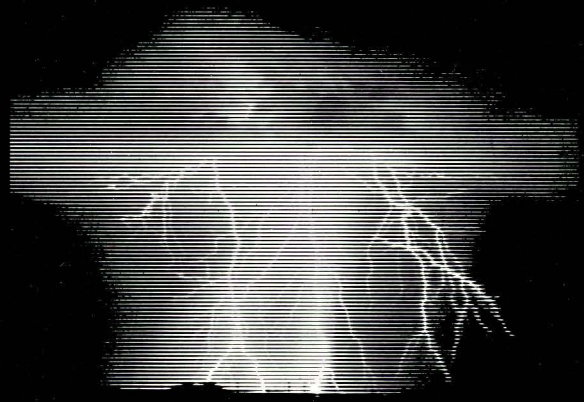
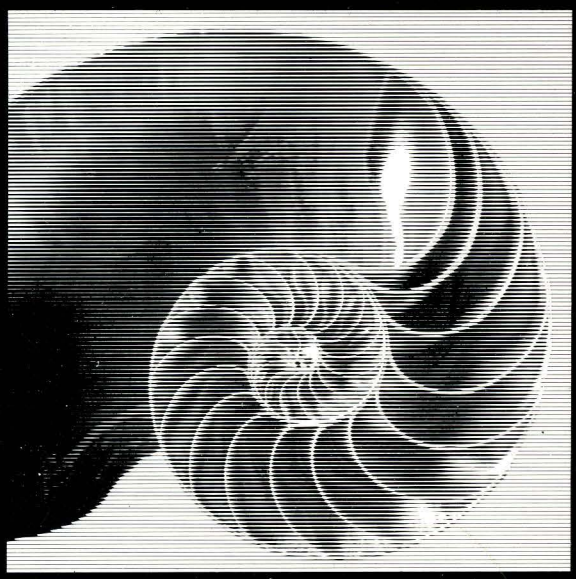
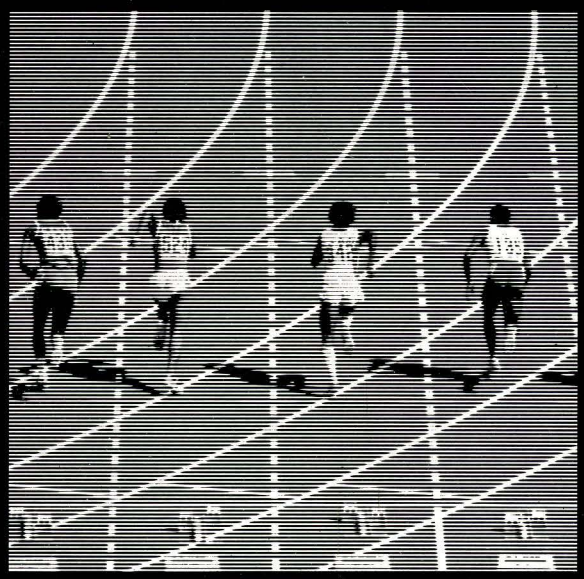
SPERRY

# Integrated Scientific Processor System







SPERRY

### *Answering Processing Demands . . . Solving the Most Pressing Problems*

The computing requirements of the scientific community are compelling: increasingly faster, more powerful systems are needed to help refine analysis to new plateaus. And to explore areas never before thought possible.

Sperry has a rich legacy of providing information processing solutions to scientific users . . . the proven SPERRY Series 1100 family of computer systems. In the past, SPERRY 1108 computers helped launch the manned space program in the 1960s.

Today, the most advanced Series 1100 systems are working in virtually every endeavor that requires high performance processing—among them energy exploration, research and development, linear programming, image processing, physical system simulation, structural analysis, and general and electrical engineering.

### *Scientific Performance Plus Commercial Information Processing*

Now, Sperry again sets new standards for scientific computer performance and architecture.

It's called the SPERRY Integrated Scientific Processor (ISP) System. Designed around the highly stable and successful SPERRY 1100/90 System, this completely *integrated* system efficiently executes scientific vector-oriented FORTRAN code.

And since it is a natural extension of one of the most powerful general purpose computer systems available—rather than an array processor or back-end processor—you get the outstanding performance of a supercomputer coupled with the rich program development and support environment of a mainframe.

With the SPERRY ISP there's no wasted time transferring data between the main processor and specialized parallel processors, keeping performance at peak levels.

All applications and program development software, including interactive screen editors, debugging aids, and database management systems available for the 1100/90 are supported in the SPERRY ISP System environment. Additionally, you don't sacrifice the ability to run commercial programs.

The SPERRY ISP System is the *one* computer system to handle your scientific-oriented research and analysis demands as well as business processing requirements. It is unique in its special properties and architecture.

### OS 1100 . . . A Single Point For Control

Designing a tightly coupled multiprocessing operating environment to oversee a system of this complexity is a major accomplishment, requiring years of industry-leading experience.

SPERRY OS 1100 is a premier example, having managed large multiprocessor configurations since the early 1970s with ease.

As your processing needs grow, the ISP System can keep pace. A basic Integrated Scientific Processing System includes a SPERRY 1100/91 Instruction Processor, and Input/Output processor, with one ISP and four million words of memory. Its design allows you to grow the configuration in logical steps as your needs dictate—to a maximum 1100/94 system incorporating two ISPs and 16 million words of memory—without obsoleting existing hardware.

And, of course, the Integrated Scientific Processor System offers the benefits you expect from Series 1100 computers—system Availability, Reliability, Maintenance support, and investment protection, combined with the evolutionary 1100 Operating System (OS 1100).

### A Common Set of Hardware

The SPERRY ISP System supports both high speed processing required by scientific programs and general purpose processing necessary for addressing commercial applications. This is possible because unlike other scientific processors which are viewed by the host computer as peripherals, the SPERRY ISP System is treated like a tightly coupled multiprocessing system.

Programs and data are accessed directly from memory without the need to cross over communication channels or interfaces found with other supercomputers. Once in memory, there is no need to reformat data, a process inherent in most host/supercomputer configurations. Nor is it necessary to manage the complicated interaction of several operating systems to complete a single job. OS 1100 does it all.

This integrated approach frees the ISP System to handle user application code exclusively. No system software executes on the Integrated Scientific Processor, thus full performance is delivered to user applications. The 1100/90 Instruction Processor handles all operating system functions such as scheduling, resource allocation and Input/Output operation for the ISP System.

You can now run vector-intensive applications that benefit from parallel computations such as reservoir modeling, physical system simulation, structural analysis and seismic processing, to name but a few. Additionally, support personnel familiar with the 1100/90 will have little difficulty maintaining the ISP, avoiding the problems associated with supporting various computers and multiple operating systems along with different sets of peripherals.

### Approaching Peak Performance

**Balancing Power**

Eliminating the slow link between host and supercomputer allows the Integrated Scientific Processor System to approach its peak performance more closely than any other supercomputer offering. You'll get more, higher quality work done in a shorter period of time. With the ISP, new approaches to problems can be explored, many that were not possible until now.

Consider this: the time from start to finish of a job running on an 1100/91-ISP can be six to nine times shorter than that required with a SPERRY 1100/91 system.

There are several contributing factors for this explosive performance increase.

As noted, a key innovation of the Integrated Scientific Processor System is shared storage with the host processor. The peak performance of a single SPERRY Integrated Scientific Processor System is 133 MFLOPS (Millions of Floating point Operations Per Second) in single precision (36-bit word) and 67 MFLOPS in double precision (72-bit word). Most significant, the ISP's high speed memory keeps pace with the arithmetic units, transferring data at 133 million words per second to each ISP.

The balance between CPU performance and memory bandpass ensures that the ISP can sustain performance in the 20 to 30 MFLOP range running double precision programs. Instruction mix and program vectorization will affect performance, yet for single precision programs one ISP executes nearly twice as fast and may exceed 40 MFLOPS. Two ISPs will double the sustained rate.

The positive impact of this balance is clearly evident when the overall time to complete a task is considered. When the time to input data and format results is included, the SPERRY ISP System is superior to other supercomputer systems. The ISP System completes jobs from start to finish quicker—while still providing all the benefits of a traditional mainframe environment.

### *The ISP in Detail*

The latest available technology forms the foundation for the Integrated Scientific Processor System, as it does with the SPERRY Series 1100/90 mainframes. Proven by the continually expanding 1100/90 customer base, the ISP design includes large scale integrated gate array circuitry and high performance packaging and interconnect techniques.

The SPERRY Integrated Scientific Processor Subsystem includes the Scientific Processor, the supporting Scientific Processor Storage Unit(s), an optional Multiple Unit Adapter (MUA) device used to preserve memory bandwidths in multiple storage unit configurations, and an Instruction Processor Cooling Unit (IPCU).

The system can range from one ISP, one 1100/90 Input/Output Processor (IOP) and one Instruction Processor (IP) to two ISPs integrated with four I/O Processors and four Instruction Processors.

The system's versatility can match virtually any processing mix. If added processing power is needed for program developmet or non-scientific applications more 1100/90 IPs are easily added. If Input/Output demands grow, additional IOPs can be configured. And when scientific processing loads expand a second ISP can be attached.

Memory may be increased in 4 MW stages to the total of 16 million words divided between MSU modules and the ISP storage units. A Scientific Processor Storage Unit can replace or complement a standard 1100/90 Memory Storage Unit (MSU); they appear identical to the 1100/90 Instruction Processor.

OS 1100 ensures that programs and data destined for execution in the Integrated Scientific Processor System reside in the Scientific Processor Storage Unit. However, programs running on the 1100/90 can address all available memory.

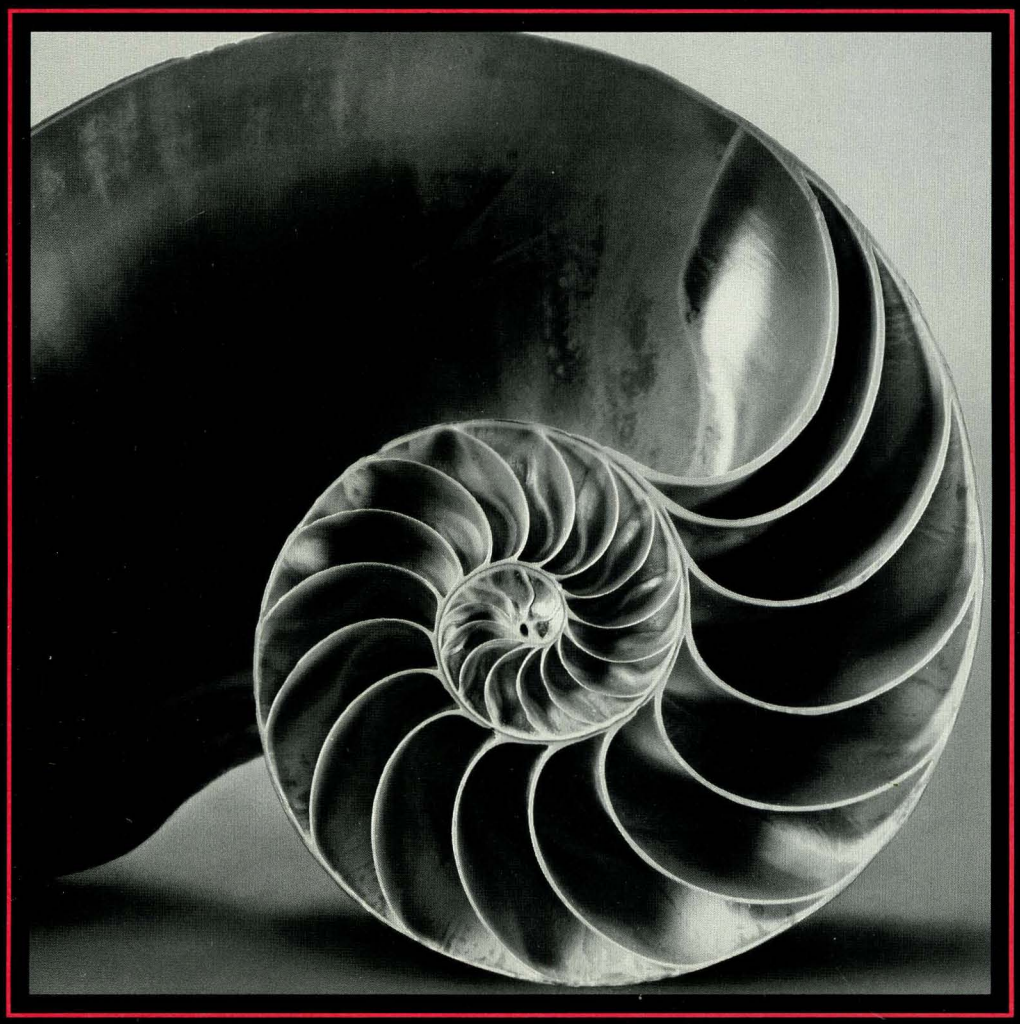
The ISP performs both high-speed floating point vector calculations and scalar computations. New architecture and extended instructions ensure continued high speed performance.

The architecture of the ISP vector module is based on the use of vector registers and pipelining. Working asynchronously in combination with the scalar unit the system can attain speeds surpassing what would normally be expected.

The varied and extensive vector instruction set performs the operations so crucial to scientific computations . . . in hardware. There is no need to depend on slower software implementations often encountered with some supercomputers.

### Integrated Scientific Processor System Highlights

- LSI Gate Arrays
- High Performance Packaging; Five time reduction in volume of electronics over previous Series 1100 systems
- 100% throughchecking
- Growth from 1100/91 with one ISP to 1100/94 including 2 ISPs
- One common, proven multi-processor operating system
- Scientific Processor is dedicated to running scientific code; 1100/90 handles all I/O and support functions



### *Scientific Processor Storage Unit*
**Servicing Different Requests**

All system storage, to the maximum 16 million words, is directly addressable by the Integrated Scientific Processors . . . and the 1100/90 Instruction and Input/Output Processors.

Contained in free-standing units of 4 MW, each of the eight banks can simultaneously service different requesters. Data transfer to and from a SPSU can occur at a maximum rate of 355 million words per second. 1100/90 Instruction and I/O Processors require, at maximum, a bandpass of 15 million words/second, while each ISP requires a bandpass of 133 million words per second. As such, each SPSU can support multiple processors with bandpass in reserve.

**Scientific Processor Storage Unit Highlights**

- Memory expansion from 4 MW to over 16 MW
- Can replace or complement standard 1100/90 main storage units
- Provides high bandwidth required to support scientific and general purpose processors.

### *Multiple Unit Adapter*
**The Means For Growth**

The Multiple Unit Adapter is used when two or more Scientific Processor Storage Units are placed in the system. It permits the ISP to access the extended memory.

One Multiple Unit Adapter supports up to four Scientific Processor Storage Units. Two adapters are required when two Integrated Scientific Processors are placed in the system.

**Multiple Unit Adapter Highlights**

- Allows ISP to address more than one scientific processor storage unit
- One MUA can be configured with one ISP and up to four scientific processor storage units.

### *The Highest Level of Software Support*

The SPERRY Integrated Scientific Processor System offers true innovation in system software to match the advances in hardware architecture.

In addition to managing all software normally available to commercial mainframe users, SPERRY OS 1100 controls a powerful, vector-oriented FORTRAN compiler specifically designed to take full advantage of the ISP. Several supporting utilities, such as state-of-the-art automatic vectorization software allow you to extend the power of the ISP.

### *All Operating System Functions Execute on the 1100/90 CPU*

With the Integrated Scientific Processor System, all data and operating system capabilities are instantly available to both the 1100/90 and ISP. But this is transparent to you; OS 1100 handles all the details including scheduling, resource allocation, and I/O.

To the programmer, using the Integrated Scientific Processor System is no different from running on the 1100/90. He or she targets execution with a simple compiler option. The operating system directs code to the Integrated Scientific Processor System without further intervention. To OS 1100, the ISP is just an additional processor.

The new SPERRY Linking System lets you unite separately compiled FORTRAN subroutines into one unified program. You can also link subprograms compiled for the Integrated Scientific Processor System to subprograms designed for the 1100/90, permitting the most efficient execution. Again, no special attention is required; the Linking System attends to all the details.

Integrating the ISP with the 1100/90 allows you to use all of Sperry's mature software tools with programs that execute in the Integrated Scientific Processor System. One system handles the design, testing, and debugging of FORTRAN application programs, monitors system usage as needed, and provides run-time support.

Scientific applications encompass tremendous amounts of code and data. Through the 1100/90's extended addressing mode total addressing space of up to 64 billion words is available, of which 16 million words are addressable at any time.

### *SPERRY Universal Compiling System, UCS FORTRAN*

**The Source of Power**

The SPERRY Universal Compiling System eliminates the dependence on machine-specific language compilers. As a result, the *identical* program development environment is supported on any machine which supports the UCS environment. For instance, the same UCS FORTRAN syntax is used on the 1100/90 IP and ISP. This compatible development environment can extend across product lines, and eliminates any problems caused by incompatible FORTRANs on host and supercomputer.

UCS FORTRAN (UFTN) is one high level programming language component of the Universal Compiling System. UFTN includes many array handling features to meet the demands of scientific processing. It is a full implementation of FORTRAN 77, and includes many enhancements that have been proposed for future levels of FORTRAN. The extensions aid in denoting vector operations, making it easier for the compiler to generate efficient machine code, and for the user to translate parallel algorithms to programming language.

The compiler also enhances program performance by detecting parallelism in the source program and generating object code that uses the Integrated Scientific Processor System's vector registers and vector instructions.

However, the UFTN compiler does more than implement array extensions. It also optimizes the object code for even more efficient operation on the Integrated Scientific Processor System.

Through a compiler option you can specify where the code will execute: on the 1100/90, the Integrated Scientific Processor System, or split between both, for optimum performance.

### *UCS FORTRAN Vectorizer*

You don't need to specifically code programs using FORTRAN array extensions to take advantage of them. The Vectorizing preprocessor (UVEC) examines FORTRAN source codes and converts them to more efficient array structures. Wherever possible the Vectorizer replaces scalar syntax with array syntax.

The Vectorizer looks at your FORTRAN source program for parallelism in DO loops and:

- Automatically replaces DO loops with array extensions. It may also restructure the code to increase detected parallelism.
- If DO loops cannot be converted, the Vectorizer prints a message indicating the problem. The message may indicate that program alterations can lead to increased vector processing.

The Vectorizer reduces system overhead by analyzing for parallelism without the need for program compilation. The system also outputs the "vectorized" source code in an easily-readable format that aids understanding of the new statements. Using system-generated examples, users will soon be able to incorporate array extensions into program on their own.

### *EML—Extended Math Library*

The Extended Math library includes functions and subroutines widely used by the scientific community beyond those provided with the FORTRAN compilers, including the BLAS (Basic Linear Algebra Subroutines).

Many of the routines have the same name as those found in the public domain or on other computer systems, but the Sperry implementations have been optimized for the 1100/90 and ISP.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All routines may be executed on the 1100/90 IP or the ISP. Some routines running on the ISP are available in assembly language versions which are included to further increase execution speed.

The EML offers:

- Fast Fourier Transforms (FFTs)
- Convolutions
- Correlation routines
- Solution to the Wiener-Levinson equation
- Geophysical calculations
- BLAS (Basic Linear Algebra Subroutines)

### *Development and Debugging Aids*

**MASP—Meta Assembler for Scientific Processor**

This extension of the 1100/90 Meta-Assembler allows you to write critical code sections in efficient machine code for execution on the Integrated Scientific Processor System.

**PEER—Performance Execution Evaluation Routine**

PEER uses statistical sampling and analysis to determine the amount of scalar versus vector processing occurring in a program. PEER pinpoints the routines requiring the most processing time so you can optimize those subroutines which yield the highest performance gain first.

The Programmer's Advanced Debugging System (PADS) and FLIT (Fault Location by Interpretive Technique) are also available in support of the Universal Compiling System to debug ISP code.

### *In Summary*

The SPERRY Integrated Scientific Processor, working in concert with the proven and reliable SPERRY 1100/90 computer, gives you all the benefits of traditional commercial mainframe computing while executing scientific applications with the performance of a supercomputer.

The ISP System incorporates the Availability, Reliability, and Maintainability features that have made the SPERRY Series 1100 renowned for several generations. The Integrated Scientific Processor System, storage, and associated interfaces all have 100 percent throughchecking on their data paths, as well as error detection/correction, to ensure reliable operation.

The entire system operates under control of one operating system—OS 1100. As such, tasks are directed to the different processors of this multiprocessing system—the ISP or 1100/90 processor—to deliver the highest performance possible. Included is a rich collection of development and support software specifically designed to operate in the scientific environment.

Backing the entire Integrated Scientific Processor System is the acclaimed Sperry worldwide support organization, with the full resources of Sperry, a $5 billion electronics and defense company to call upon.


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