COMPUTING

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Computing Power

When J. Presper Eckert, the co-inventor of the first electronic computer, was asked, "Did you have any idea what you were creating when you built the ENIAC and, later, the UNIVAC I?" He responded "I thought it would be a universally applicable idea, like a book is. But I didn't think it would develop as fast as it did, because I didn't envision we'd be able to get as many parts on a chip as we finally got."[1] Indeed as the transistors per die graph on the following page demonstrates the number of transistor per die has been growing at a tremendous rate since 1970 and is expected to grow through the year 2000. In keeping with Intel chairman Gordon Moore's 1975 prediction of a doubling every two years of the number of transistors per chip, device density has actually increased at a rate of approximately 40% per year. This miniaturization of computer components makes little difference unless there is a corresponding increase in computing performance. Fortunately there is. The processor performance graph on the following page presents the growth in the two common measures of computing performance, namely millions of instructions per second (MIPS) performed and system clock rate measured in megahertz (MHz). The performance increases have not only come from miniaturization but also from improvements in CPU architecture and logical design, testing equipment, construction materials, and manufacturing techniques. For example, new manufacturing technology allow machines to etch pathways into silicon at less than one millionth of a meter wide allowing for higher speeds because electrons have to travel shorter distances on the chip. Intel's current 80486 processor uses 1-micron etching technology. The use of submircon technology holds out the promise of quadrupling raw CPU speeds. In 1990, Motorola was producing the first such submiron chips in small quantities. It was reported that these chips could perform 200 million floating point operations per second.[2]

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[1]Brousell, David R., "What hath he wrought?," Datamation March 15 1991 v37 n6, p30

[2]Savage, J.A., "It's a fine, fine line for CPUs," Computerworld Jan 29 1990 v24 n5 , p23(2)

These trends have lead a group at Intel Corp to the following prediction:

> "The microprocessor of the year 2000, with a projected 50 million transistors on a die measuring 1 inch square, could incorporate multiple processors with an aggregate performance of over 2,000 MIPS. This estimate...assumes that Micro 2000 will operate at over 250 megahertz."[3]

By way of comparisons, the new IBM System 390 mainframe processes at 40 MIPS while the more powerful personals computers (PCs) have clock speeds of only 33 MHz. However, as pointed out by economist Kenneth Flamm, a senior fellow at The Brookings Institution in Washington, D.C., "It's always been the cost of computing power that has driven computers and their applications, at the low end as well as the high end. Every time the prices tumble...there's a huge expansion in demand for computers and new kinds of applications." Flamm's studies show a 25% price/performance improvement in computing in real dollars every year from 1957 to 1978 (see price/performance graph on the following page), and, he says, there have probably been even greater gains since then.[4] The result of the decreasing chip size, increasing computing power, and decreasing costs have combined to allow some of the computing resources of the mainframe computers to migrate into the smaller minicomputers and PCs. In other words these forces have conspired over the last twenty to thirty years to remove processing power from the data processing department and placed it in the hands of the end user.

[3]Gelsinger, Patrick P.et alis , "Microprocessors Circa 2000 " IEEE Spectrum Vol: 26 Iss: 10 Date: Oct 1989, pp: 43-47
[4]Brousell, p30

A Brief History of Mainframes to PCs

In the mid-1960's, time-sharing took computer processing into a new, interactive phase. Initially, it was based on mainframes and dumb terminals. This spread of computing power was made possible by IBM 360-generation systems, because it packed powerful time-sharing software and terminals. At that time DP professionals envisioned a day when an entire organization would be connected together through one central mainframe computer. However, in the 1970's the minicomputer, which Digital Corp put on the computing map, broadened the base of computing users and helped stretch technology further out into the organizations. By breaking up the central ownership of the computing resources the minicomputer allowed more control at the "local" level which in turn allowed more responsive usage. The minicomputer was also the first computer to actively automate word processing. Thus in a sense it was the precursor to the PC. The PC was originally pioneered at Xerox Corp and started as a hobbyist's lark. However, two applications were developed that changed the computing landscape forever. The first of these application was conceived in 1978 by Daniel Bricklin while he was a graduate student at Harvard University. It was the first electronic spreadsheet for PCs. It was VisiCalc. VisiCalc paved the way for the next spreadsheet program, Lotus 1-2-3, created by Mitch Kapor and Jonathan Sachs. These new two new applications opened a Pandora's box of powerful PC productivity tools. The age of the PC had begun. The advent of the PC essentially blew the mainframe apart and scattered its pieces all over the organizational topology. The 1990's is showing itself as the period of reconciliation during which these parcels of computing power are being integrated back together through communication networks. Each computer, whether it is a mainframe, minicomputer, or mircocomputer is being perceived as a node of the organization-wide communication network.

The New Relationship

In essences data processing architectures have been compressed from three tiers to two. The machine-centered dominions of mainframes, minicomputers and PCs have been broken down and reformed into a user-centered enterprise and work-group domains. This new architectural focus has received various labels including "cooperative," "client/server," "workgroup," "downsizing," and "rightsizing" computing.[5] The general system architectures diagram on the next page graphically represents this new relationship. This view sees the entire enterprise and selected workgroups as being supported by integrated computer hardware. The correct amount of processing power and system integration being made available to suite the job specifics. The main force behind this new orientation is the same drive that was described earlier as pushing the general computer industry. Cost. The cost per transaction per second is far less on PCs and minicomputers when compared to mainframes (see thousands of dollars per transaction/second graph on the following page). Thus the further down the processing hierarchy a specific job is pushed the more cost effective the processing may become. The incrementally growth of power has increased much more rapidly in personal computers than in mainframes. This growth in raw processing power has also played a major role in the migration of specified applications from mainframes to minicomputers and PCs. Specifically these small computers have two distinct advantages, these are:

1. Easier to learn and install
2. Hardware and software problems on PCs require relatively lower maintenance skills.[6]

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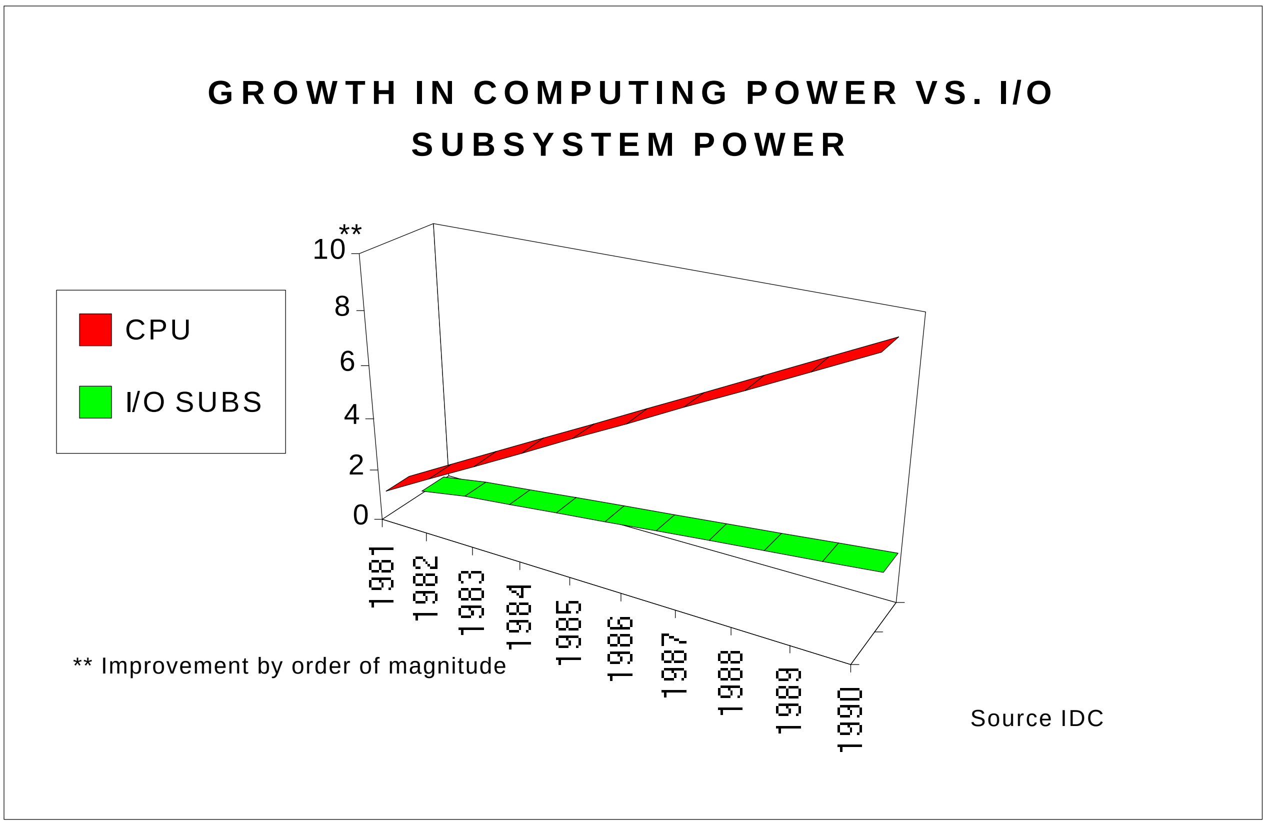
[5]"IDC white paper," Computerworld, Dec 10 1990 v24 n50, p52(8)
[6]"IDC white paper"

An important new technology that makes downsizing possible is the bridge   A bridge is a device that lets you connect two networks and operate them as if they were one. Other bridges let you link networks through microwave links, lasers, or dial-up telephone lines. Other enabling technologies include: reasonably priced high-speed data networks, high-speed modems for dial-up use, new transmission media, practical methods of centralized data storage, and new ways to manage huge networks.[7] Another reason that the rightsizing environment has arisen is because, despite all the technological gains, the disparity between the computer's ability to "crunch" data and its ability to move data through input/output subsystems has been disappointing (see graph below).



[7]Rash, Wayne , "Corporate connections," Byte Sept 1991 v16 n9,p215

CPUs simply cannot move data around as fast as they can process it. In order to put the issue in perspective consider this: CPU cycle times are in nanosecond (one-millionth of a second) range, I/O subsystems operate in the millisecond (one-thousandth of a second range. If we arbitrarily assign one nanosecond as one hour, then one millisecond is approximately 41 days. The use of user-oriented networks, combining both minicomputers and PCs, is one solution to this shortcoming. Financial services provider Textron Financial Corp. in Providence, R.I., is currently working IBM mainframes into a client/server network via a database gateway provided by Sybase Inc. Textron's IS vice president Paul Hamel expects to replaced the company's mainframes with PC-based client/server networks and a distributed database management system. Because he believes that on a cost-per-dollar-receivable basis PCs and network servers are less expensive than mainframes.[8] Examples like this seem to demonstrate that, like the railroads and cruise ships were displaced by the airlines as the dominate form of transportation, the mainframe is being displaced by the minicomputers and PCs as the dominate form of computing. It may be that mainframe technology is just too slow and inflexible to compete with nimble networks based on PCs. It appears now that most employees spends 80 percent of their computing time on PCs and only 20 percent on the mainframe. Yet corporations spend 80 percent of their MIS dollars on the mainframes hardware and maintenance and only 20 percent on PCs. Cheryl Currid, a Houston-based information technology consultant, believes that "somebody needs to take a stand, and start talking about the death of the mainframe." She believes that when MIS departments work hand and hand with end-users-they can manage and maintain large and complex networks. End-users must assume more responsibility for their own data destiny but once the end-user is educated and when things are done right, nobody misses the mainframe.[9] One way to manage a large enterprise-wide network would be to establish end-user DP departments (EUDP) for each organizational unit. The head of this EUDP would function much like a local area network administrator but may not be responsible for any particular hardware. The main responsibilities would be to solve local work group data administration problems, communicate system

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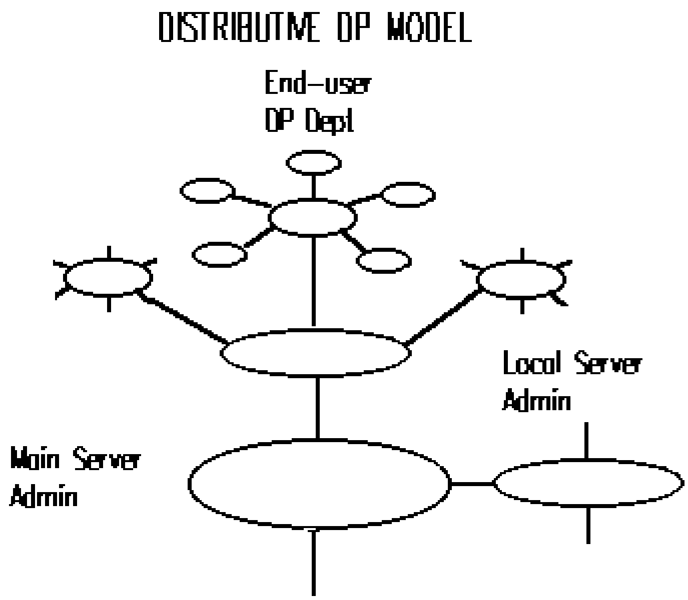
[8]Moad, Jeff , "Can Big Blue reposition big iron?," Datamation , Feb 1 1991 v37 n3 , p54
[9]Currid, Cheryl "I come not to praise the mainframe, but to bury it," InfoWorld Oct 21 1991 v13 n42 , p46

changes, and educate end-users of and assure compliance with data management policies. The EUDP would report both to the appropriate level within the organizational unit and to a local server administrator, who may in turn report to a main server administrator (see distributive DP model diagram below).



This model allows some control over the company's information, because the information can be either stored at a local or central file server. The location of data storage would depend upon its nature and system organization. This model also gives some degree of control over what software is available and to whom. The key to success using this approach is education. As American Airlines found, according to Digital Consulting, Inc., when it recently moved a flight scheduling program from an IBM 3090 to 12 workstations and a server, the greatest difficulty was in getting people at remote sites to adhere to the disciplines and procedures that an enterprise-wide downsized production application requires.[10] It has taken 20 years to make this type of model possible and it will take at least half that time to setup the organizational structure, educate the users, change perceptions of the IS professionals, and make it all work. If we are seeing the mainframe go the way of the dinosaurs, it will not come anytime soon if for

[10]Gantz, John, "Dinosaurs should beware: the future is in downsizing," InfoWorld, Sept 23 1991 v13 n38, p101

no other simple reason then that most mainframe companies have large applications and massive databases already running on mainframes and they don't see a practical way of breaking those applications into pieces that can run on smaller networked PCs and servers. There are additional reasons few companies expect to erase the need for large mainframes any time in the near future. These are the reasons given:

1. At the high end of the processing power scale, large mainframes cannot be readily and cost-effectively matched by incremental additions of small processors. This is especially true in high-volume transaction processing.
2. Mainframes have sophisticated security mechanisms for both access of data and secured transmissions.
3. Formal and standardized procedures and products for reliable backup and recovery on mainframes have been developed over the years.
4. Mainframes provide the automated control and integration of storage devices as well as other peripherals and resources necessary to carry on a global business
5. Mainframes provide system control and all-important auditing facilities that maintain data, applications and operating system integrity.[11]

PCs, may simple not be viable alternatives to mainframes for jobs that require robust security, task interleaving with other data processing jobs, and high rates of transaction processing.[12] An indication that this may be true is that, although less than five years ago the top price for a mainframe was in the range of $5 to $6 million and today these machines can exceed $24 million, there is no sign that the world's largest corporations are reluctant to buy mainframes. If the mainframes survive the 1990's they will likely be characterized as data vaults or warehouses for the enterprise. They will likely fit into a node on the network and act as a powerful server

[11]"IDC white paper"
[1212]"IDC white paper"

and data retrieval unit. For larger organizations these mainframes will link up into what IDC calls "distributed data center complexes." Distributed data center complexes are a collection of geographically diverse data centers coupled by wideband, widearea communication capabilities. Each complex is tightly coupled with all other complexes sharing central memory, storage and other mainframe facilities. In this environment each of these distributed data center complexes while to a large degree self-contained requires information sharing with smaller "mini-mainframes." Overall enterprise control of such communication will be accomplished by a "logical" mainframe which is a distributed data center computer that stands logically apart from any other CPUs. This master computer will not be intrusive. Its strategic decisions will be made transparently and according to priorities established by management. It is likely that in order to manage and control processing enterprise-wide systems of the future will require more knowledge than any one person can supply. Therefore, another feature of this type of distributed data center will be artificial intelligence, or more precisely, mainframe-based expert systems, which will help fill this knowledge gap. Expert systems will gradually replace the human component and make the thousands of split-second decisions needed to run a large mainframe complex on a daily basis...these packages will "sense" an impending problem before a critical stage is reached and actually call the manufacturer's service facility via an integral modem. Further, these diagnostic tools will place probabilities on impending failure and suggest replacement parts. Therefore, a technician dispatched from the vendor's facility will usually arrive at the installation with all parts required to fix the problem before it occurs.[13] Additionally, the successful moving of very large amounts of sensitive data over long distances with high reliability and security which is required by these distributed data center complexes is and will continue to be supplied by internal and external fiber-optic networks. Thus mainframes will make a sprawling international operation work by acting as hubs that connect various locations. IBM has demonstrated that it too sees this trend when it introduced its 390 mainframe line. Jim Cassell, a Gartner Group vice president and IBM mainframe analyst, said IBM will build on the 390's architecture to become a "megaplex" connecting all the mainframes

[13]"IDC white paper"

and client/server computers throughout an organization. The mainframe will essentially become a "super-server".[14] PCs and minicomputers on the otherhand will show enormous increases in power. What will all this mircoprocessor computing power give the organization that purchases it? Will it be the 1960's muscle cars with lots of power but little else? The basic idea behind personal computing is to help people be more creative and think up new business solutions that were simply not possible before. This will be best fulfilled by the corporate network. This network will have transparent access to information located anywhere on the network including on the mainframe. We can alos expect this future network will not only provide data but also video and audio information. Thus a new relationship appears to be emeraging. PCs and minicomputers providing the nimble powerful processing networks and the mainframe providing the data retrival and large scale number "crunching."

Impact on Industry Suppliers

The 1990 competition picked up during June when Hitachi Data Systems announced the industry's fastest processor, the model EX/420. The EX/420 was rated at approximately 150 MIPS. This introduction was followed in short order by rapid-fire announcements from Amdahl, Fujitsu and IBM.[15] This rapid-fire response indicates just how hot the competition is in the computer industry. General purpose processor speeds are now in the 150 to 210 MIPS and are, as was discussed earlier, expected to reach 300 to 500 MIPS by 1995. They may hit 2,000 MIPS by the year 2000. As commercial applications begin to require such processing power it seems likely that a customized configuration will be developed for each individual installation. It, therefore, appears clear that the moto for the age of the customer, that is,

> "The organization that provides the right service to the customer or provides it best will be the organization that survives"

applies equally well to the computer industry. Not only will services and tailor made systems be demanded but so will interconnectivity. The computer processor environment over the next

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[14]Ambrosio Johanna, "Get ready for a rough ride," Computerworld, Nov 19, 1990 v24 n47, p115
[15]"IDC white paper"

five to 10 years will continue on its heterogeneous path. Along this path, corporate data processing departments are moving into an era of hardware specialization. They are dedicating mainframes to the management of very specific business situations such as automated tell machines, on-line transaction processing (OLTP) and batch processing and then connecting these systems to minicomputers and PCs in an enterprise-wide network. Therefore, the challenge for the computer industry is to maintain multi-vendor hardware solutions.[16] Indeed the aggressive marketing of the plug-in compatable machine (PCM) vendors, joint ventures and far reaching marketing agreements among industry giants have the bigest vendors, like IBM, looking anxiously over their shoulders. What they sees is Fujitsu buying International Computers Ltd. outright and 42% of Amdahl. In another similar move, Electroci Data Systems bought 20% of HDS.[17] This competative enviornment has IBM and others attempting to reposition the mainframe as a large node on the corporate information network. Indeed IBM portrayed a barrage of System/390 product announcements as further establishing the mainframe as a key component in client/server networks. The problem is that IBM has not as of yet delivered the key products and technologies that are necessary to integrate mainframes into these systems. The new technologies need to provide the ability for the PC to access data from the mainframe in the same manner that it accesses data from the server. In a special report by Datamation (February 1, 1991) there were five critical holes that mainframe producers must fill in order to effectively integrate their mainframes into client/server networks. These are:

1. A common data management server that will transparently exchange data across a network.
2. An intelligent directory to help them easily determine what devices are and are not on the enterprisewide network at any given time.
3. A client/server resource manager to determine which network resources are being used by given processes, in order to manage overall system and network performance.

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[16] "IDC white paper"
[17] "IDC white paper"

4. A client/server transaction monitor that assures the person or system generating a transaction that the transaction has reached its target.
5. A enterprise-wide problem management server that will pinpoint failures on the network and keep track of physical inventory and security.

Internationally, five-year mainframe-market growth in the Pacific Rim is expected to double that of the rest of the world. The Japanese, Australian and Asizn markets pose an interesting dilemma for mainframe makers. IBM systems compatibility is less critical in these markets than in the U.S. As a result, several European and Far Eastern manufacturers have aggressively carved out and maintained a significant market share. Thus, IBM and the PCMs have found themselves in the unaccustomed position of playing catch-up[18]

Conclusion

The year 2000 should bring fanatic improvements in mircoprocessor computing power and the price/performance ratios. New system configuration, namely the enterprise-wide network, and new ways of doing business will emerge. In order to survive this transition the computer industry suppliers must be prepared to both invest in the R&D need to keep pace with the rapidly expanding power of the mircoprocessor and the R&D need to link the various systems together. Finally, the industry must continuously explore new customer service opportunities.

[18] "IDC white paper"