NEC

SUPERCOMPUTER
SX-1/SX-2

Super Power
Over a Billion Operations per Second

NEC SUPERCOMPUTER SX-1/SX-2

As the dreams of society continue to grow, the realization of these dreams demands that science and technology give us solutions to increasingly complex problems. These problems, arising in astronautics, energy research, electronics, architecture, mechanical engineering, and a wide range of other engineering areas, require huge volumes of data and enormous computational power.

It is the supercomputer that has given us this power and data-handling capability. And now a remarkable new supercomputer—the SX system—can provide this power and capability, along with truly astonishing computational speed.

The NEC supercomputer SX system employs truly superior computer architecture and LSI circuitry, developed from NEC's integrated computer and communications (C&C) technologies. And the SX system is the first computer to achieve processing of more than one billion floating operations per second; in fact, the SX-2 actually reaches the truly astonishing speed of 1.3 GFLOPS.

It's true: With the SX system, NEC has broken the gigaflops barrier.

GFLOPS: Giga Floating Operations Per Second

Major Application Areas

Aeronautics and Space Science	Aerodynamics, structural analysis, and image processing
Nuclear Science and Fusion	Nuclear reactor analysis, safety analysis and particle simulation
Meteorology	Numerical weather forecasting and atmospheric global circulation modelling
Molecular Science	Molecular structural analysis and molecular orbit calculation
Geophysics	Electromagnetic analysis and seismic analysis
Architectural and Civil Engineering	Structural analysis and vibration analysis
Mechanical Engineering	Structural analysis and thermo-analysis
LSI Design	Device analysis, circuit analysis, and layout design


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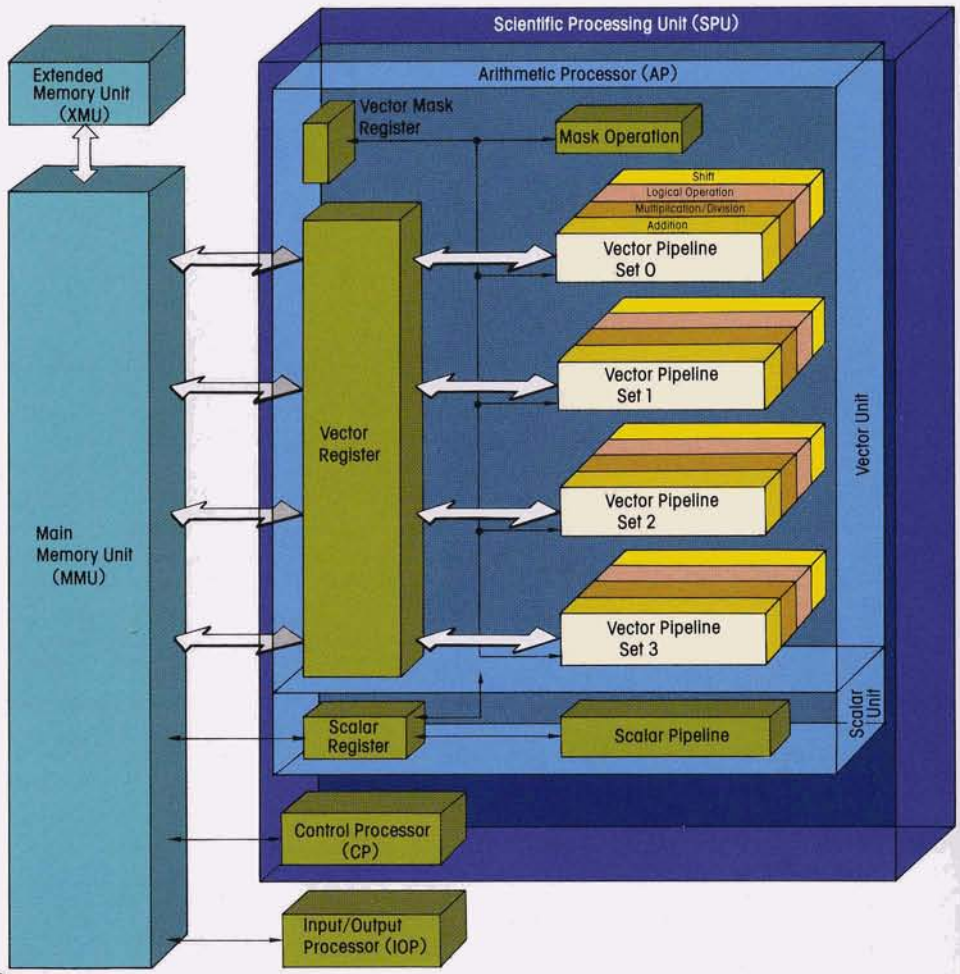
Super Speed Vector Processing at 1.3 GFLOPS

High-end science and technology require large-scale simulations. Many of these simulations are described in partial differential equations, and these are, in turn, described as simultaneous linear equations and eigenvalue problems, which are processed as vector operations.

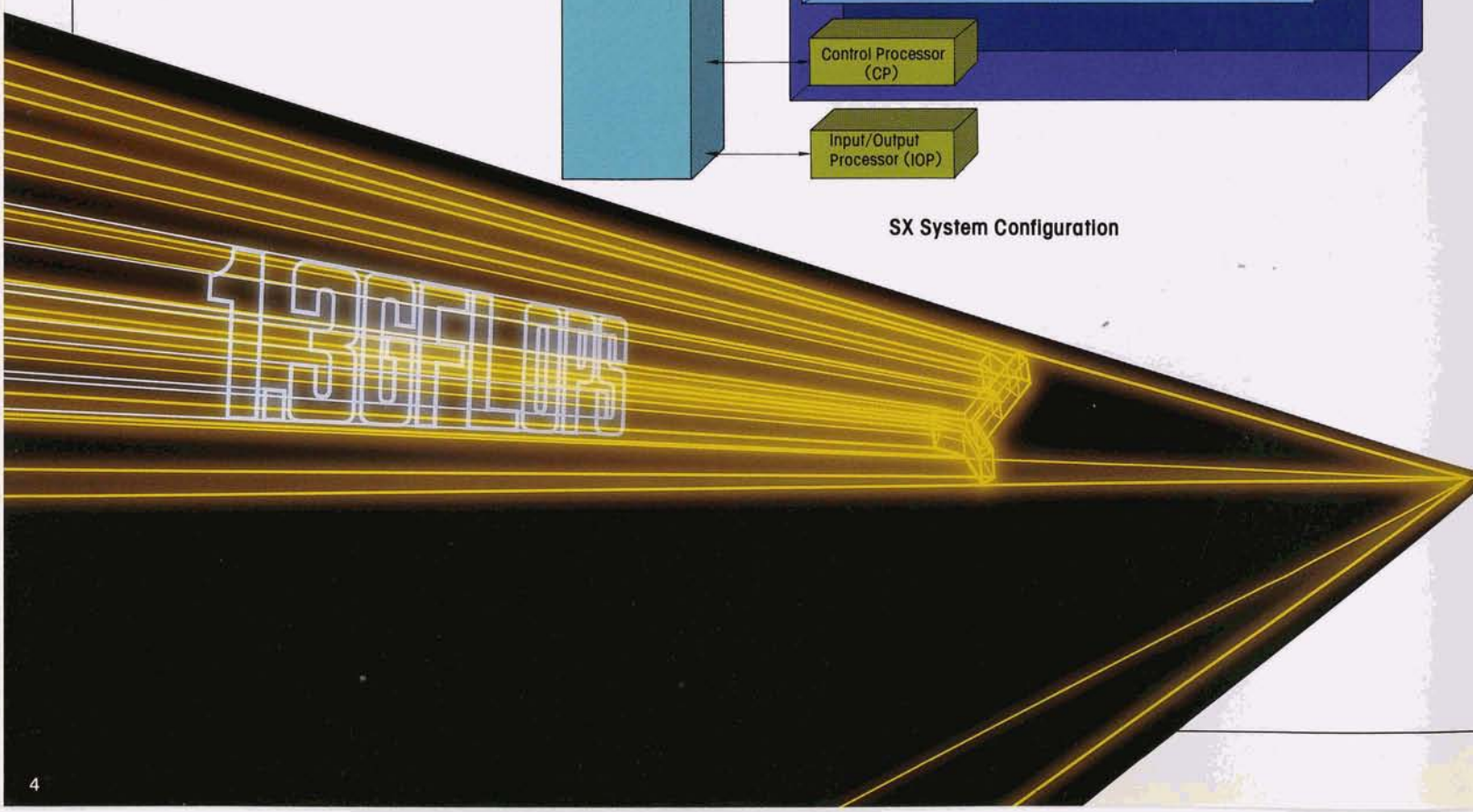
To handle these large-scale simulations, the NEC engineering staff has imbued the supercomputer SX system with a maximum speed of 1.3 GFLOPS.

High-Speed Machine Cycle

NEC is a recognized world leader in semiconductor and computer technologies, and such leadership has enabled us to create a supercomputer with a lightning-fast machine cycle. The high-speed machine cycle was achieved by employing very high-speed LSIs, as well as high-density packaging requiring only minimal wiring lengths, and is the key to the realization of the supercomputer's 1.3 GFLOPS operating speed.



SX System Configuration



Powerful Vector Unit

Processing in the vector unit is based on multiple parallel operations. Vector pipelines, consisting of a maximum of four sets, operate in parallel. Four vector arithmetic units in each vector pipeline set also operate in parallel. This enables a maximum of 16 parallel vector operations to be performed, using a maximum of 80K bytes of vector registers.

High-Throughput Main Memory

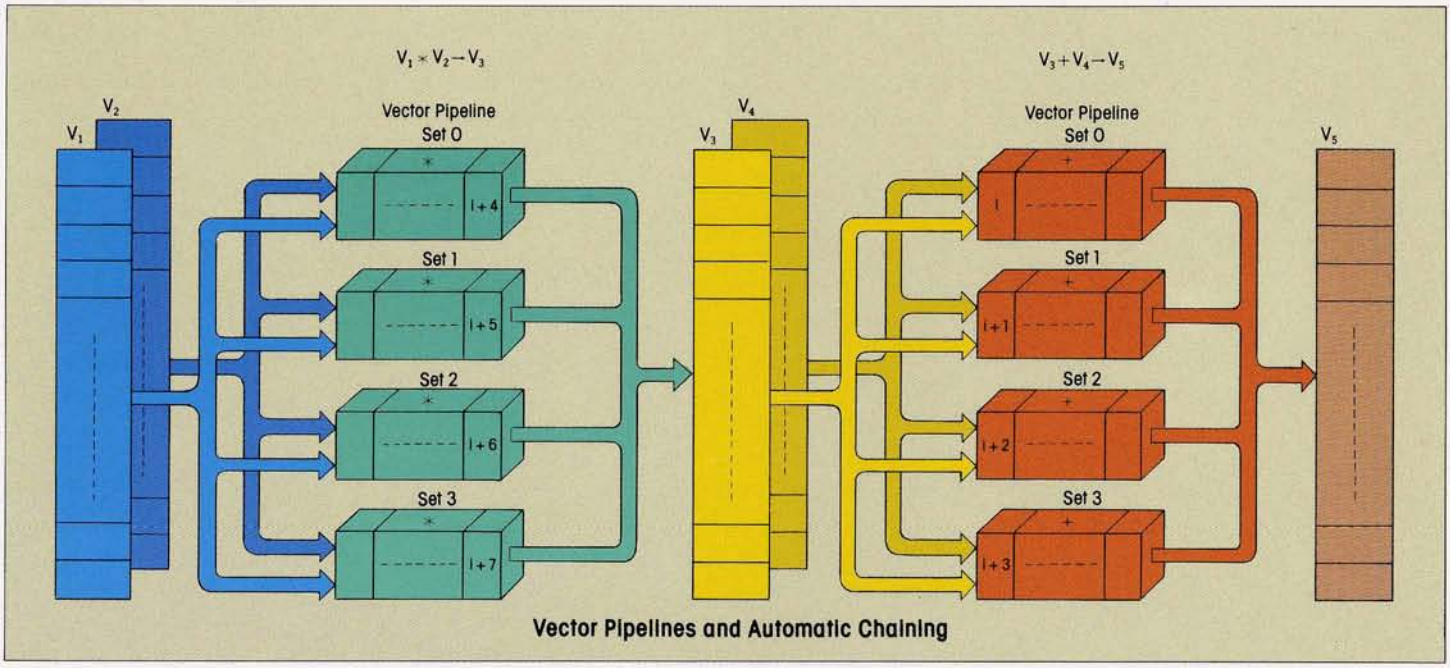
Coupled with the powerful vector unit is a main memory that assures high-speed data access. By employing high-speed MOS static RAMs as storage elements, and an interlacing system with a maximum of 512 ways, the SX system is capable of supplying up to 11G bytes of data per second.

Extensive Vector Operation Functions

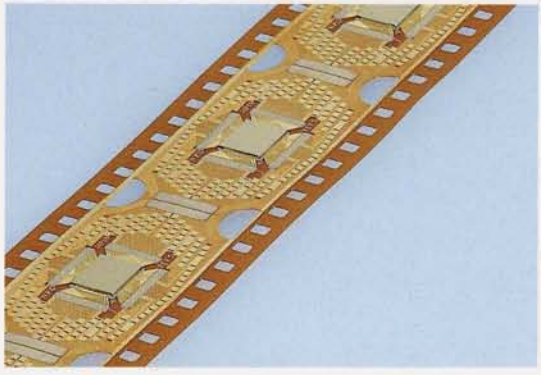
The SX system supports extensive types of vector operations. List vector data stored randomly, and vector data stored sequentially or at equal distances, can all be processed. Loops that include IF statements can be processed by a conditional vector operation function. Vector data can also be compressed and expanded.

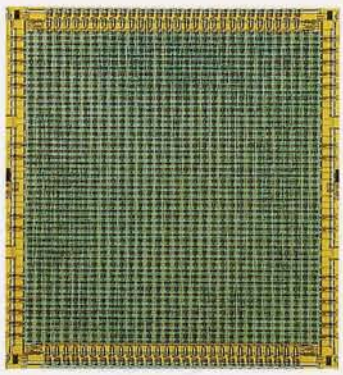
High-Level Automatic Chaining

When the preceding vector operation result is to be referenced by subsequent vector operation, the hardware detects and chains them for continuous parallel processing. This automatic chaining means more computing and data-processing power.



Vector Pipelines and Automatic Chaining





Super Performance
High-Speed Scalar Operation and Distributed Functions

Because every part of a scientific and technological computation cannot always be vectorized, the scalar operation performance of a supercomputer is also extremely important. Moreover, as computational power increases, the reduction of control program overhead has also become more and more important. In the NEC supercomputer SX system, high-speed scalar operation and a distributed function system have been combined, giving significantly improved system performance.

Scalar Pipelines

The SX system employs pipelined arithmetic units in scalar operations as well as in vector operations, so the results of scalar operations are made available successively. And scalar pipeline efficiency is further enhanced by reordering instructions according to the flow analysis technique with which data dependencies are analyzed.

High-Speed Branching and Plenty of Scalar Registers, Too

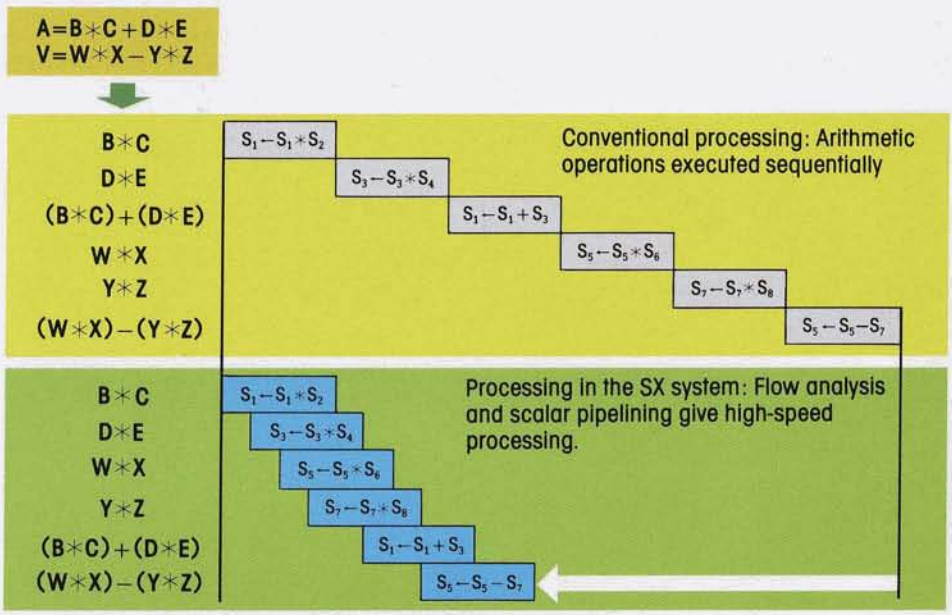
The SX system uses a high-speed branch system in which branch conditional status is predicted. If correct, the target instruction is immediately read from the instruction buffer. Further speed is gained by having as many as 128 scalar registers prepared. High-speed branching and the 128 scalar registers enable truly high-speed scalar operations.

Parallel Processing of Scalar and Vector Units

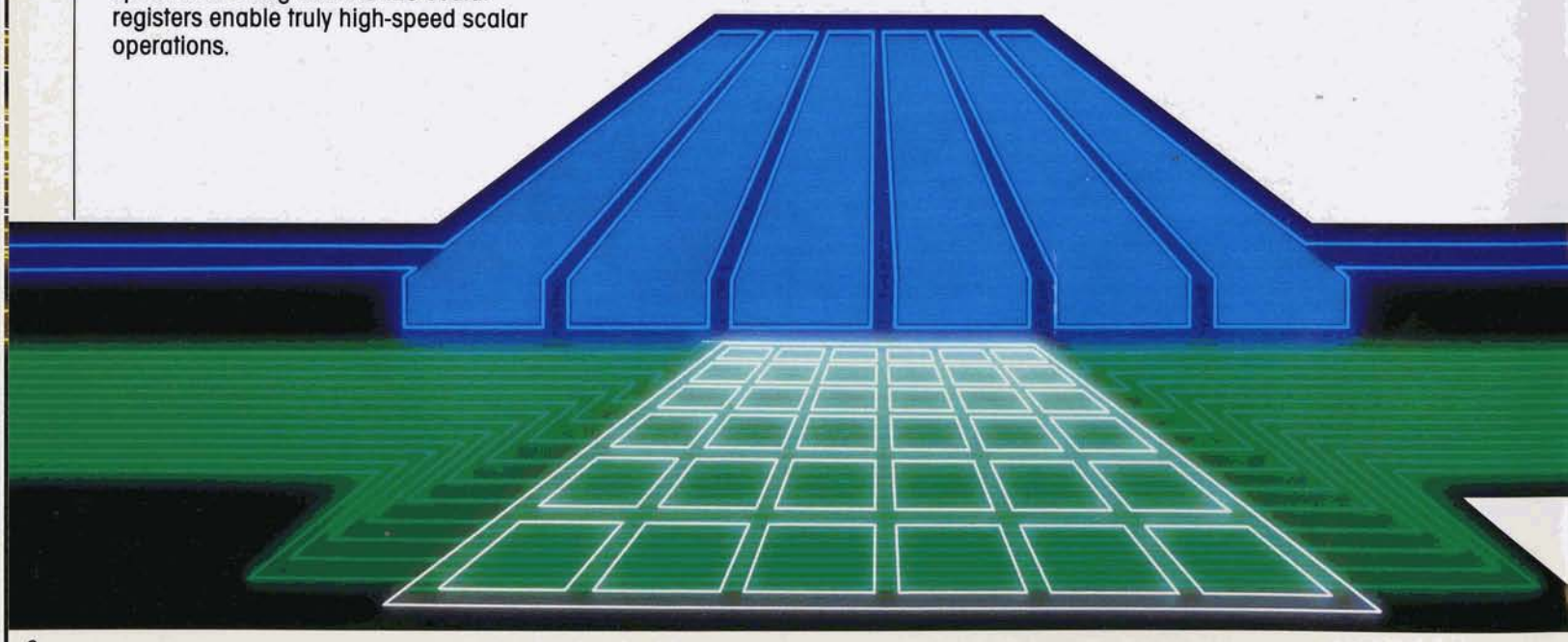
Scalar and vector units operate in parallel. This further increases system performance.

Separate Arithmetic and Control Processing

In the SX system, arithmetic operations are executed in the arithmetic processor at the same time that input/output editing is being handled by the control processor. Since the arithmetic processor and the control processor operate in parallel, the system load is distributed to them, substantially enhancing overall system performance.



Scalar Pipelines and Flow Analysis



Super Circuitry
Liquid-Cooled, High-Speed LSIs

LSI manufacturing, chip mounting, chip cooling systems—they're all extremely important factors in supercomputer performance. The NEC supercomputer SX system employs high-speed large-scale integrated circuits, as well as newly developed liquid-cooled high-density LSI packaging. Besides speed, these NEC LSI circuits help ensure the superior RAS (Reliability, Availability and Serviceability) of the SX system.

High-Speed LSIs

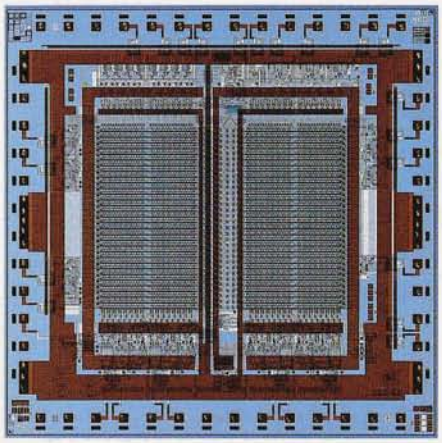
The logic circuit LSIs used in the SX system have a density of 1,000 gates per chip, with delay time of only 250 picoseconds per gate. The cache memory and vector registers are made up of high-speed 1K-bit bipolar memory LSIs with an access time of 3.5 nanoseconds.

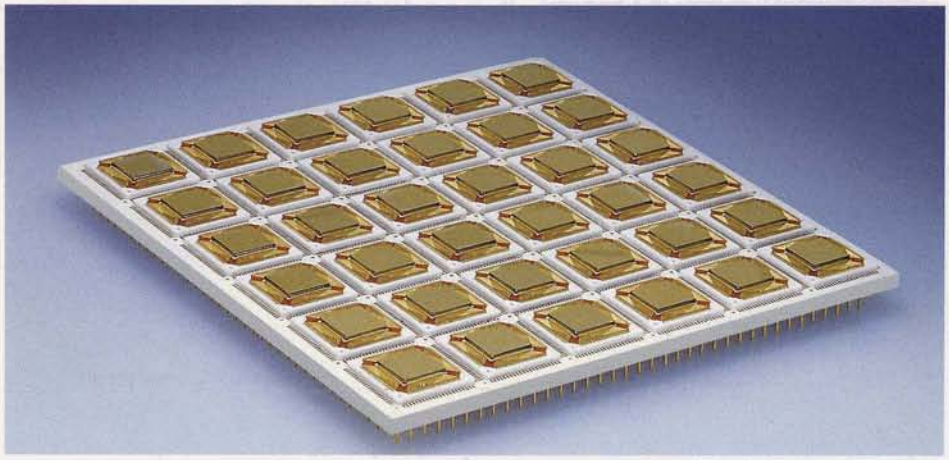
New High-Density LSI Packaging

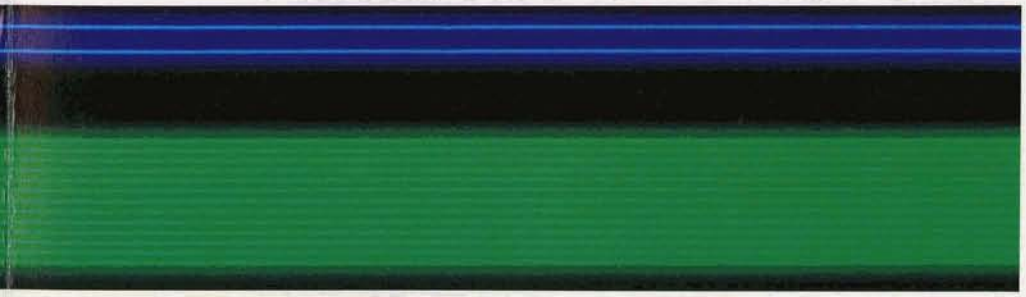
The SX system utilizes a unique, high-density packaging whereby 36 LSI chips are mounted on a ceramic substrate only 10 cm square. In fact, as many as 36,000 gates are in a single package, which helps to guarantee the astonishing speed of operation of this supercomputer. All I/O pins are arrayed on the surface of the LSI package (in a pin grid array format), and wiring length between packages has been minimized. This LSI package employs a direct liquid-cooling system, enabling more even and efficient cooling than do air-cooled systems. The cooling unit itself is air cooled, and requires no special equipment.

High System Reliability

The use of LSIs and new high-density LSI packages has further improved hardware reliability. In addition, the service processor provides automatic collection of failure information, as well as diagnostic program control. These features enable quick fault diagnosis and ensure ease of preventive maintenance, all of which improve system reliability and availability.







Super Memory
High-Performance Main Memory and Large Extended Memory

For maximum efficiency, a supercomputer's memory must be able to supply great masses of data rapidly. The NEC supercomputer SX system employs LSIs as memory elements, supporting two hierarchically organized memory units: a high-performance main memory with a maximum capacity of 256M bytes, and an extended memory unit with a maximum capacity of 2G bytes.

LSI Technology

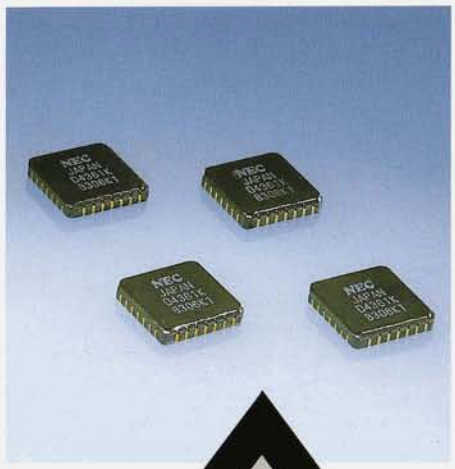
The main memory unit of the SX system uses 64K-bit MOS static RAMs; access time is only 40 nanoseconds. The extended memory unit employs state-of-the-art MOS dynamic RAMs.

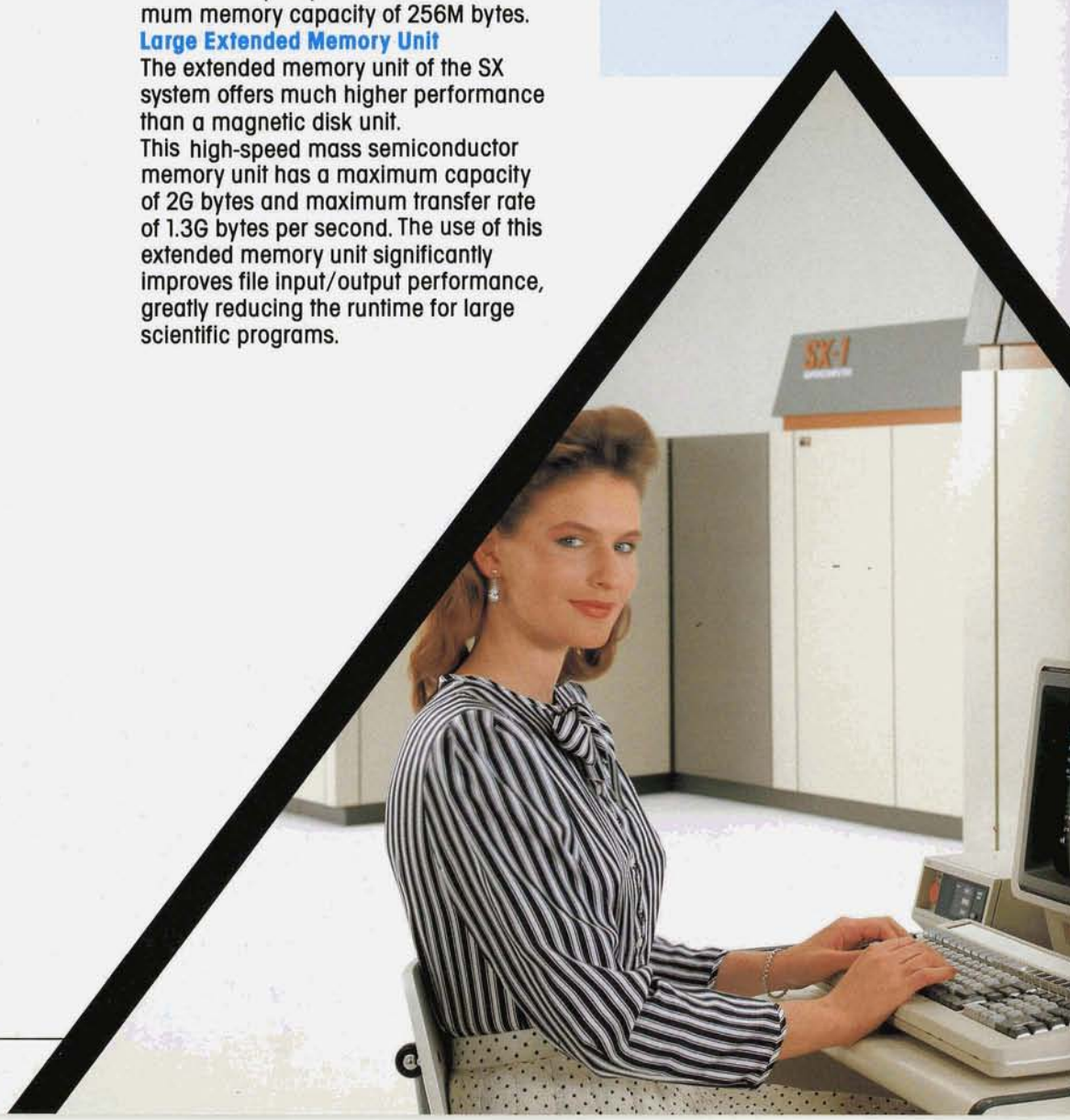
High-Speed Main Memory Unit

In the SX system, high-speed memory elements are complemented by an interlacing scheme with up to 512 ways. This gives the high-speed main memory unit a maximum data supply rate of 11G bytes per second and a maximum memory capacity of 256M bytes.

Large Extended Memory Unit

The extended memory unit of the SX system offers much higher performance than a magnetic disk unit. This high-speed mass semiconductor memory unit has a maximum capacity of 2G bytes and maximum transfer rate of 1.3G bytes per second. The use of this extended memory unit significantly improves file input/output performance, greatly reducing the runtime for large scientific programs.





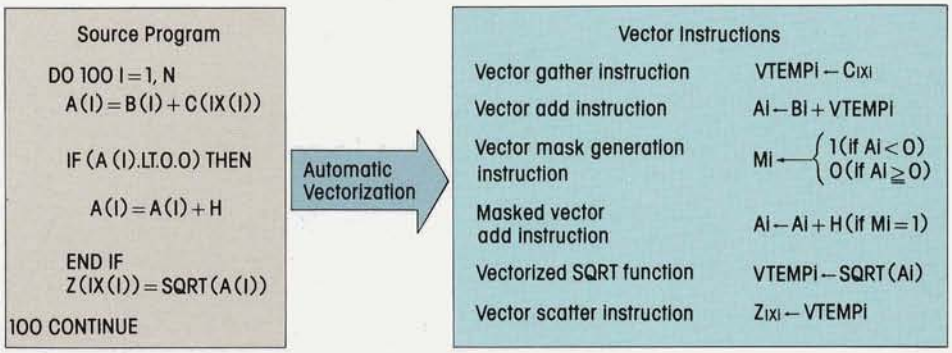
Super Software Efficient and Easy to Use

The NEC supercomputer SX system supports high-performance software that enables the most efficient use of SX system hardware and provides an easy-to-use scientific computational environment.

Sophisticated Automatic Vectorizing

Among the features of the SX system is FORTRAN77/SX, a powerful compiler that automatically generates vector instructions by analyzing DO loops. Automatic vectorizing can be done even for complicated loops containing IF statements, intrinsic functions, and list vectors. This function also divides loops containing statements that cannot be vectorized into two or more statement parts. It then vectorizes individual statement parts, if possible.

FORTRAN77/SX also offers optimal register allocation and optimization by flow analysis. This means existing FORTRAN programs compiled by FORTRAN77/SX can also make the best use of SX system performance.



Tools To Support Vectorization

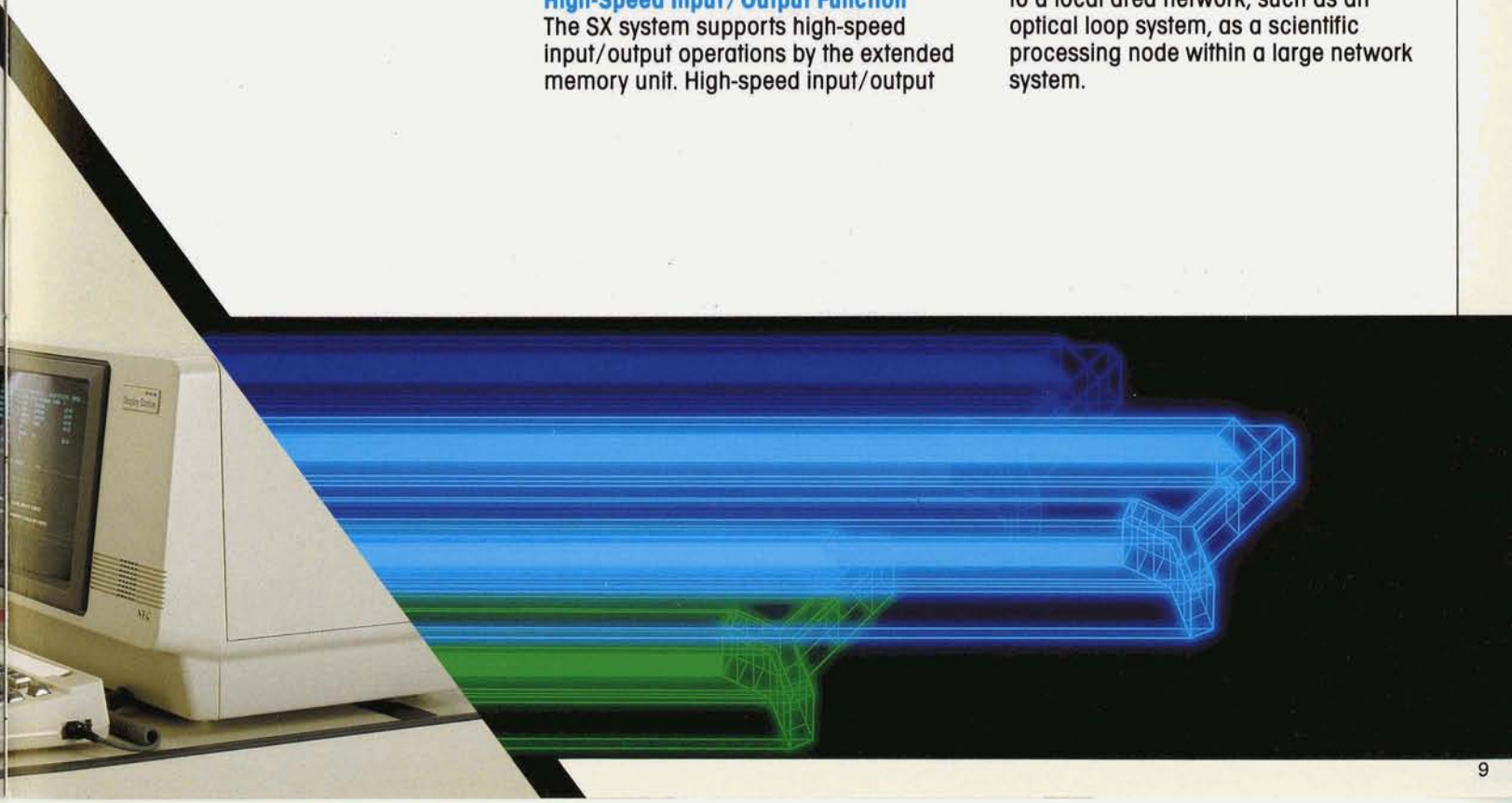
System performance is improved significantly by increasing the vectorizing ratio for programs. The SX system offers several software tools that support vectorization. ANALYZER/SX analyzes a program's dynamic and static characteristics, while VECTORIZER/SX can be used interactively to improve the vectorizing ratio. OPTIMIZER performs such optimization tasks as in-line expansion of user functions and subroutines. A vectorized advanced scientific library, ASL/SX, is also available to the user.

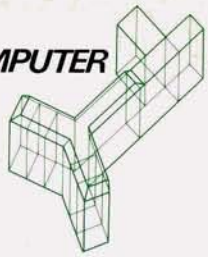
High-Speed Input/Output Function

The SX system supports high-speed input/output operations by the extended memory unit. High-speed input/output asynchronous input/output function with program execution, and using parallel input/output to or from multiple disk storage.

Support of Stand-Alone and Loosely Coupled Systems

The SX system can operate efficiently in stand-alone configurations. The SX system can also be connected to the NEC's general-purpose ACOS series computer system, constituting a loosely coupled multiprocessor system. Furthermore, the SX system can be connected to a local area network, such as an optical loop system, as a scientific processing node within a large network system.





Hardware

Central Processor

The SX system comprises two models: the SX-2 and the SX-1.

Scientific Processing Unit (SPU)

	SX-2	SX-1
Maximum Performance	1,300 MFLOPS	570 MFLOPS
Number of Instructions	155	
Registers		
Vector Registers	80K bytes	40K bytes
Vector Mask Registers	256 bits × 8	128 bits × 8
Scalar Registers	128	
Data Format		
Fixed-Point	32 bits	
Floating-Point	32/64/128 bits (128 bits for scalar instructions only)	
Logical	64 bits	
Vector Pipeline	4 sets	2 sets
Vector Arithmetic Unit	16	8
Scalar Pipeline	1 set	
Conditional Vector Operation	Available	
List Vector Operation	Available	
Cache Memory	64K bytes	
Address Translation Feature	1M bytes/page	

Main Memory Unit (MMU)

	SX-2	SX-1
Memory Capacity	128/256M bytes	64/128/256M bytes
Interlace	512 ways	256/512 ways
Memory Element	64K-bit MOS static RAM	

Input/Output Processor (IOP)

Total Data Transfer Rate	50M bytes/sec
Number of Input/Output Channels	32 (max.)

Extended Memory Unit (XMU)

Memory Capacity	128M to 2G bytes
Transfer Rate	1.3G bytes/sec (max.)

Peripheral Devices

Various peripherals for NEC's general-purpose ACOS series computer system are also available for the SX system.

Magnetic Disk Unit

Storage Capacity	2.68G bytes	1.27G bytes	635M bytes	200M bytes
Transfer Rate	3.0M bytes/sec	1.2M bytes/sec		806K bytes/sec

Magnetic Tape Unit

Transfer Rate	1,250K bytes/sec	780K bytes/sec
Recording Density	6,250/1,600 RPI	

Page Printer

Printing Speed	14,000 lines/min	7,000 lines/min	3,330 lines/min
Character Set	64 characters × 8		

Front-End Network Processor

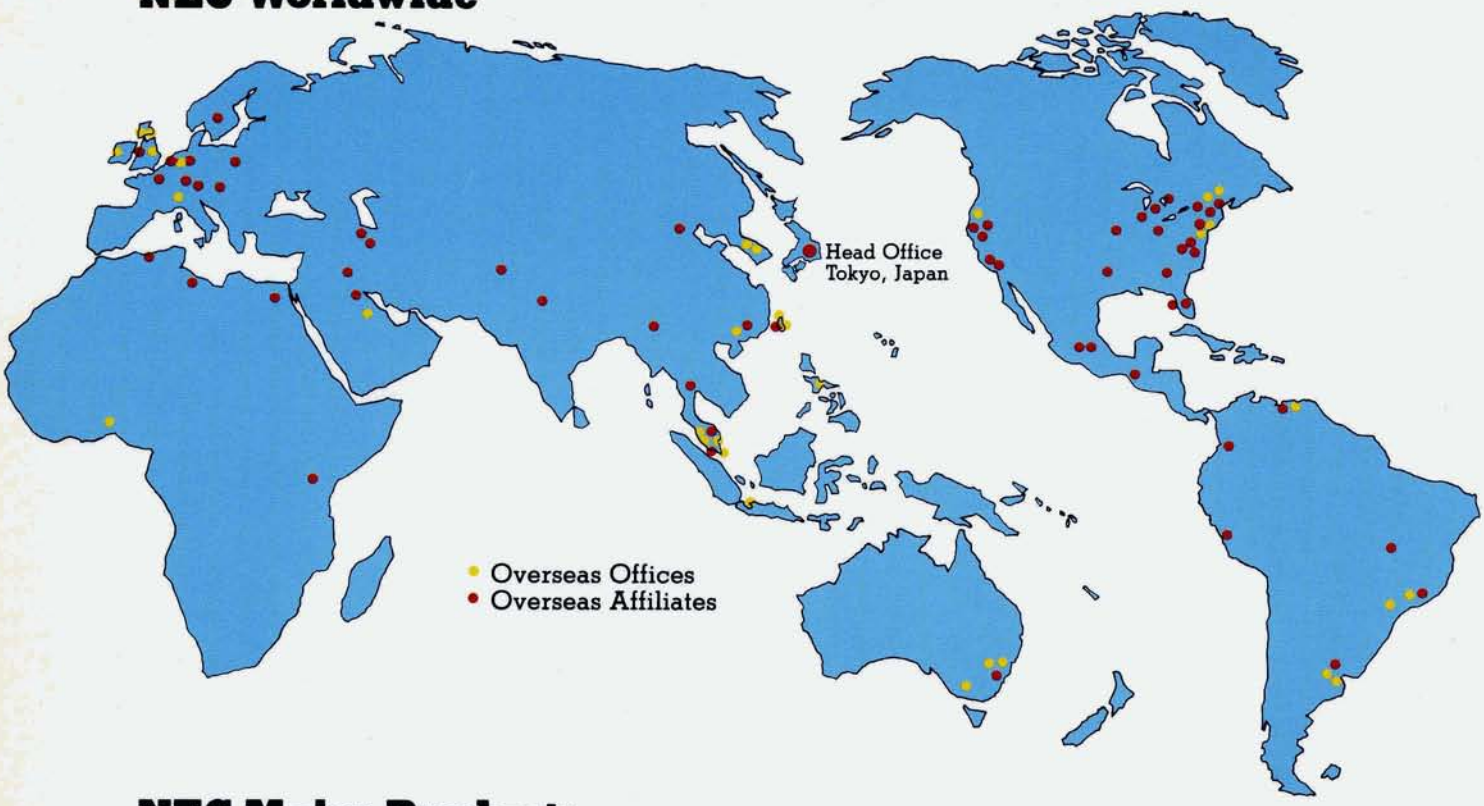
Number of Lines	272 (max.)
Memory Capacity	1M to 8M bytes

Software

Program Products

FORTRAN77/SX	FORTRAN77 compiler with automatic vectorizing functions.
VECTORIZER/SX	An interactive tool to increase vectorizing for FORTRAN programs.
ANALYZER/SX	A tool for analyzing the static and dynamic characteristics of FORTRAN programs.
OPTIMIZER	A tool for optimization, including in-line expansion of user functions and subroutines.
IDSP	Interactive Debugging Support Program: An interactive tool for dynamic program debugging.
ASL/SX	Advanced Scientific Library/SX: A vectorized advanced scientific library.
SXCP	SX System Control Program: Control program for the SX system.

NEC Worldwide



NEC Major Products

Switching Group
Telephone switching systems, electronic and crossbar, for central office and PBX and PABX uses, digital data switching systems, electromechanical devices

Transmission and Terminals Group
Telephone sets, key telephone systems, video telephone equipment, telephone conference systems, facsimile equipment, CATV, data modems

Carrier transmission equipment, power-line carrier equipment, submarine cable repeaters, fiber optic communications systems, optical connectors

Radio Group
Microwave communications systems, over-the-horizon communications equipment, satellite communications systems (satellite-mounted and ground support communications equipment), millimeter wave communications equipment, laser communications equipment, mobile and portable radio equipment, pagers

TV and radio broadcast equipment, VTR and studio equipment

Aircraft and space electronic equipment, satellites, rocket guidance and control equipment, radio navigation and radar equipment, defense electronic systems, underwater ultrasonic application equipment

Information Processing Group
General-purpose ACOS series computers, small business computers, control computers and software, minicomputers, data communications equipment and software, peripheral and terminal equipment, magnetic memory equipment, distributed data processing systems, office automation systems, word processors

Pollution monitoring systems, industrial telemetering systems, postal automation systems, numerical control equipment, medical electronic equipment, educational electronic equipment, speech recognizers, industrial and communications control systems

Electron Device Group
ICs, LSIs, microcomputers, personal computers, transistors, diodes, electron tubes, microwave tubes, color picture tubes, display tubes, plasma display panels, semiconductor lasers, laser application devices, circuit components, rectifiers, bubble memories, vacuum equipment

Home Electronics Group
TV receivers, color and black-and-white, VTRs, TV projectors, radio receivers, transceivers, tape recorders, hi-fi audio systems, lighting products, refrigerators, microwave ovens, kitchen appliances, air conditioners

Other Operations
Electrical connectors, measuring instruments and testing equipment, automatic vending machines, industrial wastewater processing systems

NEC NEC Corporation
NEC Building
33-1, Shiba 5-chome, Minato-ku
Tokyo 108, Japan
Tel: Tokyo 454-1111
Cable Address: "MICROPHONE TOKYO"
Telex Address: NECTOK J22686

For further information, please contact:

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