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The Metamorphosis of the Mainframe Computer: The Superserver

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Introduction

Mainframe computers, which once dominated the computer hardware and software markets, have become increasingly unpopular with users. Major mainframe manufacturers have felt this decline in user demand. In 1994 mainframe computers amounted to only about 30 percent of IBM's total computer sales, compared with 90 percent in 1984. Unisys Corporation announced in 1994 that it would entirely discontinue manufacturing its line of mainframe computers, electing to concentrate on more profitable areas of the computer market.

Despite a trend where users abandon mainframe solutions, computer processing demand by business, industry, government, and private users is growing at a geometric rate. Unfortunately, the growing demand for computer services has been imperfectly sustained by smaller-scale but more user-friendly computers, especially networks of personal computers.

However, evidence suggests that the decline of the mainframe computer will soon end. Based on this information, we believe that the mainframe will reemerge to prominence. However, it will do so in a transformed state--as a superserver. In its metamorphosis, the superserver will replace the general purpose processor as a multi-purpose processor which will perform a broad spectrum of functions, including functions of the legacy system, the database server, and the windows server.

The Centralized Mainframe Environment

Computers were first developed in monolithic Von Neumann, centralized mainframe paradigm. Large-capacity computer facilities multiprocessed users with dumb terminals.

Now disparagingly called "legacy systems" because of their supposed connection to a bygone era, central mainframe computer sites still exist at more than eighty percent of large companies.

Centralized mainframe technology is a mature technology with room to grow, which might have specialized architecture such as pipelining, vector processing, array processing, MIMD processing, etc. Furthermore, mainframes are ideal sites for maintaining large storage facilities that may include large DASD farms and off-line tape storage. The mainframe paradigm alludes to central-site, time-shared, and mostly text-only environment. Despite having the power necessary to support the diverse data types and communications streams common to multimedia, the vast majority of mainframe systems have not been adapted for multimedia purposes. These systems are still designed to excel at batch processing, with only a portion of the system capacity allocated to interactive use. Not surprisingly, most people with personal computer experience would characterize mainframes as distinctly un-user-friendly.

Local Personal Computer Environment

Personal computers became popular with the introduction of the IBM Personal Computer in 1982, and gained popularity primarily as an alternative to the cumbersome processing requirements of centralized mainframe computing. Local computing gave users freedom and flexibility to define their own computing needs, and ultimately gave rise to a classification called end-user computing. Now, with Windows-metaphoric environments, PC systems are becoming very user-friendly. The marketing trend in PC systems is to bundle complete desktop multimedia workstations, creating a local multimedia capability entirely unknown to mainframe users.

Unfortunately, freedom has its price. PC users are burdened with the never-ending cycle of hardware and software upgrades, maintenance, security, which are all functions once handled for them by the central computer IS and operations staff. And PCs are deceptively expensive. Business Week (March 6, 1995) reports that the average cost of a personal computer over five years to be approximately $40,000. Even before companies understood PC upgrade-cycle costs, they began to network PCs in order to share the more expensive peripheral devices.

Distributed Computing Environments

Networking computers is one way of re-introducing the computer economies of scale, common during the central mainframe era. With the correct software, companies that network can share resources between legacy mainframes, minis and personal computers. While users on a network still have a certain amount of local computing freedom, they find networking environments increasingly restrictive. However, the network paradigm does mean that upgrade planning by an oversight group is now necessary in order to limit the diversity of attached terminal devices and to control the end-user created workload on the support staff.

The characteristic proliferation of workstations, file servers, database servers, application servers--as well as retained mainframe systems represents a significant challenge for IT management in terms of staffing, equipment, and expenditures. While PC systems are generally user-friendly, even mainframe systems have become more accessible with Windows front-end packages that interface between desktop users and text-based mainframes. Furthermore, networks no longer restrict local multimedia capability. With the advent of expanded communications bandwidth, they now can support limited networked multimedia capability. Full network multimedia support will soon become reality.

Evolution of Microprocessors

The rapid computer evolution within the last 15 years has been a reflection of business and research pressures. In the early 1980s, microprocessors and in turn personal computers were not taken seriously. They were thought of being used by hobbyists. But now personal computers are a significant and integrated part of our cultural and technical evolution.

Microprocessors have come a long way since the advent of the first 4 bit Intel 4004 microprocessor with 256 bit-memory in 1971. Today, they compete with mainframes in terms of architecture, sophistication, and performance, and in some ways clearly surpass them such as cost, accessibility, space, and power consumption. This evolution is partially due to the following factors: (1) increase in device density and thus in the number of transistors per chip, (2) increase in clock cycles and increase in the number of operations per cycle, (3) transforming the 40-year-old mainframe architectural knowledge to microcomputer world, (4) advent of Reduced Instruction Set Computing (RISC), (5) business and end-user demands.

The VAX-11/780 super minicomputer, introduced in 1978, has a single processor with the speed of 10 MIPS. Little more than 10 years later, the 80486 microprocessor chip surpassed the VAX speed. Five years after that, the 54-MIP 80486 chip was surpassed by the 150-MIP 80586. Recently, Intel commented on a Micro 2000 project which will have attributes such as: 100 million transistors, 250 MHz clock speed, four processors each having the rate of 700 MIPS, with virtual reality and artificial intelligence applications. These developments suggest that today's microcomputers are equivalent to the mainframe power-houses of 10 years ago and the supercomputers of 20 years ago, yet at a fraction of the size and cost.

Client/Server Environment

True Client/Server networking heralds the beginning of an incremental return to the centralized computing environment. The primary difference lies in the local client workstation, which typically possess a compute capacity and operating system that is remarkably similar (if not identical) to that of the server, especially if the workstation is a recent acquisition. The server, on the other hand, acts much like its centralized mainframe predecessor--fielding requests, processing them, and responding to the on-line client. A

big difference, though, lies in the server operating system, which is tailored to on-line, rather than batch, processing. Another big difference is that the server is much more restricted than the mainframe in the number or attached users that it can support, primarily due to the simplicity in processing capacity of the server.

Client/Server applications are undoubtedly contributing to the rapid expansion of network computing demand. Still, Client/Server computing does nothing to solve a company's problems of continuously upgrading, coordinating, and maintaining vast quantities of local workstations or the attendant support issues.

Client/Superserver Environment

Despite the inherent user-unfriendliness of mainframe user-interfaces, IT managers recognize that centralized mainframe computers can offer considerable economies of scale. Most mainframes are also much more powerful than most servers. As the price of PCs and workstations drop and the Client/Server trend grows, some organizations are utilizing the relatively massive mainframe processing capacity by converting it into a kind of superserver. The "transformed" mainframe is gaining popularity. The new mainframe is playing rolls as a central repository source, as a data manager, and is providing security. For critical applications, these mainframes have been providing piece of mind and archive data from servers which have little fault tolerance features and that lack strong backup capability. They are also acting as database servers for large enterprises which need global information. Accordingly, mainframe operating and control systems are evolving to support user-friendly interfaces and applications, while retaining the capability of supporting legacy functionalities.

With the current trend leaning toward distributed computing, superservers have bright future. Superserver features, in one form or another, include: (1) cheap, fast, powerful, and reliable microprocessors, (2) enhanced I/O systems supporting asymmetric processor capability, (3) multiple processors having RISC technology, (4) massive, scalable memory and storage capacity, (5) fault tolerance and recovery capability, and (6) security features that increase privacy and data integrity. Most of these features were once primarily associated with mainframes and supercomputers. Superservers now are beginning to rival mainframes in many dimensions, as minicomputers briefly rivaled mainframes during 1980s. As a consequence, distinctions between mainframes and superservers is becoming increasingly blurred.

As the need for computing resources increases, including computing power, the computer industry will respond with increasingly powerful servers. To benefit from this technology, IT managers may elect to replace their existing servers with these powerful servers. Although some superservers have symmetric multiprocessing capability with asymmetric functionalities that increase the I/O throughput, the authors feel that the real solutions lie in distributed processing, i.e. multi-superserver processing. Distributed computing has been evolving around Tightly Coupled Systems (TCS) and Loosely Coupled Systems (LCS) for approximately 40 years. TCS and LCS have merits which generally complement each other.

We believe that the future Client/Server will use a combination of TCS and LCS. A superserver will employ multiple state-of-the-art microprocessors configured in tightly coupled fashion and will exploit symmetric processing to achieve high performance. The superserver will take advantage of asymmetric processing to further improve the throughput of specific tasks, such as applying I/O processors to handle intensive I/O operations for relational database systems. In terms of capability, they will be indistinguishable from mainframes. Furthermore, superservers will be interconnected using loosely coupled technology, allowing for Massively Parallel Processing (MPP). As the result, superservers will have enormous amount of MIPS power, and theoretically capable of achieving linear or near linear scalability.

In addition, we visualize powerful desktop workstations becoming optional in the corporate environment. With the simultaneous expansion of communication bandwidth to practically unlimited levels, maintenance of software, as well as licensing and upgrading of software packages will be better controlled centrally, just as centralized mainframe support staffs control these items. The advent of the superserver that absorbs local corporate workstations solves a number of other problems for IT managers.

Expensive, difficult-to-manage inventories of local workstations now can become relatively inexpensive. Because workstations need no longer be complete nor sophisticated as servers. A true client workstation with a broad network bandwidth will cost a fraction of a full workstation to purchase, to maintain, and to replace. True clients will be infinitely more portable, becoming dedicated to presentation, sending, and receiving, because hard processing and storage is supported at the superserver site.

Conclusion

Evidence suggests that the decline of the mainframe computer will soon end, and that the mainframe will reemerge to prominence in a transformed state--as a superserver. In its metamorphosis, the superserver will replace the general purpose processor as a multipurpose multiprocessor system which will perform a broad spectrum of functions, including functions of the legacy system, the database server, and the windows server. Furthermore, powerful desktop workstations will become optional in the corporate environment as it becomes more economical for workstations to function as true clients.

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