Mainframes: Technology Overview

Synopsis

Editor's Note
This report discusses the many mainframes introduced during 1989 and the first four months of 1990. It looks at how vendors are implementing new technology to stay competitive and maintain a healthy profit margin in a market that has a projected growth of only 5 to 8 percent. For a market overview of mainframes, see Report 70C-000DJ-101; for product comparison columns, see Report 70C-000DJ-301.

The personal computer has not replaced the mainframe as some industry wizards had prophesied. In fact, the increase in PCs has solidified the mainframe's position as a secure repository for large databases and corporate information. Downloading data stored on a mainframe is the best way to distribute accurate information to networked PCs.

Some mainframe vendors responded to the PC challenge by thinking "small." Most vendors now offer so-called smallframes or departmental systems that feature mainframe architecture and use mainframe operating systems. With better price/performance, a smaller footprint, and reduced power and air conditioning requirements, these systems are designed to ward off the PC onslaught. Other vendors responded by thinking "big" and announced even more powerful mainframes with performances rivaling those of supercomputers.

The most activity in the mainframe sector is taking place at the low end and high end—all is quiet in the midrange.

Analysis

System Size and Capacity

Physically, the mainframes are growing smaller. Current technology—very large scale integration (VLSI), emitter coupled logic (ECL) gate array logic, and denser chip packaging—reduces the footprint, while air cooling helps reduce overall size and cost. To conduct heat away from the densely populated chips, Digital Equipment and Unisys clamp pin fin heat sinks directly to the processor unit.

Main memory capacity continues to increase. Memory capacity ranges up to 2 gigabytes on the multiple-processor Hitachi AS/EX and Tandem Cyclone 916 systems. In most mainframes the 1M-bit memory chip is standard, and several manufacturers, including IBM and Hitachi, have developed 4M-bit dynamic RAMs.

Various expanded storage concepts have been implemented to enhance the mainframe's main storage capabilities. IBM first introduced expanded storage with its 3090 Series in 1985. Unisys has an extended main storage feature to overcome limitations on memory addressing. Amdahl and Hitachi have a similar option that allows users to set aside a portion of main memory for expanded storage.

Processors are becoming faster. Many systems have a cycle time of 10 nanoseconds; the Control Data Cyber 2000 is even faster. Instruction pipelining, memory interleaving, and large cache memories to enhance system throughput are now standard. Tandem's Cyclone systems have an impressive pipelining scheme: a dual two-stage prefetch pipeline and a dual six-stage execution pipeline. Up to 16 instructions can be in some stage of execution, simultaneously. Four-way, eight-way, or sixteen-way memory interleaving allows for the servicing of up to 16 simultaneous memory operations on the Amdahl 7300 systems. Cache memory capacity ranges up to 512 kilobytes

per processor and can be divided into data and instruction cache. Many systems also have a system-level cache. The Bull DPS 9000 features a megabyte of system cache.

Fault Tolerance

The entrance of Tandem into the mainframe market with its NonStop Cyclone puts added focus on the demand for fault-tolerant or redundant systems. For years Bull has been offering redundant models in its DPS 90 and DPS 9000 large-scale mainframe lines. The NCR 9800 System achieves fault tolerance through the use of multiple, loosely coupled, function-specific processors. A form of redundancy in the Unisys A Series is accomplished with the Mirror Disk. This feature duplicates real-time data on disk units and maintains multiple copies of disk packs.

Another way to achieve fault tolerance is through tightly coupled systems in which two central processors operate under a single copy of the operating system. Most vendors, including IBM, Unisys, and Digital Equipment, offer tightly coupled models.

New Technology

UNIX, formerly only in the minicomputer, personal computer, and workstation domain, is now readily available for large systems. Mainframe vendors offer their own versions of UNIX or run UNIX as a guest under their proprietary operating systems.

More and more vendors are now offering a vector processing option. Depending on the application, a vector processor provides 10 to 20 times faster execution than a scalar processor. Digital Equipment will offer vector processing on its new VAX 9000 Series.

Reduced instruction set computer (RISC) architecture appeared five years ago on technical workstations to handle special applications. Now the technology is expanding into processors for general-purpose computers. For example, the VAX 9000 is a combination of CISC/RISC architecture. Another emerging trend is a superscalar architecture in high-performance processors to increase the ratio of instructions executed to clock cycles. While a RISC processor can execute one instruction each clock cycle, Tandem's Cyclone, with superscalar architecture, executes up to two instructions per cycle, according to the company. IBM also has an

The Unisys V Series is designed for high-volume batch and transaction processing. Main memory capacity ranges from 10 to 160 megabytes, expandable in 10- or 20-megabyte increments. The high-end V 560 is a dual-processor system offering 80K bytes of high-speed cache memory.

active superscalar project but has not yet made an announcement. IBM's long talked about Summit, expected to feature some new technology, should be introduced this year.

Security

Mainframes with their proprietary operating systems were inherently secure systems compared to small computers and networked PCs, which are prone to unauthorized access and to the planting of computer viruses. Now that many mainframes are part of large networks and work together with PCs and network servers, they are exposed to the same dangers. All vendors offer special security software packages for their systems, such as IBM's RACF and Unisys' InfoGuard. Security will continue to be important as the global market opens up and companies expand their operations overseas.

Plug-Compatible Systems

Amdahl and Hitachi, the two IBM plug-compatible vendors, have consistently provided better price/performance. Not only have the two companies maintained compatibility at the all-important software level with IBM operating environments, they

have also introduced product innovations that were not available from IBM. Amdahl originated logical partitioning and the implementation of UNIX at the mainframe level, and both ideas have been adopted by IBM. The Siemens System 7.500 Series is also based on the System/370 architecture, but it is not an IBM plug-compatible system.

Transaction Processing

Mainframes and transaction processing go hand in hand. With their tremendous I/O and processing capabilities, they are well suited to handle global electronic money transfers, automated teller machines, and airline and hotel reservations. Retailers and other vendors are also turning to mainframes to handle their sales and inventory. On-line transaction processing is one of the fastest-growing business applications for the mainframe. Once only known for its number-crunching speed, the mainframe is now becoming the preferred application-specific machine for companies with large databases and demanding on-line transaction processing needs. ■