthrow the old order. Unlike their giant computer-market competitors, neither AT&T nor NCR has a huge installed base of proprietary mainframe and minicomputer systems. So they can sell micro-based network computing as the replacement for those older systems without damaging themselves.

'LOBOTOMY.' Minicomputers and mainframes aren't likely to die off quickly, but they aren't particularly suited to the new concept of networked computing, either. They're designed to control strings of "dumb" terminals rather than to work collaboratively with hundreds of other computers. As general-purpose processors, they handle in a single box all four main functions of a computer: communications with humans, communications with other machines, managing data files, and executing programs. Each second, a nightmarishly complex program called the operating system divides the processor's time among hundreds of tasks. Some large mainframes spend as much time switching among those tasks as they do getting work done. Upping the hardware's speed can make a mainframe more productive -- but only to a point.

Networks, the experts say, can beat out the mainframe in most applications by assigning tasks to specialized microcomputer servers. Simple work, such as word processing, is best done in workstations and PCs. Complex tasks, such as searching a massive data base, performing lengthy calculations, or routing electronic mail among hundreds of workers, can be assigned to their own servers. Says Larry Boucher, a former IBM mainframe engineer and co-founder and chief executive of Auspex Systems Inc., a Santa Clara (Calif.)-based server maker: "The central-processor model doesn't make any sense anymore. It has to change." Powerful micros, he says, finally make it possible to "give the mainframe operating system a lobotomy."

That gives the new high-powered servers the opportunity to take on the most critical mainframe function of all: storing the data that, in effect, defines the corporation. "The corporate jewels are the data," says Bruce J. Nelson, another PARC veteran who is now director of technology at Auspex.

'NASTY SECRET.' Simple PC networks have been around for years, relying on souped-up PCs as their central file cabinets. Yet even the fastest PCs, with the largest-capacity disk drives, have severe limitations when they are asked to serve too many desktop clients. "Slow performance," says Glenn R. Dinetz, director of American Management Systems Inc.'s PC-LAN consulting group. "That has been the nasty secret of PC networks." And nets could get even slower as they begin shuttling digitized images of documents. The digitized image of a typewritten page takes up 10 or even 50 times more computer memory than the normal, coded version.

So, in the past year or so, the market has seen a raft of specialized file servers that can reliably move data through a network to hundreds of PCs at a time. Compaq Computer Corp., NetFRAME Systems, and others have established a new class of microcomputer-based hardware. Compaq's $20,000 Systempro has received perhaps the most attention: Powered by one or two Intel 80486 chips, it can supply data to a network twice as fast as a regular 80486-based PC can. Depending on its software, it can send entire files or just certain items selected in response to complex queries. Just this month, IBM brought out a $14,145 server called the PS/2 Model 95, also based on the fastest Intel 80486 chip. Says James A. Cannavino, vice-president and general manager of IBM's Personal Systems unit: "Now you start to be able to get at the data. And applications that would have been sluggish or unusable now are easy."

That's what's making server shipments take off. "Servers are the aftershock of the desktop boom," says Sam Bogoch, CEO of Torque Computer Inc., a New York server maker. Forrester Research Inc., a market researcher, pegged last year's server market at $3.2 billion, including standard PCs sold as servers. Forrester expects it to grow 30% annually, to $11.7 billion by 1994. Most of that spending will go for file servers, the rest for servers that perform tasks such as running laser printers or communicating with remote networks. At the same time, mainframe and minicomputer shipments are expected to rise only around 5% annually. Servers are becoming "part of the customer mindset," says James Fischer of Anderson Consulting. 'We're convinced they're the answer to the future."

The new market has attracted several startups, some with impressive funding. NetFRAME Systems and Parallan, for instance, have raised more than $42 million between them. They, along with Tricord Systems Inc., are pushing further than IBM and Compaq with sophisticated servers. Tricord says its PowerFrame can achieve up to 10 times the performance of Compaq's Systempro. It uses the same Intel chips as Compaq but joins them internally using a higher-speed "bus," or data highway. The machine sells for about $35,000, says James D. Edwards, Tricord's president. In some tests, he adds, the Tricord machine has rivaled the performance of a $9 million IBM 3090-400 mainframe.

Not only are these new servers inexpensive, but they cost less to maintain and upgrade. Most are built around the standard hardware formats developed by IBM and its rivals. That means that add-on cards and disk drives designed for the PC, the IBM Personal System/2, or the so-called EISA format (an alternative to IBM's PS/2 Microchannel) will fit the servers, too. Terry L. Martin, data processing manager at Western General Services, recalls paying $19,000 for a used, 100-megabyte disk drive for a company minicomputer. The Chicago-based insurance-claims processor then switched to a PowerFrame server and 58 PCs and paid only $5,000 for a new, 1,200-megabyte drive. "There's no comparison," Martin says.

BETTER PROGRAMS. Software's another saving. PC programming tools -- programs that provide shortcuts for programmers -- "are far better" than those for mainframes, says Jim Johnson, executive director of management information systems at Fort Howard Paper Corp. He reckons a cost saving of "at least 10 times" for developing a new software function on PCs vs. writing it on a mainframe. And servers save support costs because they're generally easier to maintain than mainframes. "Customers are trying to reduce the number of people needed to support all their machines," says Gianluca U. Rattazzi, president and co-founder of Parallan, whose server can be monitored remotely.

Specialized servers are playing big roles in engineering networks, too, where the demand for increased performance is insatiable. Epoch Systems Inc.'s InfiniteStorage product, for instance, keeps masses of data on hand for instantaneous access. But it slashes costs by storing only the most frequently used files on costly, high-speed magnetic disks. The rest get moved automatically to slower-access but far-cheaper optical disks and magnetic tapes.

Startup Auspex is attacking another problem. Its NS5000 file server dishes out data so fast to workstations that they need only very small disk drives of their own -- a big cost saving. The machine also replaces the weak file-handling functions of Unix, the standard software in workstations. Says CEO Boucher: "Servers are going to blow the doors off" traditional mainframes.

Perhaps no company believes that more fervently than NCR. By shifting completely to a product line of micro-based servers, personal computers, and the networks to connect them, the $6 billion company is making an uncharacteristically bold bid for technology leadership. It's NCR's big chance to shed its image as an also-ran in the corporate computing race so long dominated by IBM. "We're no longer a boring company," says Chairman Exley. With a broad product line based entirely on advanced microprocessors and industry standards, he says, NCR will help customers to "cap their investment" in aging mainframes. "No one has heard this story from any other supplier."

Certainly not from IBM or the other old-line mainframe companies. Networking computing's foundation in commodity microprocessors and standards means slimmer profit margins than traditional proprietary machines provide. NCR, though, risks little because it depends on proprietary mainframes for just 9% of its equipment and software revenues, Exley says. So it can afford to ride the microprocessor's plummeting cost curve. D. H. Brown Associates Inc., a Tarrytown (N. Y.) market researcher, reckons that microprocessor power for the dollar increases by a staggering 32% per year. Mainframe customers are lucky to see a 15% improvement in performance for a fixed price each year.

Those economics have piqued the interest even of corporate computer managers -- the generally conservative executives who have, for the most part, remained loyal mainframe fans. At Fort Howard Paper, "we're very eager to decelerate our spending on mainframes," says computer

chief Johnson. The company recently bought a Tricord server to try out in its legal and public affairs departments. At retailer Burlington Coat Factory Warehouse Corp., a Sequent Computer Systems Inc. server and a network of micros has been brought in and an old mainframe is expected to be unplugged soon.

Still, computer chiefs aren't "betting the farm" yet on PCs and servers. Even with heavy-duty servers such as Tricord's, the technology is too new to be entrusted with critical and sensitive tasks such as payroll processing and financial accounting. And despite their higher costs, mainframes and minis will hang on for a while, if only because customers have invested billions of dollars in software for those machines.

That gives IBM and DEC, among others, one more opportunity, some say their last, to lift sales of their outmoded centralized computers by, in effect, converting them to network servers. IBM, for instance, just brought out software to give its System/370 mainframes the networking language used by most Unix-based workstations.

DEC, meanwhile, is pushing a software scheme called Network Application Services that makes its VAX minis into servers for many popular desktop computers. One convinced customer: accounting firm Coopers & Lybrand, which chose a large VAX to hold data for 2,500 PCs in its New York office. The VAX's main advantage, says Stephen C. Rood, manager of microtechnology: software powerful enough to serve that many PCs from a single location. Compaq Systempros, another option Coopers & Lybrand considered, were limited to serving just 255 PCs apiece.

What may really prolong the the mainframe's life is software. The complexities of PC-server networking can be frightening, especially when customers mix gear from several suppliers. A simpler solution -- for now -- is to stick with one supplier, buy its various sizes of machine, and let it make the networking connections. That is exactly what IBM has in mind with a scheme called Systems Applications Architecture -- software standards and protocols that will eventually link all sizes of IBM machine.

PIECEMEAL PROGRESS. IBM, naturally, would keep the mainframe at the center of corporate networks. But the programming that's needed to form a "seamless" SAA network is not all in place. In the meantime, dozens of PC and networking companies are hammering out standards to let all workstations and servers -- from any supplier -- work together. If that can be accomplished, customers will be able to improve their networks piecemeal as better technologies and products become available.

Trouble is, even as many suppliers boast of writing their software according to widely accepted industry standards, the products they ship often display bothersome peculiarities. "There are a lot of hairy issues to resolve between suppliers," says Auspex' Nelson.

Still, despite some confusion, the vision of network computing hatched at PARC is rapidly coming of age. Powerful microprocessors are creating the necessary servers and workstations. Equally important, the low price of these speedy machines provides a compelling economic reason for dispensing with the old ideas of how computer systems should be constructed. If these networked systems really do topple the mainframe and mini, it will be the biggest change in data processing since ENIAC's vacuum tubes first added 1 and 1 to make 10 -- in binary, that is.

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Business Week
26-11-1990