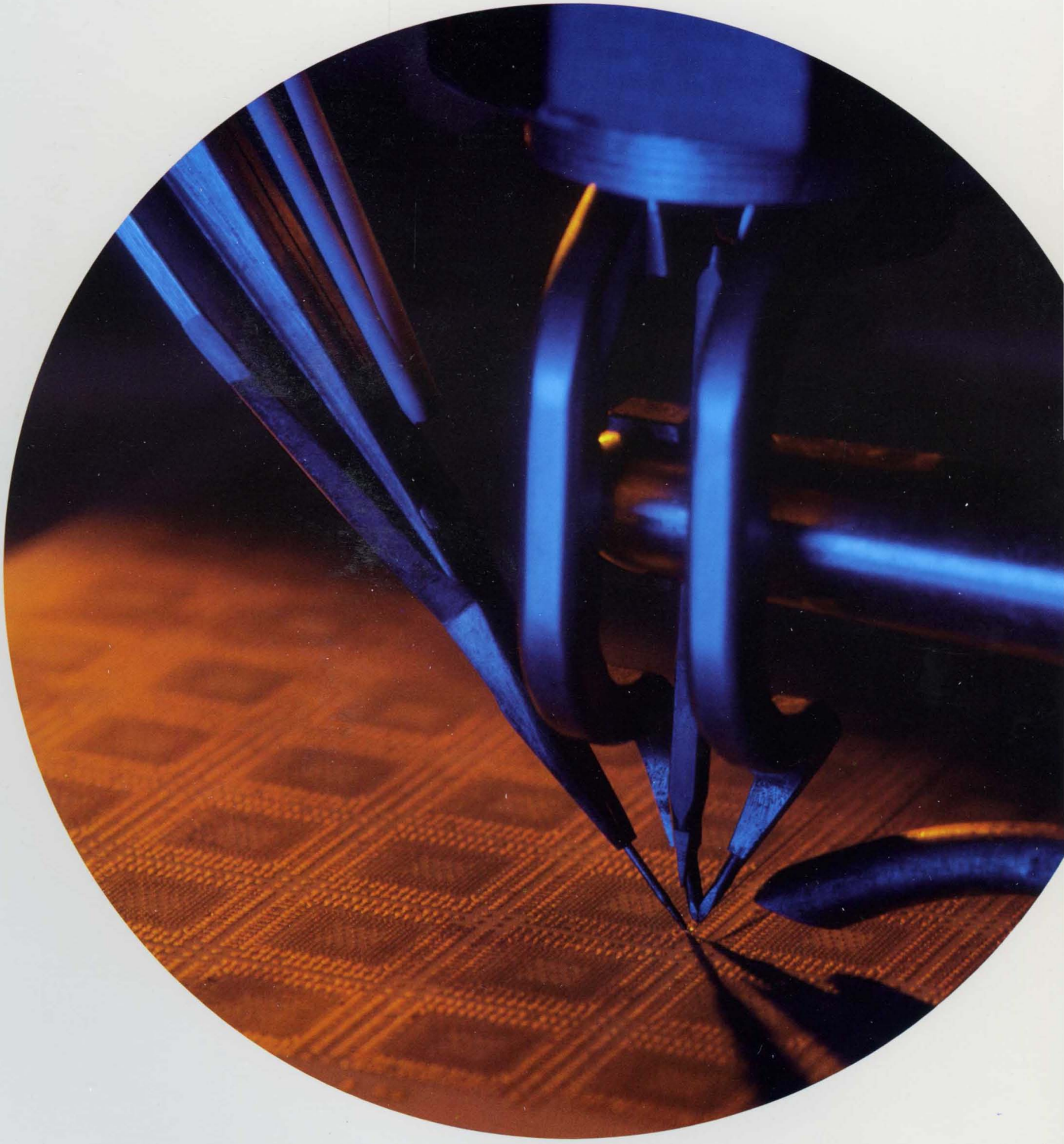
IBM

The IBM 3090 Processor Family

A Balance of Technology and Design



The IBM 3090 Processor ... The Base For Growth Into The 90s

The IBM 3090 family of processors continues to provide large systems customers with an ever-increasing range of growth options to satisfy both commercial and numerically intensive data processing requirements.

The IBM 3090 Advanced Design and Technology Provides:

- Enhanced performance
- Excellent availability
- Extended growth potential
- Specialized function for numerically intensive computing
- IBM's largest single system image

The seven models of the enhanced 3090 family — with new price/performance, technology, and functional improvements — demonstrate IBM's technological leadership while establishing a base for your large systems growth into the 90s.

The advanced design of the 3090 family, allows IBM to continually improve it. For example, at announcement in February, 1985, 64K-bit memory chips were used in central storage and 288K-bit chips in expanded storage. IBM then became the first in the industry to utilize one-million-bit (megabit) chips in central storage. In January, 1987, IBM enhanced the technology of the memory chips yet again — making use of a new, smaller, faster 1-megabit chip in central storage and the original 1-megabit chip in expanded storage. Additionally, the number of chip sites contained in some of the unique Thermal Conduction Modules (TCMs) has been increased from 100 to 132. Other enhancements since the original announcement include:

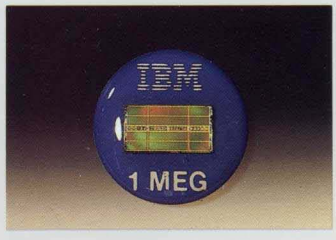
- Up to six optional fully-integrated Vector Facilities for numerically intensive computing, plus 171 new instructions specifically for the Vector Facility which have been added to the architecture
- Broadening of the model range from two to seven models
- Growth from two to three Central Processors controlled by one System Control Element (SCE) — allowing IBM's largest single system image, the six-way Model 600E
- An increase in processor storage size
- An extension to the number of channels
- Improvements in cycle time
- Significant increases in the machine's microcode capability

These and other improvements detailed in this brochure are the results of a forward-looking design — planned from the beginning to allow enhancements *within* the 3090's basic design and the System/370 architecture. This approach assures continued enhancement to your investment in 3090 processors. Turn the pages to discover how the IBM 3090's advanced design and technology makes it possible to realize the full performance potential of the IBM 3090 Processor Family.

IBM 3090 Processor Family

- Up to tenfold performance growth
- Up to 2304Mb processor storage
- Up to six Vector Facilities
- Up to 128 channels
- Largest IBM single system image
- Densest packaging technology
- Seven models

The IBM 3090 provides large system growth options now and into the 90s.



The newest IBM one-million-bit memory chip used in the IBM 3090 is now available as a *chiplet* — a dime-sized, epoxy encapsulated *real chip* with an adhesive back. Ask your IBM marketing representative for your *free* megabit of memory today.

IBM 3090 Design

A Balanced System That Allows For Continual Improvements

A *Total* System Solution

From the beginning, IBM engineers designed the IBM 3090 processors to provide a *total system solution* with a balanced set of hardware, software, and microcode to meet your data processing and communications needs. Today's 3090 processor is the proven result of over twenty years of large processor evolution within IBM. With this base to build upon, the design process starts with computer simulation, called cycle simulation. Cycle simulation takes a logical description of the design and simulates it on a cycle-by-cycle, bit-by-bit basis. Models of a central processor, cache, and system control element representing over *three hundred thousand circuits* are run through many millions of System/370 instructions before hardware is built.

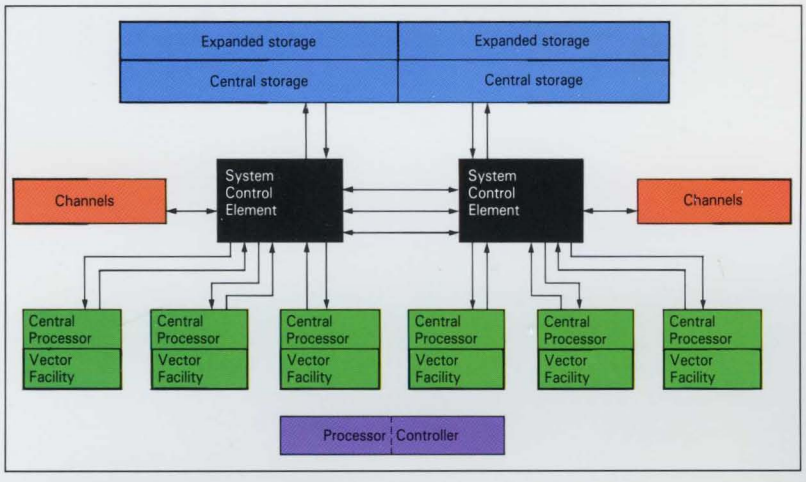
The physical design is done in parallel with cycle simulation. A Boolean comparison program, first introduced in the 308X design process, is used to prove the logical equivalence of the physical design and the simulation model. Finally, before hardware is built, there is a full statistical analysis of a complete physical design.

Then, even after hardware is built, exhaustive tests, which have been developed over time, thoroughly validate the architecture, function, and performance in real operating conditions which include MVS, VM, and user application code.

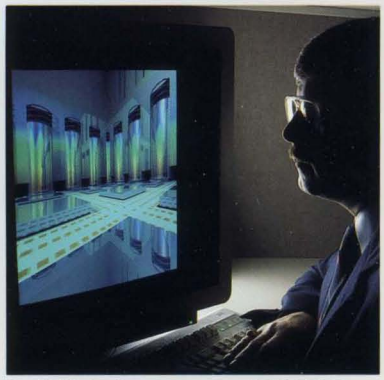
The benefit to you is a balanced system containing proven IBM technology, IBM software, and IBM's System/370 Extended Architecture, all specifically designed to provide impressive growth options and availability ... setting an unparalleled standard of leadership in the process.

IBM 3090 Design Features:

- More, parallel 64-bit wide data paths to reduce information flow bottlenecks
- Improved System Control Element (SCE) for faster information flow
- Enhanced in-flight bit error detection and correction for improved availability
- Overlapped Instruction Element and Execution Element for simultaneous execution
- Increased (up to 128) channels on the largest 3090 models
- A new channel subsystem utilizing a Reduced Instruction Set Computer (RISC) channel processor and individual microprocessor-controlled channels
- Up to six Vector Facilities supported on a 3090 Model 600E
- Processor storage incorporating both central and expanded storage
- Increased (up to 2048Mb) expanded storage
- Up to 256Mb of high-speed central storage on largest models



This diagram of the IBM 3090 Model 600E conceptual design shows the dynamic interaction between a System Control Element (SCE) that connects up to three central processors (with optional Vector Facilities), the channel subsystem, the processor storage, and the other side of a six-way complex. The SCE is the heart of the 3090 system since it manages the flow of information between all the elements of the processor complex.



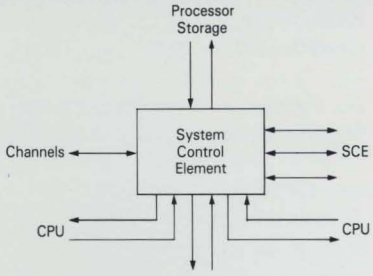
An IBM designer uses an IBM 5080 display to view a specially-developed three-dimensional model closeup of a cutaway Thermal Conduction Module (TCM). Extensive design using sophisticated imaging techniques results in highly reliable packaging for the IBM 3090.

IBM 3090
System Control Element

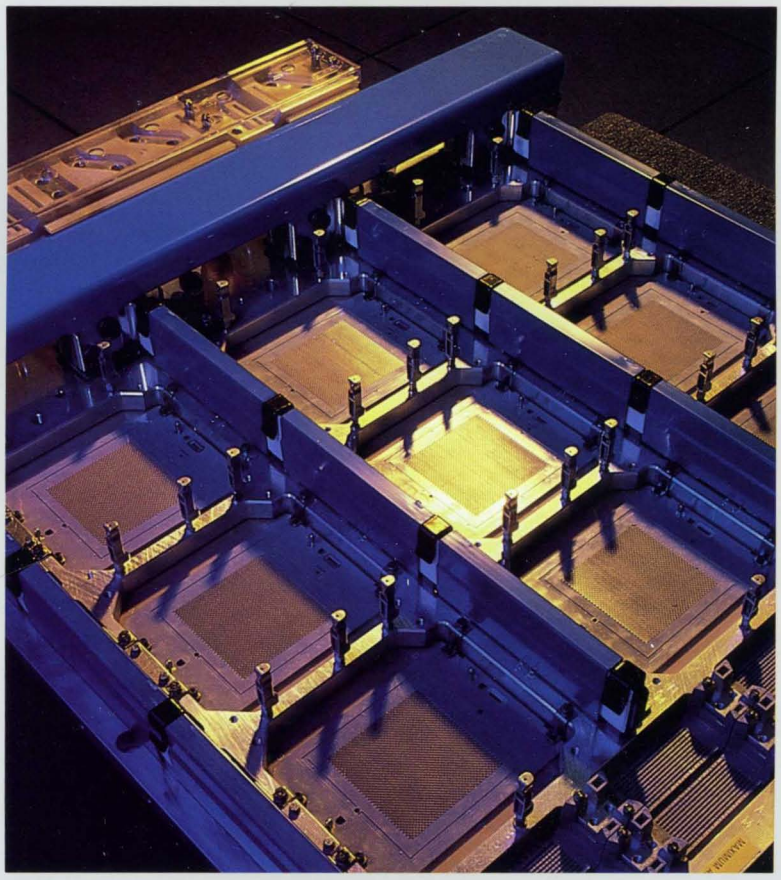
The Key To The Increased Performance Of The IBM 3090 Multiprocessors

The System Control Element (SCE) is central to the 3090 Processor's efficient functioning. It connects the elements of the processor complex. The paths to and from the SCE have been enhanced in the 3090 system. For example, the 3090 four-way and six-way multiprocessors provide three times more datapaths between System Control Elements than the 3084-QX multiprocessor, allowing the higher performance levels of the larger models.

The SCE manages contention for critical system resources among the various system elements. It has two request registers for each element of the processor complex, one for fetches and one for store requests. These registers are connected by independent request and address buses, and thus can be set by a processor element on any cycle in which they are free. On each cycle, the SCE can examine all request registers and select one on a priority basis. This degree of concurrence is key to the IBM 3090's increased performance over the IBM 308X processors.



The System Control Element accepts and processes data requests from the 3090 central processors, storage, and the channel subsystem. The enhanced design of the IBM 3090 System Control Element, implemented with advanced logic circuits, increases system performance, reduces large systems constraints, and contains even more error correction for improved availability.



TCMs are mounted on a specially-developed 22-layer circuit board. The multilayer design incorporates over 1500 meters (nearly 5000 feet) of wire needed to provide the large number of interconnections that make up the processor complex.

IBM 3090
Expanded Storage

For Impressive Price/Performance Improvements

Designed to:

- Improve availability
- Optimize for paging
- Balance the storage hierarchy
- Improve price/performance
- Allow for growth

Performance

Expanded storage is a critically important element in the IBM 3090's storage hierarchy. It is designed for electronic block transfers of 4Kb pages between itself and central storage. It is a separate storage under the control of the operating system, providing performance similar to additional central storage. The block-data transfer is done directly between expanded storage and central storage, with little interaction to the rest of the system. Each page is transferred in 70 to 75 microseconds, allowing new levels of consistency in application response. Its operation is transparent to subsystem and user programs, and no program changes are required. In combination with central storage, up to *2304Mb* of processor storage is available.

Within the 32-bit Extended Architecture, each central storage address designates only one byte, limiting the addressability to 2Gb. Expanded storage utilizes a 4K byte page to potentially extend processor storage *up to 16 trillion bytes*.

Expanded storage can provide significant performance improvements. Some customers experience:

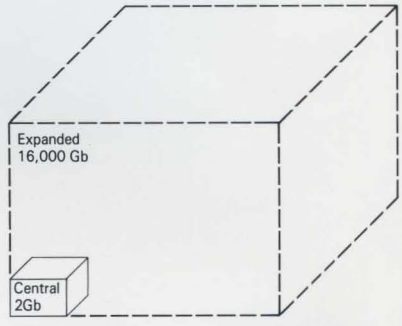
- External paging load reduced 50%
- Response time improved 67%
- Transaction volumes increased 30%
- Job elapsed times reduced

Availability

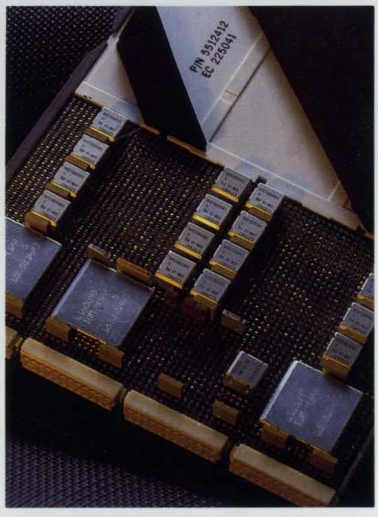
The IBM 3090 storage system has many enhancements compared to earlier large systems that improve its availability. Both central and expanded storage have error-correcting codes. The central storage has single-bit error-correcting, double-bit error-detecting code.

Expanded storage has improved availability with a single and double-bit error-correcting, triple-bit error-detecting code. A 4-bit error is always detected if caused by a single-card-level failure.

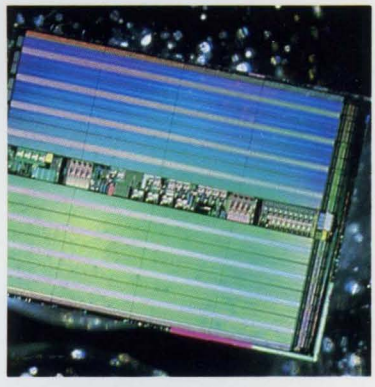
Both central storage and expanded storage utilize a technique, called double complement, that corrects errors that exceed the limit of the error-correcting code. And, to reduce the probability of accumulating soft errors, both central and expanded storage on the enhanced models use a technique known as *scrubbing*, which periodically reads lines from the storage arrays, corrects, and rewrites them as needed. Hence, soft errors are not allowed to accumulate.



Expanded storage, using a 32-bit addressing structure, extends the system's processor storage capability to over 4 billion 4K pages, or *16 trillion bytes* — many times the on-line data in a typical large system installation.



Two megabytes of memory are packaged on one card in the 3090 expanded storage. Each small module contains an IBM one-million-bit memory chip.



IBM-developed and built one-million-bit memory chips are used in the 3090 processors. This first generation IBM 1-megabit chip is used in 3090 expanded storage.

IBM 3090 Channel Subsystem

A More Flexible Channel Implementation

Channel Processor

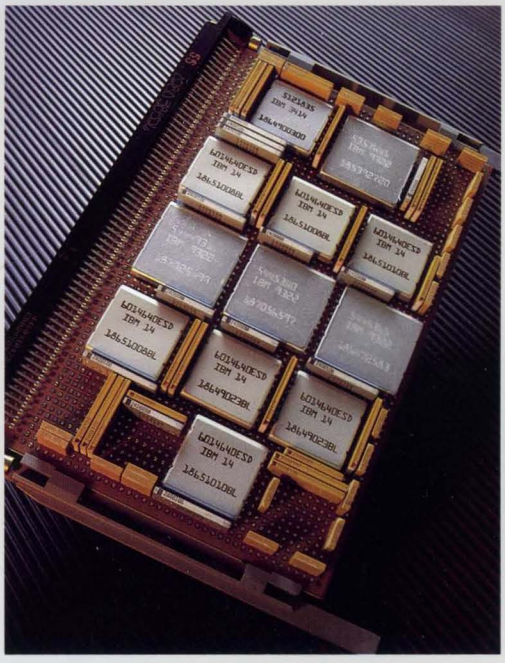
The Channel Processor on the 3090 system is a powerful Reduced Instruction Set Computer. Only those instructions required to process non-time-dependent channel functions are implemented. In this way the channel processor can perform its function faster, more efficiently, and provide greater flexibility.

Microprocessor-controlled Channels

The time-dependent functions of channel operation are performed by an individual microprocessor for each channel. The benefits are the microprocessor can be specifically designed for the characteristics of that individual channel, and diagnostics can be performed on an individual channel, while the remainder of the system continues to operate.

The 3090 system supports up to 128 channels. The byte multiplexer channels have been enhanced both in performance — providing up to three times the data rate of those on 308X — and function to reduce the system programmer load. Previously, configuring byte multiplexer channels required considerable calculation and balancing to stay within aggregate data rate restrictions. The 3090 byte multiplexer can be simply configured up to its full data rate.

The IBM 3044 Channel Extender allows a channel to be extended up to 2km (6600 ft) at speeds up to 1.25 Mb/sec using fiber optic serial channels.



High-speed logic, microprocessor and array chips are packaged on channel cards which can be easily added to expand your system.

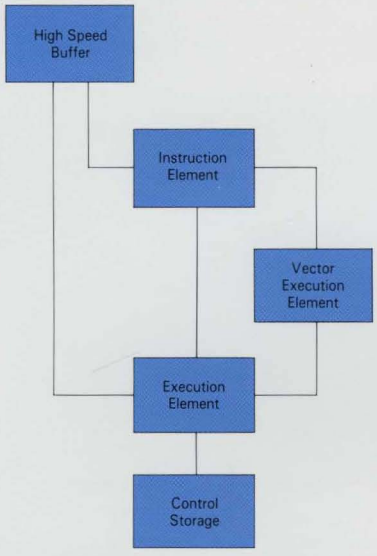
IBM 3090
Vector Facility

The IBM 3090 System With Vector Facility Offers The Most Powerful Computing Product IBM Has Ever Built

The Vector Facility adds a pipelined arithmetic unit to each central processor in a 3090 system, thereby providing a substantial performance improvement for numerically intensive applications. The IBM 3090 was designed at the outset to take advantage of this highly cost-effective facility which can yield throughput improvements of 1.5 to 3 times, scalar performance.

Optimum Performance and Ease of Installation

Because it was planned from the beginning, the Vector Facility is *both* integrated *and* separate. The IBM 3090 Vector Facility is integrated in that the Vector Architecture provides 171 new vector instructions that can appear in the instruction stream of any central processor with a Vector Facility. A program instruction stream could be a combination of vector and System/370 instructions — instructions being routed to their appropriate processors only after decoding in the instruction element (IE). It is separate in the sense that it is implemented using a set of vector registers and a pipelined arithmetic unit packaged on a separate board using IBM's proven TCM technology. The board can hold three Vector Facilities, one for each central processor in a Model 300E. This arrangement allows the Vector Facility to be offered as a cost-effective field upgrade.



A Vector Facility is attached to the instruction and execution elements of a 3090 central processor. The instruction element fetches and decodes all the instructions including any vector instructions that are in the instruction stream. The instruction and execution elements access control storage, much as they do in System/370 operations, and then transfer the operands to or from the Vector Facility.

Built-In Flexibility

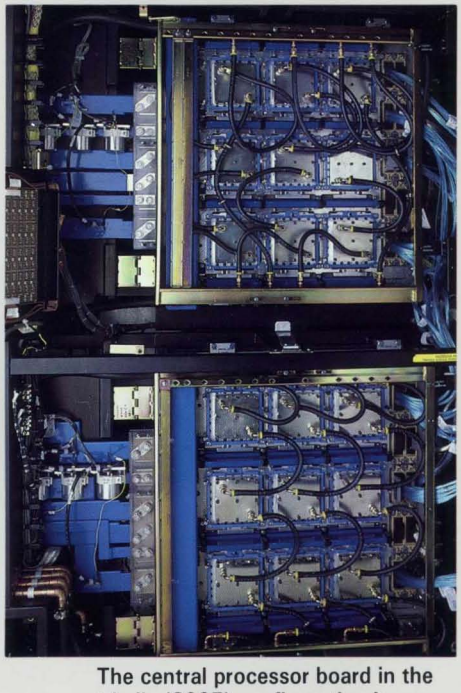
With the Vector Facility integrated in 3090 design and architecture, users can concurrently run commercial and numerically intensive applications. Further improvements in performance of certain vector applications can be achieved by running them in parallel across multiple processors using the VS Fortran Program Multitasking Facility. With this flexibility, IBM 3090 users can achieve a better operational balance for their entire workload and improve total systems performance. This potential performance improvement is achieved at outstanding price/performance.

Scalar, Vector, and Parallel Processing in One System

Good design, implemented with TCM technology results in Vector Facilities that are easy to install and use; can run in parallel with scalar jobs to provide a high level of performance; and offer an integrated systems solution for general-purpose *and* numerically intensive processing.

Vector Facility Highlights:

- Available on each processor
- Up to six on Model 600E
- 171 Vector instructions
- Vector performance on the enhanced 3090 models improved up to 17% over previous 3090 models
- Up to ninefold range in 3090 vector throughput, from Model 120E to Model 600E



The central processor board in the triadic (300E) configuration is located above the Vector Facility board. Nine Thermal Conduction Modules (TCMs) make up each IBM 3090 Vector Facility board. Three TCMs are required for each Facility, and three Facilities are accommodated on each TCM board.

IBM 3090 Software Support

IBM Software Functions Evolve To Meet Continuing Customer Growth Requirements

The IBM 3090 is fully supported by IBM's two main large system operating systems – MVS/Extended Architecture (MVS/XA) and VM/Extended Architecture (VM/XA). In addition certain models of the 3090 family are supported by MVS/370, and VM/SP HPO.

MVS/XA

MVS/XA is designed to manage large processor features such as multiprocessor configurations and expanded storage. MVS/XA includes software availability features that complement the extensive 3090 hardware availability features.

MVS/XA has been enhanced over time to address large systems effects and fully exploits the 3090 Model 400E (four-way) and 3090 Model 600E (six-way) in both single image and partitioned modes. In addition, MVS/XA provides support for up to six Vector Facilities, Expanded Storage, and Data In Virtual facility.

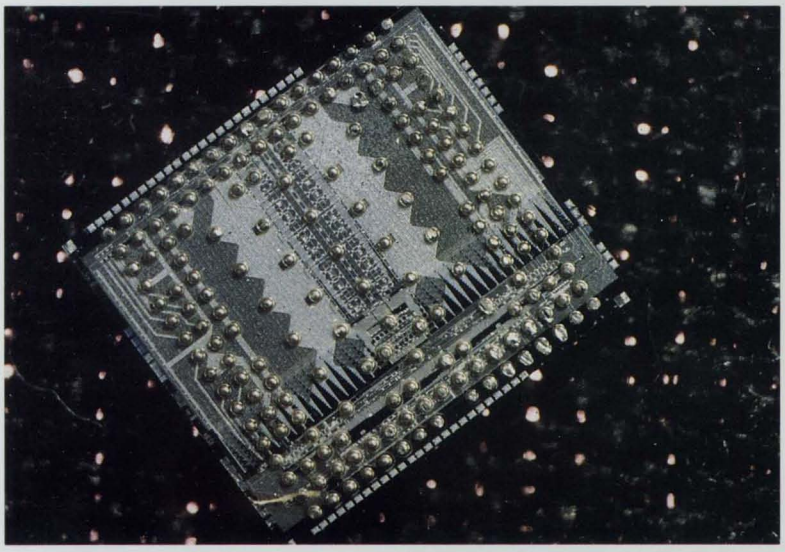
VM/XA

VM/XA was designed to allow multiple guest operating systems to run on one physical processor complex. It exploits IBM's Extended Architecture using large real and virtual storage and taking advantage of the Dynamic Channel Subsystem, while dynamically sharing all system resources.

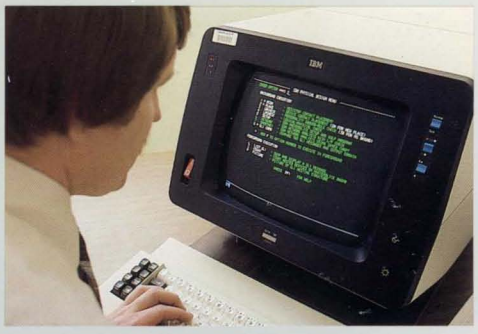
Using Start Interpretive Execution (SIE) microcode, designed for 370/XA hardware and supported on all 3090 processors, a preferred guest can run at near native performance. Enhancements to SIE on the enhanced 3090 Models provide performance improvements for VM/SP HPO and VM/SP as guests.

VM/XA fully supports all 3090 Models including support for the Model 400E (four-way) and Model 600E (six-way) in both single image and partitioned modes, as well as support for up to 6 Vector Facilities and Expanded Storage.

VM/XA System Product (VM/XA SP) is IBM's premier VM operating system for the 3090. It provides a growth path for VM/XA Systems Facility (VM/XA SF), the currently available implementation of VM/XA, and VM/SP HPO. VM/XA SP supports all the functions of VM/XA SF plus has an enhancement for multiple preferred guests. It also provides additional processor capacity for VM/SP HPO customers.



A combination of technology, innovation in hardware, microcode, and software delivers a balanced system to meet your requirements for capacity, function, and high performance in IBM large systems. The new double-density Read Only Storage (ROS) chip – which is 36% faster and 21% smaller than the previous chip – significantly increases the microcode capability of the enhanced 3090 models.



Continuous IBM software enhancements allow users more productivity than ever before.

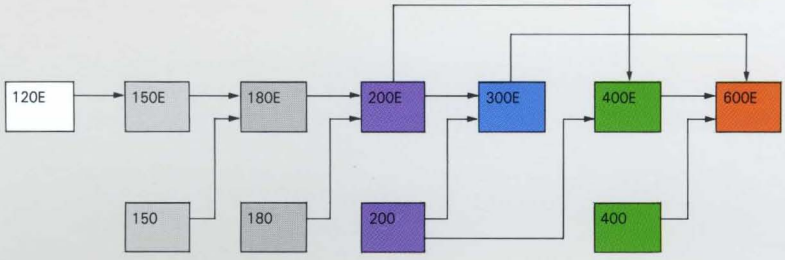
IBM 3090 Growth and Upgradability

Up To Ten-fold Field-Upgradable Growth

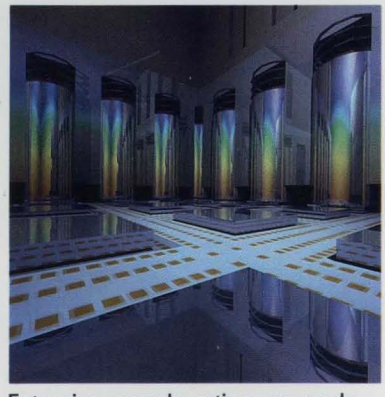
IBM continues its growth leadership by offering up to ten-fold field-upgradable growth potential in the enhanced 3090 family. In addition, IBM 3090 Models 150, 180, 200, and 400 are upgradable to enhanced models. Upgrades can be performed quickly — in as little as one shift depending on the model.

Moreover, *all models of the enhanced 3090 family* offer — *in one processor unit* — Expanded Storage, the powerful Vector Facility and extensive implementation of IBM System/370 Extended Architecture — the base for IBM's future large systems direction.

The availability of these very attractive upgrade options for all 3090 customers demonstrates the extendibility of the 3090 advanced design and technology. This extendibility reinforces the soundness of an investment in the 3090 family, while it demonstrates IBM's continued leadership in large systems.



IBM 3090 upgrade options allow up to ten-fold growth in processor power.



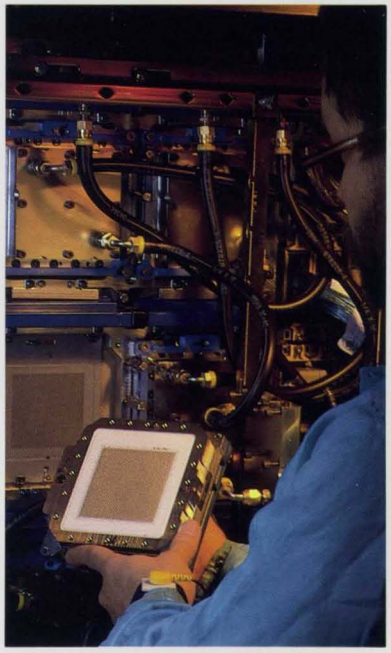
Extensive upgrade options are made possible in part by the extendibility of the 3090 advanced packaging technology as shown by this three-dimensional computer-generated closeup of a cutaway Thermal Conduction Module.

IBM 3090 Processor Options

Improved Granularity

- Wider model range
- Larger processor storage
- Additional channel capability
- Up to six Vector Facilities

The enhanced 3090 family consists of seven models — three uniprocessors (the Models 120E, 150E, and 180E), a dyadic (Model 200E), a triadic (Model 300E), a four-way (Model 400E), and a six-way (Model 600E). In addition, the enhanced 3090s offer attractive granularity with many options in Central and Expanded Storage, channels, and Vector Facilities. The objective is to provide a variety of upgrade options to allow capacity requirements to be met within budgetary constraints.



The Thermal Conduction Module is the basic building block which allows a wide array of model upgrades to satisfy your data processing needs.

IBM 3090 Processor Options

Model	Processor Storage						Channels			Vector Facility		
	Central storage			Expanded storage								
	Min.	Max.	Incr.	Min.	Max.	Incr.	Min.	Max.	Incr.	Min.	Max.	Incr.
120E	32	32	0	0	128	64	16	24	8	0	1	1
150E	32	64	32	0	128	64	16	24	8	0	1	1
180E	32	64	32	0	256	64	16	32	8	0	1	1
200E	64	128	64	0	1024	64 up to 256, 256 up to 512 then 512	32	64	8 up to 48 then 16	0	2	1
300E	64	128	64	0	1024	64 up to 256, 256 up to 512 then 512	32	64	8 up to 48 then 16	0	3	1
400E	128	256	128	0	2048	128 up to 512, 512 up to 1024 then 1024	64	128	16 up to 96 then 32	0	4	1
600E	128	256	128	0	2048	128 up to 512, 512 up to 1024 then 1024	64	128	16 up to 96 then 32	0	6	1

IBM 3090 Memory Technology

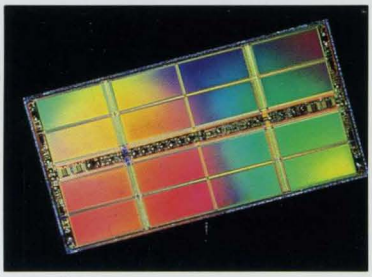
Uses IBM-Designed And Built One-Million-Bit Memory Chips

The IBM 3090 Processor Family continues the commitment to product excellence and leadership in its memory technology. One megabit (million-bit) memory chips are used for *both* central and expanded storage in the 3090. Today's chips are sixteen times denser than the memory chips used in previous IBM large systems for central storage. Additionally, the original 1-megabit chip used in central storage — shipped as an industry first in 1986 — has been replaced by a second generation 1-megabit chip *which is smaller and faster*. The first generation 1-megabit chip is now used in expanded storage where it replaces the previous IBM 288K-bit memory chip.

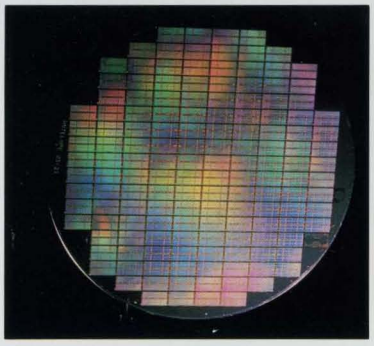
This capability of the 3090 design to incorporate new chip technology as it becomes available demonstrates the extendibility of an initial investment in the 3090 family. The increased speed of the mega-bit chip used in central storage in the enhanced models is a major factor in the performance improvements over the previously available models. Likewise, the increased density of the megabit chip used in expanded storage contributes to the increased processor storage *with no increase in the physical size of the system.*

IBM Advances the Technology

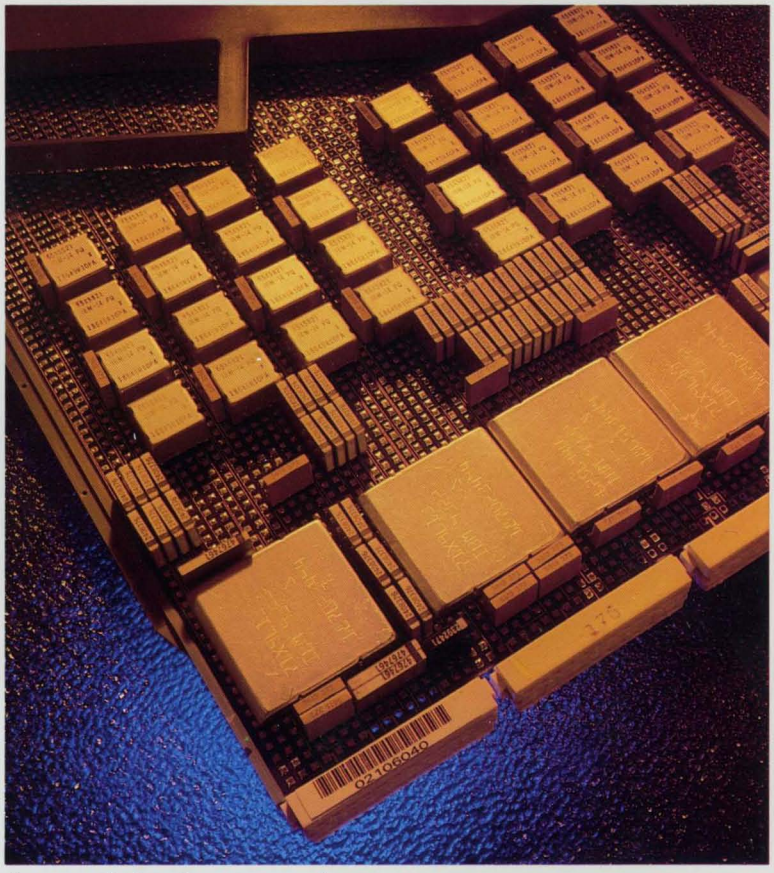
Design and manufacture of such advanced memory chips is the result of many years of research and development. For example, IBM invented the dynamic memory cell in 1968. This allowed one transistor to store one bit of information rather than the 3 to 6 transistors required in the static random access memory cell which was then predominantly used for memory storage. The one-device cell still forms the basis of the cell design in the IBM megabit chips.



A combination of advances in manufacturing technology, circuit design, and chip architecture have made this chip — used for central storage in the IBM 3090 — one of the fastest, most advanced one-million-bit memory chips in the industry.



This wafer, 125 mm (five inches) in diameter contains approximately 150 of the newest IBM one-million-bit memory chips. To further enhance manufacturing productivity, IBM is first in the industry to phase in production of these advanced chips on 200 mm (eight-inch) wafers. The new 200 mm wafers can hold almost three times as many chips as the 125 mm wafer.



Four megabytes of memory can be stored in this field-replaceable circuit card.

IBM Million-Bit Chip History

IBM first announced the original 1-megabit chip as an experimental device in April, 1984. Developed at the IBM Burlington, Vermont laboratory, this chip became the world's first megabit chip in volume production in August, 1985. In another industry first, it was announced for use in the IBM 3090 in April, 1986. The newest megabit chip was announced for use in 3090 central storage in January, 1987.

The latest chip, one of the industry's smallest megabit chips, is manufactured in the silicon gate N-type Metal Oxide Semiconductor (NMOS) process. The chip can access data stored in a memory cell in only 80 nanoseconds (billionth of a second). *At its fastest, the chip can "read" about 2,200 pages of text in one second.*

Its 1-micron (millionths of a meter) lines are about a hundredth of the width of a human hair. Because of these minute dimensions, special dry-etching techniques to provide better linewidth control and optical projection tools using shorter wavelengths had to be developed. IBM developed these techniques and designed the machine tools to produce the wafers. To wire the chip and improve speed, a low resistivity tungsten silicide material was introduced.

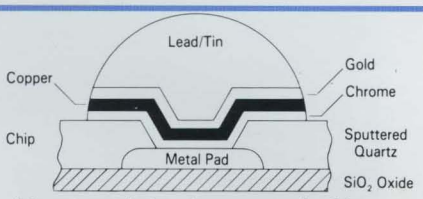
Among the techniques used to reduce overall chip size was a unique IBM enhancement technique called "n-skin" that helped shrink the chip's storage capacitor by 16%. To further reduce the chip's size, a low temperature, high pressure isolation oxidation process was developed.

The chip is mounted on a ceramic substrate that uses the IBM-patented "flip-chip" bonding technology. The substrate is then enclosed in a metal cover to form a 23-pin module for use on a high-density 4Mb circuit card.

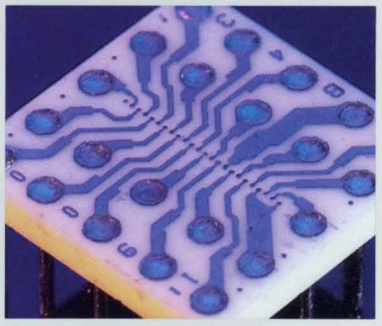
IBM 3090 Memory Highlights:

- One-million-bit storage chips
- Chips are 16 times denser than used in the 308X memory
- Each million-bit chip contains 1,048,576 bits
- Each chip can store approximately 100 pages of typewritten text
- Second generation IBM one-million-bit chips are used in central storage in enhanced 3090 models
- Up to 256Mb of high-speed central storage in largest models

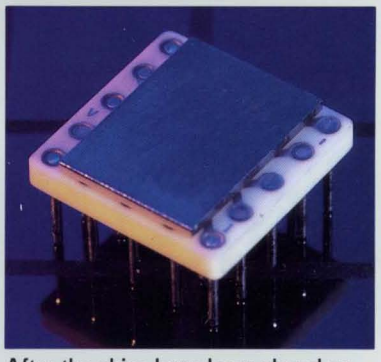
Round wafers of ultra-pure silicon are placed in an oxidation oven, which deposits a layer of silicon dioxide on which each layer of circuitry will be etched.



After the chip has been coated with a protective coating, tiny holes are etched down to the metallized interconnections on the chip. At each of these points, metals are evaporated onto the chip to produce small domes, called controlled collapse chip connection (C4) pads.



The chips are then joined to ceramic substrates on IBM-designed automated tools. The chips are flipped over, so their circuitry and the C4 pads face downward, and are aligned on the substrates so precisely that each pad makes contact with a corresponding circuit pattern previously screened on the ceramic base.



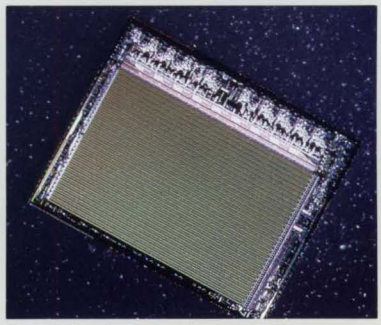
After the chips have been placed on the ceramic base, the chips "ride" the substrate through a furnace with tightly controlled temperatures. When the substrates emerge, the C4 "dome" has "reflowed," and each is now a highly reliable soldered connection.

IBM 3090 Logic Technology

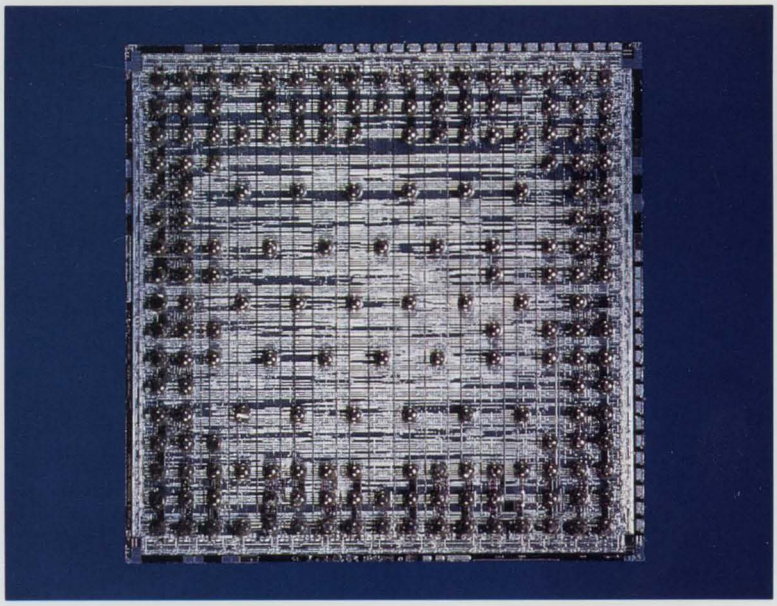
Fast ECL Logic Chips

The base for technology improvements in most 3090 enhanced models is the logic chips, that can permit reducing the central processor cycle times to 17.2 nanoseconds from 18.5 nanoseconds on the previously available 3090 family. The 3090 logic chips use current-switch, emitter-coupled logic (ECL). Patented by IBM in the early 1960s, ECL chips are substantially faster than those logic chips used in the 308X systems. The 3090 also takes advantage of a more extensive and more tailored menu of arrays for such uses as working storage, directories, and control storage.

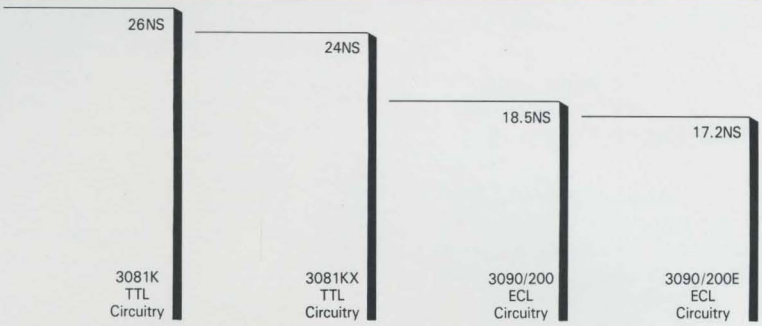
IBM engineers further exploit the inherent speed advantage of the ECL chips by providing the capability of placing 132 chips in some TCMs (one-third more than those packaged in previous 3090 models) on a unique IBM-developed multi-layer ceramic (MLC) package. *More than 450 feet (160 meters) of wire are imbedded within the 36 layers of the substrate.* This substrate, which can be held in the hand, eliminates a whole level of packaging because the multi-layer ceramic substrate, when encapsulated, becomes the Field Replaceable Unit (FRU).



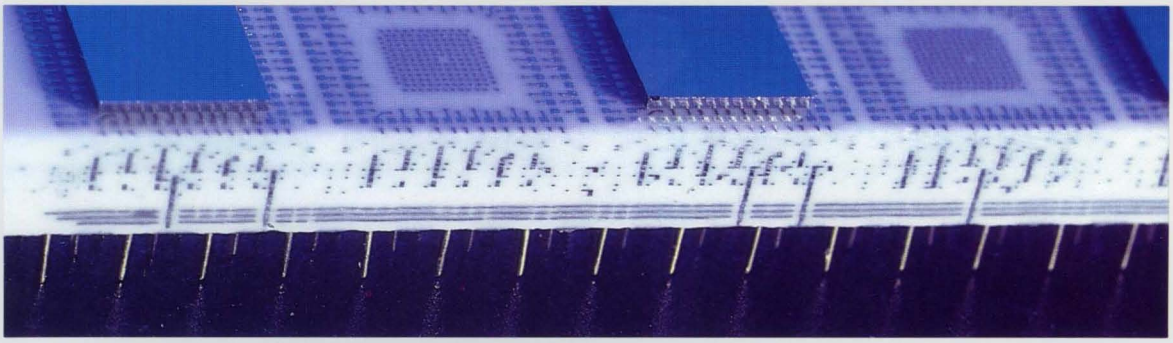
Specially-developed array chips for control storage, working storage and directory applications are packaged on the 132 position MLC substrate next to the logic chips for faster access.



Fast bipolar emitter-coupled logic (ECL) chips allow the reduction in central processing cycle time on 3090 models compared to 308X models.



A steady progression of technology and design enhancements have allowed the machine cycle times on IBM large processors to continue to improve.



Multiple layers of buried wiring are revealed in this cutaway view of the substrate. The wires interconnect the chips soldered onto the surface using the special IBM-developed C4 process, resulting in high interconnection reliability and density.

High density packaging techniques provide the potential for 132 logic and support chips to be packaged on this multi-layer ceramic substrate. This is the highest logic density package in the industry.

IBM 3090 Logic Packaging

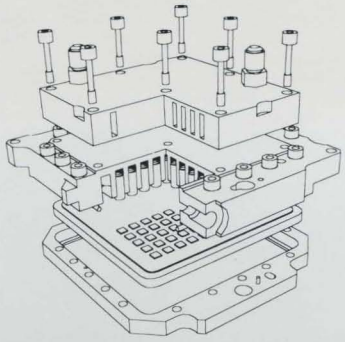
Continual TCM Improvements Illustrate The Extendibility Of The Packaging Technology

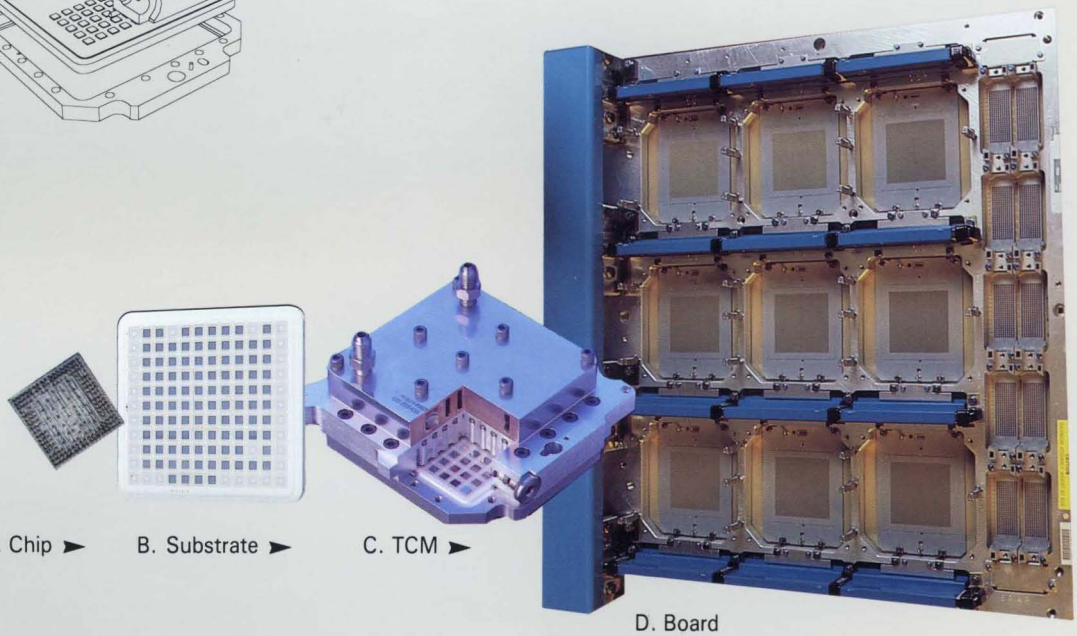
Design and technology balance is nowhere more apparent than in the unique packaging approach IBM has taken in the IBM 3090 series. Starting with the state-of-the-art ECL logic chips, the IBM-developed C4 interconnection technique, the 36-layer ceramic substrate, and the water-cooled TCM, IBM engineers have solved the difficult problem of packaging dense logic chips closer together for faster switching speeds, while at the same time providing a reliable method for efficient heat removal.

The fundamental vehicle to accomplish this continues to be the Thermal Conduction Module. Since 1980 and the first use of TCMs in the 308X, the computing power of a single TCM – and consequently the amount of heat dissipated – has been increased significantly. Yet the ultimate capacity of this packaging technology has still not been approached. And, in terms of compactness, the TCM is unmatched in the industry for its packaging density.

TCM Highlights:

- Proven reliability
- Broad extendibility
- Densest package in industry
- IBM exclusive
- Easily replaceable FRU
- Highly efficient cooling technology





A. Chip ➤ B. Substrate ➤ C. TCM ➤ D. Board

The TCM's higher packaging density is key to increased performance and system availability.

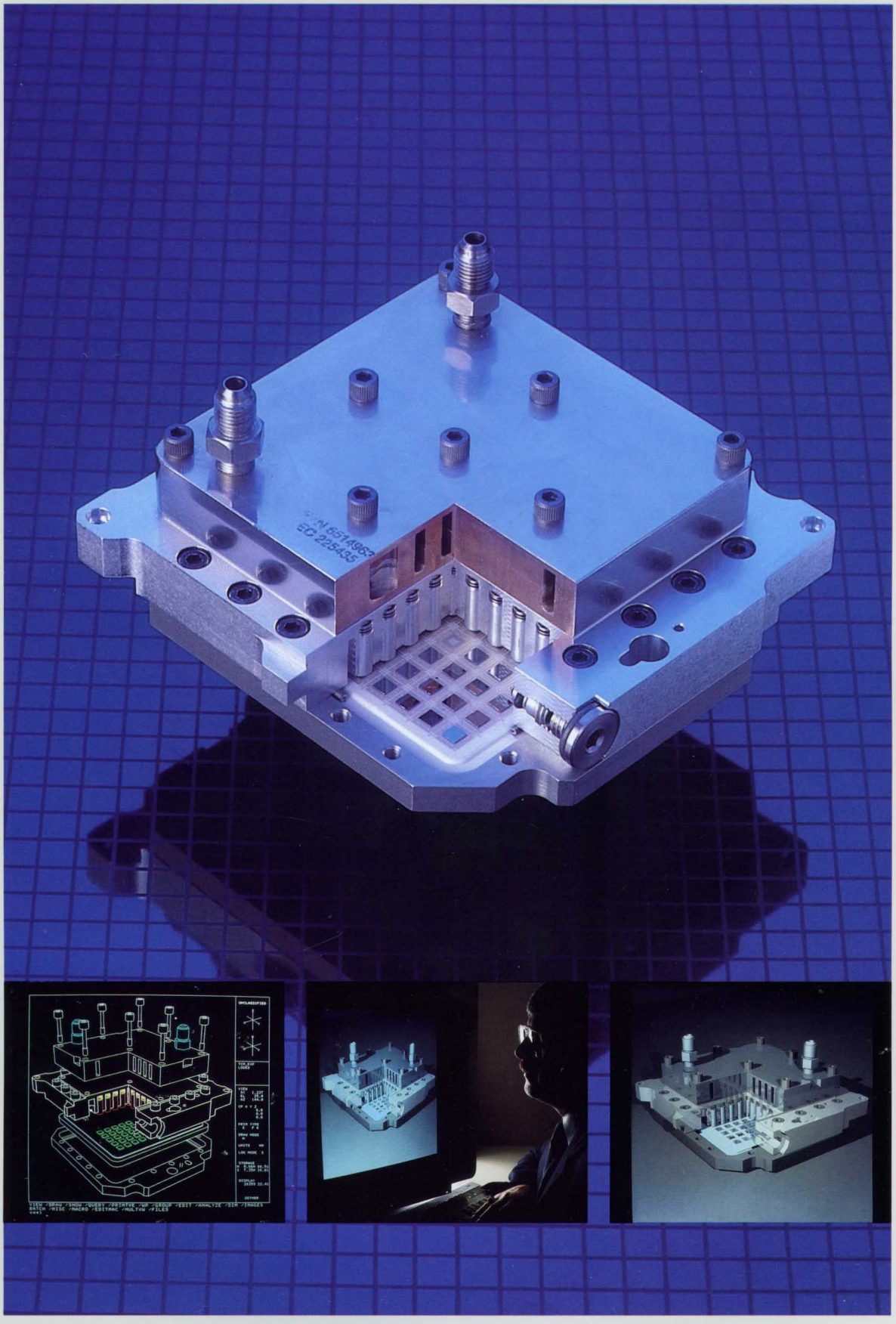
A. High-speed ECL logic and support chips are connected to the multi-layer substrate using the IBM C4 interconnection technology.

B. The 36-layer ceramic substrate – unique in large-scale general purpose computers – has the capability to support up to 132 logic and array chips, and can accommodate 320 centimeters of wiring per square centimeter of surface area.

C. The Thermal Conduction Module houses the multi-layer substrate and cools up to 132 chips mounted on the ceramic substrate. The substrate is clamped between a baseplate and a "hat" equipped with spring-loaded metal pistons. Each piston presses against the back of a chip, conducting heat to a cold plate bolted on top of the hat. The cold plate in turn gives up the heat to chilled water that is pumped through channels in the plate. The module's ability to dissipate heat is enhanced by filling the internal volume of the hat with helium, which has a higher heat conductivity than air. Each module has 1800 connecting pins.

D. Nine TCMs can be mounted onto a 22-layer glass epoxy circuit board which measures 60 X 70 cm (24 X 28 inches) and provides connections between the 16,200 pins of the modules and 1,800 additional terminals for cables leading to other subassemblies. The board also provides power to each module. In total, the board holds over one kilometer of internal wiring, and 16,000 kilometers (nearly 10,000 miles) of glass filament.

Two printed-circuit boards can be mounted onto a structurally-rigid steel frame which represents the final level in the packaging hierarchy.



IBM 3090 Manufacturing Excellence

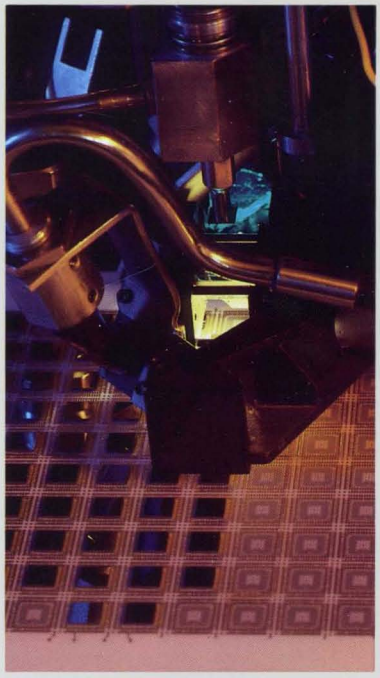
Leader In Quality

Excellence in design is meaningless if the design goals cannot be implemented on the factory floor. Both come together at the Data Systems Division's extensive laboratory and manufacturing facility in Poughkeepsie, N.Y., where hundreds of IBMers labor to deliver the 3090 to IBM customers. They are supported by thousands of IBM engineers, programmers, technicians and support people. Among them are those supplying cards from Brooklyn, N.Y., logic chips from Fishkill, N.Y., and high-speed control storage and megabit memory chips from Burlington, VT. Finally, IBMers in a nearly half-mile-long final test area at Kingston, N.Y., put the 3090 through its paces. Many people with one goal: to deliver the best quality large system that IBM has ever offered.

Automation and robotics are an integral part of the manufacturing process for the IBM 3090. From semiconductor fabrication to the TCM board assembly, IBM process control computers, IBM robotics and IBM-designed automation systems are employed to improve worker safety, quality, productivity, and to decrease manufacturing time and costs.

For example, in the TCM board assembly manufacturing operation, housed in a new 105,000 square foot facility, IBM Series/1 computers drive IBM robotic systems

An IBM-designed closed circuit television system enables the operator to carefully align the chips before they are bonded to the ceramic substrate.



Logic and array chips are mounted on multilayer ceramic substrates and bonded using the IBM-invented C4 process.

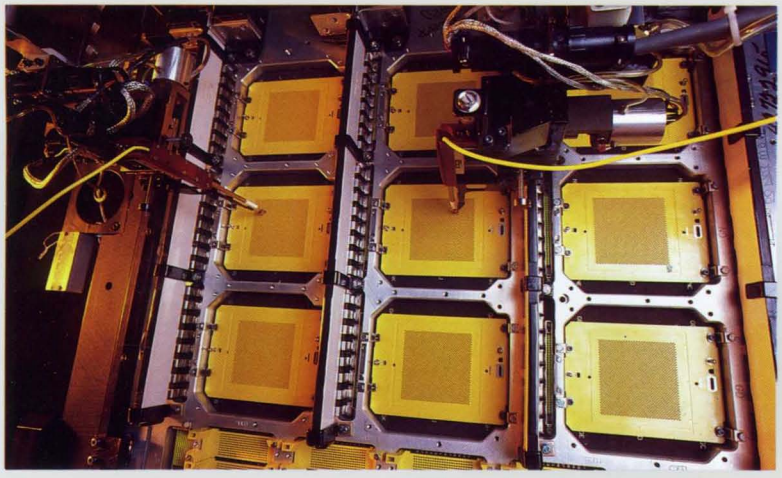
An assembler at the control panel of the machine that puts twisted pair wires on the TCM circuit board.

in automated production lines. The system transports TCM boards on roller bearing tracks to operators in human factors-designed workstations. Laser bar code readers scan the boards as they travel along the spurs of the system. Ergonomically-designed hydraulic lifters position the boards for the ease and safety of process operators. When a task is done, the handling system moves the boards to the next phase of the operation.

In addition to the special handling system, automation is used in the testing of the boards. The automatic ground bond tester is a two-armed IBM robotic system that checks for proper wire grounding. Robots are also used in capacitor insertion and for various other repetitive routines.

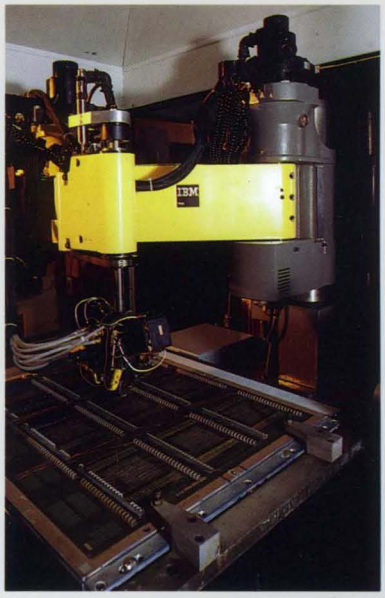
Completed frames are put into test cells at Kingston where they are cabled together and powered-up — just as if it were a customer installation. Components, subassemblies, and assemblies are rigorously pretested at every step to ensure they meet the stringent quality parameters set for them. For example, each TCM is "burned-in" for a period equivalent to 1,400 normal operating hours.

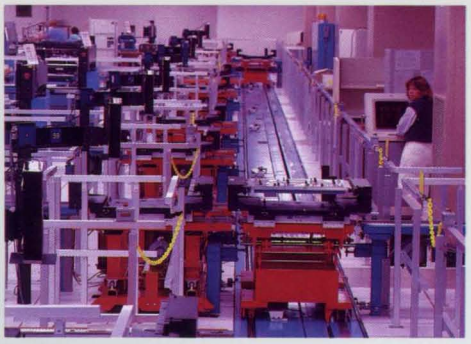
The result is a high-quality, reliable system; a system that can provide the function and performance you need to satisfy nearly any information processing requirement.



IBM robotic systems are widely used in production and testing of the 3090 TCM boards.

TCM boards are delivered and transferred automatically to work stations by the car-on-track conveyor system for greater operator safety and efficiency.





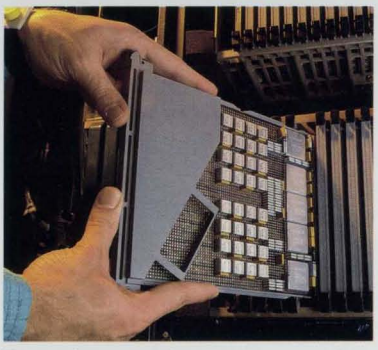
Parts move to people in the board assembly area on specially-built transport systems.

IBM 3090 Reliability, Availability, Serviceability (RAS)

Designed To Provide Improved Availability

The IBM 3090 was designed from the beginning to provide even better availability than the previous family of large systems processors. Its high availability is achieved through the use of new design tools, reliable Large-Scale Integration (LSI) memory and logic chips, Thermal Conduction Module technology, improved manufacturing techniques, enhanced built-in error detection and correction, and the duplication of key components in the Processor Controller.

Systems product assurance personnel perform a series of tests to ensure that IBM 3090 systems meet design specifications.



Dense four megabyte memory cards in the IBM 3090 feature fast, reliable IBM-designed and manufactured one-million-bit chips.

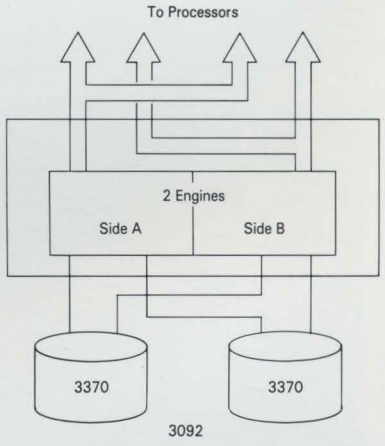
The IBM 3092 Processor Controller is an integral part of system final test. Normally used as part of the processor complex in an installation to control, monitor, and provide fault diagnosis, the diagnostics on the IBM 3092 Processor Controller are so comprehensive that they actually perform the final detail "check-out" of a processor complex before shipment. Only when the diagnostics have been run through "clean" twice is the IBM 3090 ready for shipment.

Approximately one quarter of the IBM 3090's circuits are there for availability. The IBM 3092 Processor Controller can contain one (on the 120E) or two independent processors. On the two processor version, one is acting as "hot-standby" for the other. Also, all key information recorded is duplicated on two IBM 3370 disks which are connected to both processors in the 3092 — again, one is active and the second is "hot-standby." The 3092 Processor Controller also has the ability to compile an error history on its 730Mb capacity IBM 3370 disks, including information on intermittent failures. If intermittent failures exceed a threshold, the 3092 automatically contacts the IBM remote support center by autodial link. Replacement parts are ordered, which may be installed at your convenience.

When hard failures occur, the extensive diagnostics will be able to point to failing "Field Replaceable Units (FRUs)" in more than 90% of the cases. The 3092 initiates a maintenance call to the Service Center for the Customer Engineer and at the same time the FRUs are requested to be dispatched from the parts center. This significantly reduces down-time and brings your users back on-line as soon as possible.

To further enhance availability, extensive use is made of error detection/correction codes throughout the processor complex. For example, Expanded Storage incorporates an enhanced error correction capability. All double-bit errors are detected and corrected, and all triple-bit errors are detected. In addition, four-bit errors in a single block are detected. This makes it possible to install very large, fast LSI memory while maintaining high availability.

Taken together, all of these elements add up to assure you of the highest quality and exceptional availability in every IBM 3090 processor.



The IBM 3092 Processor Controller can contain one (on the 120E) or two independent processor engines. On the 3092 diagram shown above for a 3090 model 400E or 600E, one is in the active state, monitoring the IBM 3090 processor complex, the other is in standby ready to take over should the active one fail. Also, all key information recorded is duplicated on the two IBM 3370 disks which are connected to both processor engines in the 3092.

IBM 3090 Performance

A *Total* System Solution

Multiprocessors are vital prerequisites for meeting customers' growth requirements. The IBM 3090 family offers the widest range of processor configurations from uniprocessors to IBM's largest single system image, the six-way Model 600E. The "traffic-controller" System Control Element provides more overlap and more buffers than were available on previous IBM large systems, to ensure that these multiprocessor configurations work efficiently.

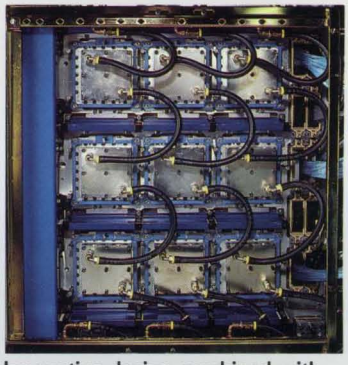
Overall performance is enhanced by improved cycle times (up to 28% faster than 308X), more instruction overlap (up to seven instructions in various stages of processing at any time), and improved data paths (more, wider paths with key paths parallel to allow simultaneous read and write).

But the IBM 3090 was designed to provide outstanding performance for *both* numerically intensive and commercial applications. For numerically intensive processing, the 3090 contains a high-speed multiplier, fast add/subtract circuits for floating point calculations, special loop control facilities which supplement the overlapped instruction/execution unit design, wide 64-bit data paths, and the 64Kbyte high-speed buffer with improved management in each processor. For additional performance, the optional Vector Facility, available for attachment to each processor in an IBM 3090 complex, provides a highly cost-effective feature which can yield throughput improvements of up to six times for suitable programs.

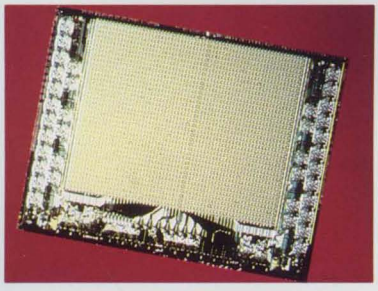
The IBM 3090's integrated approach to processing not only makes it possible to combine numerically intensive scalar and vector work on one system, it also allows commercial data centers to handle scientific work which previously required specialized equipment. In both cases, the overhead of running separate installations can be reduced and access to data can be simplified by containing it within a single system.

IBM 3090 Performance Features:

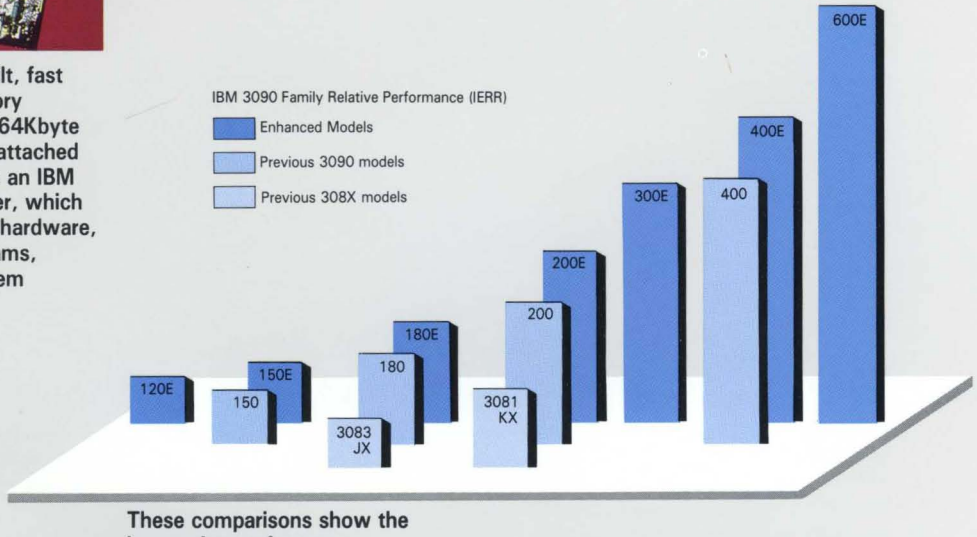
- Cycle time (18.5 to 17.2 ns)
- Instruction decode/execution overlap
- Integrated Vector Facility
- Expanded Storage
- 64Kb high-speed buffer with improved Buffer Management
- More, wider data paths
- Powerful, flexible RISC I/O processor
- Dedicated microprocessor for each channel
- SIE microcode support
- Multiple High Performance Guests support
- Enhanced, in-flight error correction
- Parallel data paths allowing simultaneous read and write



Innovative design combined with advanced technology results in Vector Facilities which are easy to install and use.



This IBM-developed and built, fast static random access memory (SRAM) chip is used in the 64Kbyte high-speed buffer which is attached to each central processor in an IBM 3090. The high-speed buffer, which is dynamically managed by hardware, and is transparent to programs, substantially improves system performance.



These comparisons show the impressive performance improvements for the IBM 3090 enhanced models over previous models.

IBM 3090 Summary

Continued Leadership In Large Systems

New IBM technology — teamed with innovative design — offers improved levels of price/performance as well as increased function to allow you to build upon your large systems investment and manage your growing data processing requirements within a single system image.

The IBM 3090 Processor family offers a wide spectrum of growth options, ranging from the entry Model 120E up to the six-way Model 600E, providing up to a ten-fold increase in processing power.

Processor storage can be increased from 32Mb to 2304Mb, and channels from 16 to 128. Both provide for increased capacity for the 3090 system.

You can also add up to six fully integrated Vector Facilities for handling numerically intensive computing applications. The result is exciting extensions to the technology and design of previously available 3090 models and significant flexibility for you.

Ask your IBM marketing representative for more details about the IBM 3090 Processor family today.

IBM 3090 systems line up for final test prior to shipment at the half-mile-long testing facility in Kingston, New York.

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