SPARC
SCALAR
PROCESSORS

SCALAR
CACHES

TUAL ADDRESS
TRANSLATION

EXPANSION

**CRAY S-MP Series
Overview**

**high performance
compute servers**

**powerful
visualization
servers**
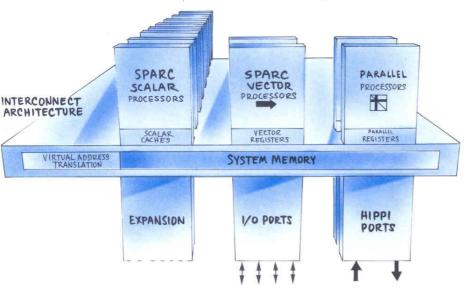
**high speed
communications
servers**

**terabyte capacity
file servers**

**CRAY
RESEARCH**
Superservers, Inc.

The CRAY S-MP Superservers

Cray Research, Inc., creates the most powerful and highest quality computational tools for solving the world's most challenging scientific and industrial problems.

Cray Research Superservers, Inc., a wholly owned subsidiary of Cray Research, now

The foundation of the CRAY S-MP series is its system interconnect. This high speed architecture, with a bandwidth of 1 gigabyte per second, supports modular upgrades to the system to accommodate changing application needs. Through the system interconnect, customers enjoy flexibility, value and upward compatibility, making the CRAY S-MP series the right super-servers for today's, and tomorrow's, needs.

introduces the CRAY S-MP series of compute, visualization, communications, and file servers. These systems offer superior performance on their own, and an unprecedented level of interoperability between workstations and large scale computers.

The CRAY S-MP series of high-performance systems are designed to bridge the gap between supercomputers and today's distributed, heterogeneous development environments. These systems can handle the demands of multiple large multi-user applications, such as design engineering, computational fluid dynamics, E- and M-CAD, chemistry, and distributed graphics.

CRAY S-MP series computers can be configured to provide a wide range of capability and performance, satisfying requirements as small as departmental compute servers and as large as central data center systems.

Scalable Processor Architecture (SPARC)

The CRAY S-MP series' scalar processors are based on the Scalable Processor Architecture developed by Sun Microsystems, the most widely used non-proprietary RISC architecture. Each CRAY S-MP system is certified by SPARC International to meet the SPARC Compliance Definition. Currently, over 3,500 applications adhere to the SPARC Applications Binary Interface (ABI) and can run immediately, without change, on any of the CRAY S-MP series systems.

The CRAY S-MP series of high-performance computer systems ties SPARC scalar, vector, and parallel vector processors into a single, integrated heterogeneous system. The CRAY S-MP series provides the versatility to meet today's diverse user requirements and the scalability for tomorrow's growth. With powerful unified compilers and libraries under a UNIX-based operating system, the CRAY S-MP series offers a software-rich integrated environment that surpasses other distributed systems for ease-of-use, productivity and performance.

The CRAY S-MP System Interconnect

The foundation of the CRAY S-MP series is its system interconnect. Cray Research Superservers engineers have designed an open system interconnect that is independent of specific processor types. As a result, the CRAY S-MP series can be configured into systems offering a wide variety of scalar, parallel scalar, vector, and parallel vector processors to match application needs.

All CRAY S-MP systems provide a superior virtual memory architecture with features to manage large numbers of big jobs efficiently. The size and complexity of many applications require resources beyond those found in today's workstations and work-group servers. Time wasted on non-productive file and memory management activities dominates the environments of many workstation users. Many mainframes and other work-group servers also carry these burdens. The CRAY S-MP system, however, is as easy to use as a workstation while providing mainframe and supercomputer performance and connectivity. It provides the convenience of virtual memory while supporting powerful vector and parallel vector processing.

Solutions For Any Server Requirement

The CRAY S-MP series offers a broad range of models. Each one, from a low-cost entry-level system to a fully-configured model, meets particular applilcation, performance, and budget needs. All CRAY S-MP systems offer the highest-performing SPARC processor available, with 67 MIPS (64-bit data path) performance per processor. Systems are available with up to eight SPARC scalar processors, offering 533 MIPS (64-bit data path) peak performance. Developers using SPARC workstations can use the CRAY S-MP system as a compute server to accelerate applications without recompilation. In addition to symmetric multiprocessing, some or all of the processors may be applied to a single task.

In addition to SPARC scalar performance, the CRAY S-MP series also offers vector and parallel options, all within a SPARC-compliant system. Because of their modular nature, CRAY S-MP computers may be upgraded easily, in the field, with additional scalar, vector, or parallel vector processors to support application needs.

The CRAY S-MP series can be configured to meet the demand of large-scale communications, archival, and file server requirements. VME bus and ANSI High-Performance Parallel Interface (HiPPI) channels, together with a comprehensive suite of networking software, provide high-speed links to other computers and a variety of visualization, network, and disk array products.

The CRAY S-MP system is an ideal compute and file server for today's distributed development environments. Outstanding NFS transaction rates are achieved by the SPARC multiprocessor architecture and the I/O system. Applications developed on SPARC workstations can be run without modification on the CRAY S-MP system for reduced development time and increased productivity.

Running on CRAY S-MP systems, the UniTree Intelligent File Storage and Management System provides an integrated hardware and software environment that supplies broad information management services. UniTree provides transparent hierarchical data storage management using an implementation of the IEEE Mass Storage Reference Model. It complements the CRAY S-MP system's computing power with sophisticated software for managing vast amounts of data using high-performance communications to disk storage and tape silos. Using HiPPI connections, the system can provide up to 512 gigabytes of on-line disk storage at sustained transfer rates over 128 megabytes per second and can support terabytes of on-line data using secondary storage devices.

As supercomputers have provided increasing levels of computational speed, the need for high-performance visualization and graphics servers has increased many fold. The CRAY S-MP series fills this need with an architecture which offers connectivity to supercomputers and the ability to accelerate graphics algorithms using parallel processing.

For certain applications, the CRAY S-MP series can be configured with parallel vector processors. The CRAY S-MP series' parallel vector processor is well suited for graphics algorithms such as 3D rendering. The system's large physical memory capacity and virtual memory architecture can effectively off-load graphics processing tasks from the supercomputer, while providing the high-bandwidth communications required to serve large numbers of workstations or X Terminals. A CRAY S-MP system with parallel vector processor option provides a high performance visualization facility while freeing supercomputer resources for productive computational tasks.

Unified Software Environment

The richness of the CRAY S-MP series Unified Software Environment (USE) gives developers easy access to all the performance features of the CRAY S-MP system. Users of the SPARC environment will find familiar interfaces since the CRAY S-MP operating system is an enhanced implementation of SunOS - the most widely used non-proprietary RISC operating system. Cray Research Superservers has extended SunOS to support parallel processing, symmetric multiprocessing, vector, and parallel vector processing.

The Cray Research Superservers powerful Unified FORTRAN and C compilers, when compiling in scalar mode, maintain binary compatibility with the rest of the SPARC ABI. When compiling with vector and/or parallel vector options, code is automatically generated to use those processors efficiently, even when no explicit directives are given. The compilers automatically detect code constructions and match them to available processors.

Developers can also use compiler directives to fine tune the CRAY S-MP system's vector and parallel vector processors for special application needs. Cray Research Superservers provides a complete software development environment with compilers, debuggers, math libraries, and loaders to aid code development. An application can use the combination of processors that best suit its internal algorithms.

Additionally, the Unified FORTRAN and C compilers are available for SPARC workstations. With these compilers, applications created on SPARC workstations will easily run on the CRAY S-MP series.

Extensive Mathematical Libraries

Mathematical libraries implement commonly used algorithms into callable routines. Cray Research Superservers has implemented a collection of mathematical libraries to provide easy-to-use interfaces to its high-speed processors. CRSmath is based on an industry-standard mathematical library in use over 15 years and used by thousands of scientists and engineers. For the modular CRAY S-MP series, CRSmath routines are available in scalar only, scalar/parallel, scalar/vector, and scalar/parallel vector versions. Whatever mix of processors are present, CRSmath provides routines that exploit these high-performance units. And since linking is automatic at run time, developers don't have to change their programs to use these routines.

Extending SPARC Capabilities

Recognizing the advantage to customers of providing an open RISC environment, Cray Research Superservers chose SPARC for the CRAY S-MP series because it is the most widely used RISC engine. The CRAY S-MP architecture provides for incorporation of powerful vector and parallel vector processors to handle compute-intensive jobs. And SPARC's open specification allows implementation of an alternative memory management system designed to control the instruction and data space required by many large-scale commercial, scientific, and engineering applications.

SPARC brings many advantages to the user. More than 3,500 applications are available with the SPARC ABI. Since the CRAY S-MP series is certified SPARC-compliant by SPARC International, users can look forward to a "plug and play" environment for these applications.

The CRAY S-MP series extends the SPARC domain to include up to eight SPARC processors running in parallel. The UNIX-based operating system manages all system resources so that multiple processors can be used in several different ways. With symmetric multiprocessing, multiple job streams may be run. By compiling a task to use two or more processors in parallel, the operating system efficiently mixes parallel and symmetric multiprocessing workloads together to maximize system throughput.

Vector and Parallel Processing

Cray Research Superservers has adapted vector processor technology to SPARC scalar architecture, bringing significant capabilities to it. Convolutions and first order linear recursion are two vector forms that dominate certain algorithms. The CRAY S-MP system implements these forms in hardware, and provides extensive compiler support for them. By compiling with Unified FORTRAN and C Compilers, developers frequently take full advantage of vector processing without any explicit direction. Using Cray Research Superservers' Unified Software Environment, the resources of the vector processor are as convenient to use as any scalar resource.

The CRAY S-MP system's modularity extends to the parallel vector processor. Available with 4 to 168 Intel i860 processing elements in up to two parallel arrays of as many as 84 processing elements each, it is configurable for specific

applications and workloads. The CRAY S-MP parallel vector processor delivers high-performance to algorithms operating on multi-dimensional data arrays. The parallel vector processor unites its processing elements into a cohesive parallel processing unit to deliver massive power to such compute intensive applications as signal processing or dense equation solving.

Unified FORTRAN and C programs can take advantage of the parallel vector processor automatically, just as with the vector processor. For users with these kinds of applications, Cray Research Superservers provides a complete programming environment to develop and tune programs for as many processing elements as required.

Cray Research Superservers provides tools to integrate special programs into the heterogeneous server environment, making the parallel vector processor straightforward and easy to use.
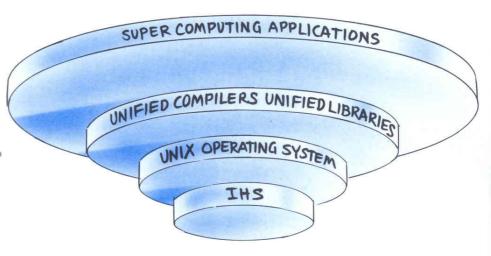
Vast Virtual Memory

The CRAY S-MP system's scalability in compute power demands scalability in memory architecture and capacity. Fully byte addressable, a four gigabyte per process virtual address space removes artificial memory constraints from large tasks. Physical memory in the CRAY S-MP system is configurable from as low as 64 megabytes up to the full four gigabyte address space. 64-way interleaving and one gigabyte per second bandwidth of the system interconnect ensure timely memory access to all processors.

High Performance I/O Systems

Given the processing power of the CRAY S-MP series, high speed I/O systems are necessary to support multiple users and prevent applications from becoming I/O-bound. With up to eleven VME subsystems, the CRAY S-MP series offers the industry's most popular IPI-2 disks, SCSI tape, and tape cartridge products. The VME subsystems can be combined through disk striping to provide extremely high-performance disk operations. VME also serves to provide Ethernet, FDDI, and UltraNet network capabilities.

Where there is a requirement for very high capacity and high transfer rates, the CRAY S-MP series supports HiPPI. Featuring 100 megabyte per second dual simplex channels, HiPPI serves as the platform for Cray Research Superservers disk array systems which may contain up to 256 gigabytes of disk storage. Transfer rates of up to 128 megabytes/second are available to service the most demanding applications.

The CRAY S-MP Series: Modular Design For Future Flexibility

The CRAY S-MP system's unique modularity allows in-field upgrades when needed. From a CRAY S-MP entry system featuring a single SPARC scalar processor with 67 MIPS performance, the system can grow with additional scalar, vector, and parallel vector units. The CRAY S-MP system's real memory can be expanded to four gigabytes, all with single module upgrades. With its modular design, the CRAY S-MP series has the flexibility to produce integrated:

- High-performance compute servers
- Powerful visualization servers
- High speed communications servers
- Terabyte capacity file servers

Systems of unprecedented power and interoperability, filling the gap between workstations and large scale computers.

Cray Research Superservers' Unified Software Environment offers easy access to high-performance computing. USE compilers automatically optimize code to use available processing power, and provide tools for developers to tune applications for highest performance. It provides top-to-bottom solutions for a wide range of computing applications.

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CRAY S-MP Specifications

Scalable Interconnect Architecture:
- 30 ns clock
- 1 GB/sec bandwidth
- Heterogeneous connectivity:
  - SPARC scalar processor
  - Vector processor
  - Parallel vector processor
  - Memory
  - HIPPI
  - Multiple VME

SPARC scalar processor:
- Scalable Processor ARChitecture (SPARC)
- 15 ns clock
- 64-bit data path, 67 MIPS
- Maximum of 8 scalar or 4 scalar/2 vector processors
- Independently upgradable

Vector/Parallel Vector processors:
- Up to two vector processors
- 30 ns clock
- Eight vector registers, 1,024 64-bit elements
- Special vector forms
- Up to two parallel vector processors
- 25 ns clock
- 4-84 Processing Elements (PEs) per processor
- 1, 3, 5, or 7 parallel vector busses
- 4, 8, or 12 PEs per bus

Memory:
- 64 MB to 4 GB real memory
- Multiple 267 MB/sec peak transfer paths
- 64-bit data transfers
- Memory interleaving
- 4 GB of virtual address space per process

Input/Output Systems:
- HIPPI (ANSI X3T9.3)
- VME (IEEE P014)
- IPI-2 disk interface
- SCSI tape interface

Unified Software Environment:
- UNIX Operating System compatible with SunOS
- Vector interface extensions
- Large memory extensions
- ANSI FORTRAN 77:
  - Automatic vectorizing/parallelizing
- VAX FORTRAN and Cray CFT77 FORTRAN compatibility
- ANSI vector/parallel C
- C++, Ada, Pascal
- Editors:
  - vi, EMACS, EDT
- VMS environment support
- System administration tools
- Application development tools
- Source level performance profilers
- Large application source level debugger
- Source code and revision control systems (SCCS and RCS)

Peripherals:
- HIPPI disk array
- Removable Storage Units:
  - IPI-2 disk drives
    - 1 GB, 3 MB/sec

- EXABYTE
  - 2.5 or 5.0 GB capacity
- Quarter-inch cartridge
  - 525 MB capacity
- High Performance Units:
  - IPI-2 disk drives
    - 1 GB, 6 MB/sec
  - 125 ips SCSI tape drives
    - 1,600/6250 bpi
    - 800/1,600/6,250 bpi
  - Half-inch tape cartridge
    - IBM 3480 compatible
    - IBM extensions

Communications and Networking:
- IEEE 802.3 Ethernet, TCP/IP, and DECnet
- FDDI
- NFS distributed file system
- Network Queueing Software
- HiPPI
- UltraNet

Graphics:
- X Window system
- OPENLOOK
- OSF/MOTIF
- Graphics libraries and programs
- Applications Visualization System (AVS)

Applications Software:
- Access to over 3,500 SPARCware industry-standard applications
- Popular compute-intensive UNIX-based software programs and utilities
- CRSMath applications-oriented math library