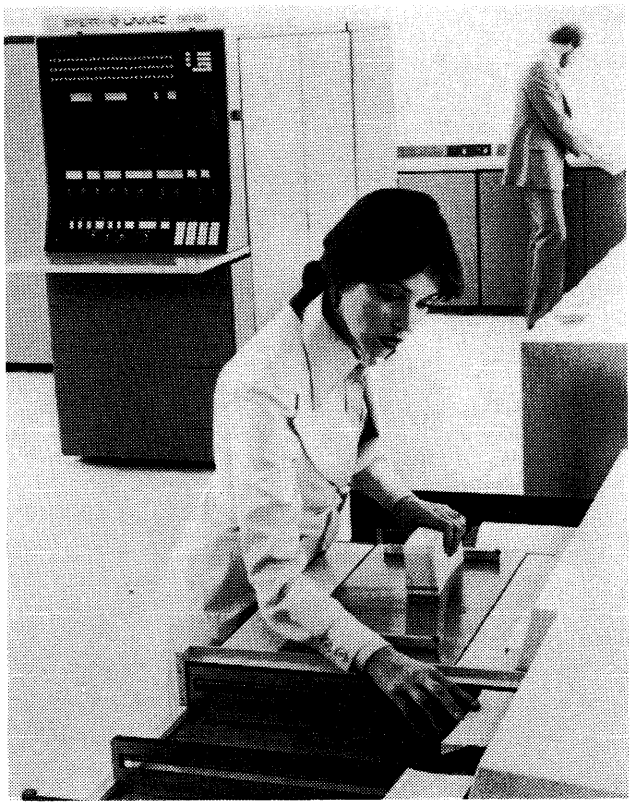
Sperry Univac 90/60 and 90/80



The Sperry Univac 90/80 computer system is available in three models: the 90/80-2, 90/80-3, and 90/80-4. The performance level of the 90/80-2 is about 25 percent less than that of the 90/80-3. The 90/80-4 is a high-performance model that includes a high-speed buffer memory and provides about 35 percent greater performance than the 90/80-3.

MANAGEMENT SUMMARY

The Series 90 family of computer systems was introduced in 1973 to provide an upward growth path for users of Sperry Univac's 9000 Series and Series 70 systems. The original Series 90 model, the 90/70, is no longer marketed. The 90/60, initially a scaled-down version of the 90/70, now offers the same memory capacity and processor speed as the 90/70. The 90/60 is still actively marketed, but it is no longer in new production.

Introduced in 1976, the 90/80 is the largest member of the Series 90 family. It provides a growth path from the 90/60, 90/70, and large-scale Series 70 systems, and also competes with the IBM 370/158 and 3031 processors.

In a move designed to provide upward compatibility between the byte-oriented Series 90 systems and the word-oriented Series 1100 systems, Sperry Univac announced the 1100/60 Attached Virtual Processor (AVP) in October 1980. The 1100/60 AVP is a special-purpose CPU that enables execution of applications written for the Series 90 VS/9 operating system concurrently with applications written for the OS 1100 ➢

The 90/60 and 90/80 computer systems are the largest members of Sperry Univac's Series 90 family of byte-oriented, IBM-compatible computers. The 90/60 provides from 512K to 2048K bytes of main memory. Memory capacity on the 90/80 ranges from one million to eight million bytes. The VS/9 virtual memory operating system supports concurrent processing, interactive processing, and data communications. The 90/60 and 90/80 systems offer performance equivalent to the IBM 4331, 4341, and 3031 processors.

CHARACTERISTICS

MANUFACTURER: Sperry Univac Division, Sperry Corporation, P.O. Box 500, Blue Bell, PA 19424. Telephone (215) 542-4011.

MODELS: Sperry Univac 90/60, 90/80-2, 90/80-3, and 90/80-4. The 90/70 and the original 90/80 are no longer marketed.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 decimal digits, or 8 binary bits. Two consecutive bytes form a 16-bit "halfword," four consecutive bytes form a 32-bit "word," and eight consecutive bytes form a 64-bit "doubleword."

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; 1 halfword (16 bits) or 1 word (32 bits) in binary mode. Certain operations use a doubleword (63-bit integer field plus sign) in binary mode.

FLOATING-POINT OPERANDS: Standard floating-point hardware provides for addition, subtraction, multiplication, division, loading, storing, and sign control of short or long format operands. The short format provides 24-bit precision and is represented by one word, which uses bit 0 for the sign, bits 1 through 7 for the exponent, and bits 8 through 31 for the fraction. Long format is represented with a doubleword which provides 56-bit precision; the long format is similar to the short format except that the fraction is contained in bit positions 8 through 68. A guard digit is carried by the hardware for intermediate "place holding" during addition/subtraction, multiplication, comparison, and halving. Extended-precision floating-point is available only on the 90/80.

INSTRUCTIONS: 2, 4, or 6 bytes in length, specifying 0, 1, or 2 main storage addresses, respectively.

INTERNAL CODE: EBCDIC or ASCII, depending upon setting of a mode bit in the program status word by certain processor instructions. The processor is sensitive to zone fields and edit control characters.

MAIN STORAGE

STORAGE TYPE: MOS (metal oxide semiconductor).

CAPACITY: 90/60—from 512K to 2048K bytes in 7 sizes: 512K, 768K, 1024K, 1280K, 1536K, 1792K, or 2048K bytes. ➢

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operating system. Several VS/9 software products, including IMS, have been modified for use with the 1100 Series. In addition, a series of programs are available to facilitate conversion from VS/9 to OS 1100.

PROCESSORS AND PERIPHERALS

The 90/60 processor offers an instruction repertoire that includes the complete IBM 360/50 set of instructions. Architectural features include Dynamic Address Translation, writeable control storage, and MOS main memory. Minimum main memory is 512K bytes, expandable to 2048K bytes. The processor cycle time is 200 nanoseconds.

The 90/80 system is available in three models: the 90/80-2, 90/80-3, and 90/80-4.

The entry-level 90/80-2 system includes a 130-nanosecond CPU with 1024K bytes of main memory, a peripheral processor with one 183-KBS byte multiplexer and four 1500-KBS block multiplexer channels, system console, power distribution panel, and motor/alternator. Main memory is expandable to 2048K bytes, and the I/O subsystem is expandable to 16 channels through the addition of an F2011-00 interface extender. The peripheral processor provides 240 block multiplexer subchannels in the basic system and up to 496 subchannels in the expanded configuration. The 90/80-2 can be upgraded to 90/80-3 status using the F2756-01 upgrade kit.

The 90/80-3 is nearly identical to the 90/80-2, differing only in processor cycle time and memory capacity. This higher-performance version features a machine cycle time of 98 nanoseconds, providing about 30 percent more internal performance than the 90/80-2. The basic 90/80-3 configuration includes the CPU with 2048K bytes of main memory, expandable to 4096K bytes, a peripheral processor with one 183-KBS byte multiplexer and four 1500-KBS block multiplexer channels, system console, power distribution panel, and motor/alternator. Like its smaller counterpart, the I/O subsystem for the 90/80-3 is expandable to 16 channels through the F2011-00 interface extension.

The basic 90/80-4 system includes the 98-nanosecond CPU, 2048K bytes of main memory, a five-channel group consisting of one byte multiplexer channel and four block multiplexer channels, a 32K-byte high-speed buffer, and a system console. Memory is expandable to 8192K bytes in 2048K-byte increments. The I/O subsystem can be expanded by adding up to three additional block multiplexer channels.

The 90/80 systems are designed around two processors, an Instruction Processor and a Peripheral Processor, each with separate processing capabilities.

The Instruction Processor is the processing and control portion of the 90/80 system. It contains the sequencing

90/80-2—1024K or 2048K bytes. 90/80-3—2048K, 3072K, or 4096K bytes. 90/80-4—2048K, 4096K, 6144K, or 8192K bytes.

CYCLE TIME: 600 nanoseconds per 4-byte access in the 90/60; 490 nanoseconds per 8-byte access in the 90/80. The 90/80-4 also features odd/even interleaving; eight bytes are fetched from each of two banks on each memory cycle.

HIGH-SPEED BUFFER: The 90/80-4 contains a 32K-byte buffer made up of bipolar memory with an access time of 55 nanoseconds. The buffer is organized in two 16K-byte sections, one for instructions and one for operand data. On memory store operations, data is automatically written through to memory.

CHECKING: In all models, a single-bit error-correcting, double-bit error-detecting code is appended to each 32-bit word. Upon reading each word from memory, single-bit errors are automatically corrected and transferred, while multiple-bit errors are detected and flagged for appropriate program action.

STORAGE PROTECTION: The standard storage protection feature uses 16 keys to provide read and/or write protection for 2048-byte blocks of storage. An interrupt is generated whenever a read or write instruction is attempted in an unauthorized storage location. Storage protection is also provided through the virtual address structure, which does not allow users to map into each other's address space.

RESERVED STORAGE: The first 604 bytes of main storage in the 90/60 and the first 1024 bytes in the 90/80 are reserved to hold specific operating information.

CENTRAL PROCESSORS

REGISTERS: The programmer has access to sixteen 32-bit general registers that are used for indexing, base addressing, and as accumulators. (A second full set of 16 registers is used by the operating system.) Four double-word floating-point registers are standard.

DYNAMIC ADDRESS TRANSLATION: This feature, standard in all 90/60 and 90/80 central processors, translates virtual storage addresses into real main memory addresses as each instruction is executed. The DAT feature incorporates a Translation Lookaside Buffer (TLB) consisting of eight 32-bit registers in the 90/60 and thirty-two 32-bit registers in the 90/80. Addresses are 24 bits in length, and include a 4-bit block designator, a 4-bit segment designator, a 4-bit page designator, and a 12-bit displacement designator.

The total addressable virtual memory space is 8,388,608 bytes, organized into a hierarchy of blocks, segments, pages, and bytes. A page consists of 4,096 bytes, one segment includes 16 pages, one block contains 16 segments, and the entire addressable virtual memory space comprises 8 blocks. Block, segment, and page tables are maintained in main storage for each executing program, the contents of which are used to construct physical main memory addresses for each instruction.

The TLB maintains the real page addresses for the eight most recently referenced pages, all of which can be examined concurrently within 30 nanoseconds. If a "TLB hit" occurs (in which the block, segment, and page designators of the instruction match a real page address in the TLB), the TLB page address is concatenated with the instruction's 12-bit displacement address to form the required real main memory address.

The DAT uses a three-table look-up procedure to develop real page addresses for instructions that are not found in

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Sperry Univac 90/60 and 90/80

CHARACTERISTICS OF THE UNIVAC 90/60 AND 90/80 SYSTEMS

	90/60	90/80-2	90/80-3	90/80-4
SYSTEM CHARACTERISTICS				
Date of introduction	October 1973	October 1977	October 1977*	May 1978
Principal operating system	VS/9	VS/9	VS/9	VS/9
Relative performance level	1.00	2.60	3.50	4.80
Monthly rental, basic system**	$8,289	$21,802	$27,852	$26,544
Monthly maintenance, basic system	$1,391	$2,669	$3,432	$3,709
MAIN STORAGE				
Type and Size	4K MOS	16K MOS	16K MOS	16K MOS
Cycle time, nanoseconds	600	490	490	490
Bytes fetched per cycle	4	8	8	8
Interleaving	No	No	No	2 to 1
Minimum capacity, bytes	524,288	1,048,576	2,097,152	2,097,152
Maximum capacity, bytes	2,097,152	2,097,152	4,194,304	8,388,608
Increment size, bytes	262,144 or 524,288	1,048,576	1,048,576	2,097,152
Error correcting	Yes	Yes	Yes	Yes
HIGH-SPEED BUFFER	None	None	None	Yes
Type	—	—	—	Bipolar
Cycle time, nanoseconds	—	—	—	150
Capacity, bytes	—	—	—	32,768
PROCESSING UNIT				
Cycle time, nanoseconds	200	130	98	98
Floating-point arithmetic	Yes	Yes	Yes	Yes
Extended floating-point arithmetic	No	Yes	Yes	Yes
Decimal arithmetic	31 chars. max.	31 chars. max.	31 chars. max.	31 chars. max.
Programmable registers:				
User-programmable	16	16	16	16
Executive use only	16	16	16	16
Floating-point	4	4	4	4
Instruction repertoire:				
Non-privileged 9400/9480	Yes	Yes	Yes	Yes
Non-privileged Series 70	Yes	Yes	Yes	Yes
Non-privileged IBM System/360	Yes	Yes	Yes	Yes
Non-privileged IBM System/370	No	Yes	Yes	Yes
Total instructions	144	154	154	154
Dynamic Address Translation (DAT):				
Type***	TLB	TLB	TLB	TLB
Translation time, nanoseconds (assumes DAT hit)	32	32	32	32
No. of page entries	8	32	32	32
Range of memory covered by DAT	32,768	131,072	131,072	131,072
I/O CONTROL				
No. of channels per system, maximum	6	8	8	8
Aggregate data rate, bytes per second	5,700,000	8,000,000	8,000,000	8,000,000
High-speed channels:				
Type of channel	Selector	Block mux.	Block mux.	Block mux.
No. of high-speed channels	1-5	4-7	4-7	4-7
No. of subsystems per channel	8	8	8	8
Data rate, bytes per second	1,100,000	1,500,000	1,500,000	1,500,000
Byte multiplexer channels:				
No. of subsystems	8-16	8-16	8-16	8-16
No. of subchannels	15-63	256	256	256
Data rate, bytes per second	175,000	183,000	183,000	183,000

*Original 90/80 computer was introduced in June 1976 and was equivalent in performance to the 90/80-3.
**One-year lease.
***TLB = Translation Lookaside Buffer.

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and controls for interrupt action, timing facilities, initial program loading, and instruction execution.

The microprogrammed Peripheral Processor provides the input/output processing facilities for the 90/80. This design frees the Instruction Processor from handling input/output processing, thereby gaining the efficiencies of specialized design as well as the added benefits of distributing the central processing workload.

Sperry Univac offers a wide variety of peripheral equipment for the 90/60 and 90/80 systems. Mass storage devices include the 8405 Fixed-Head Disk, with a storage capacity of 3.1 or 6.2 megabytes; the 100-megabyte 8430 Removable Disk Subsystem; the 200-megabyte 8433 Removable Disk Subsystem; and the 8450 Dual Disk Drive, a fixed-media unit with a capacity of 307 megabytes. The 90/60 and 90/80 systems support the Uniservo 14, Uniservo 16, Uniservo 22/24, and Uniservo 30 Series magnetic tape drives. Card readers and band printers are also available for use with the 90/60 and 90/80 systems.

Communications capabilities are provided through the Multi-Channel Communications Controller (MCC), which supports up to 128 half-duplex or 64 full-duplex communications lines. The MCC has a peak throughput capacity of 25,000 characters per second and can concurrently support up to eight different line speeds ranging from 45 to 56,000 bits per second.

SOFTWARE SUPPORT

The principal operating system for the 90/60 and 90/80 systems is VS/9, a virtual memory operating system that offers functional capabilities for concurrent processing, data communications, and interactive processing. VS/9 provides file management capabilities, reliability and recovery capabilities, and accounting functions.

Communications support is provided by the Virtual Integrated Communications Access Method (VICAM). VICAM is a set of generalized software components that provide a wide range of functions for user applications. A set of prescribed procedures in the form of macro instructions affords the user an interface to remote devices and message files.

Information management capabilities are provided by DMS/90, a generalized data base management system based on CODASYL specifications, and IMS/90, an on-line storage and retrieval system.

Available programming languages include COBOL, FORTRAN, BASIC, RPG II, and Assembler. A Virtual Memory Editor (EDT) can be used for modifying source-language programs stored in VS/9 files in sequential or indexed sequential format.

COMPETITIVE POSITION

The 90/60 system is comparable in performance to the IBM 370/138, IBM 4331 Group 1, and Honeywell Series

the TLB. The block, segment, and page designators in the instruction point to locations in the block, segment, and page tables maintained in main memory by the operating system for each program. The translation process requires between three and four main storage cycles to generate a real address.

CONTROL STORAGE: In addition to main storage, a fast writeable control storage is available for the micro-programs used to support integrated emulation, floating-point hardware, microdiagnostics, and the native-mode instruction set. The floating-point hardware is included in the basic prices. The cycle time of this separate MOS memory is 80 nanoseconds per 72-bit word access. Data is loaded into the writeable control storage via a cassette prepared by Sperry Univac support personnel. An additional control storage module is available to support SMOOTH.

INSTRUCTION REPERTOIRE: In the 90/60, all 132 nonprivileged instructions of the IBM System/360 instruction set are provided. Also included are an add immediate instruction, an emulation aid instruction, and floating-point instructions. The standard instructions handle fixed-point binary arithmetic, decimal arithmetic using variable-length operands in packed formats, packing and unpacking, radix conversion, editing, loading, storing, comparing, shifting, branching, and logical operations, as well as instructions for handling ASCII or EBCDIC characters.

The 90/80 system native instruction set is upward-compatible with the 90/60 instruction set. In addition, the 90/80 native instruction set includes all nonprivileged instructions of the IBM System/370 universal instruction set, plus extended floating-point capabilities and instructions unique to the 90/80 system.

INSTRUCTION TIMES: All times are for register-to-indexed-storage (RX) instructions, except where indicated, and are estimated in microseconds.

	90/60	90/80-2	90/80-3	90/80-4
Binary add/subtract (32 bits):	2.10	1.27	0.96	0.58
Floating-point add/subtract (short):	6.18	4.32	3.25	2.95
Floating-point multiply (short):	12.20	6.15	4.62	4.41
Floating-point divide (short):	29.10	15.42	11.58	11.19
Floating-point add/subtract (long):	6.83	5.23	3.94	3.55
Floating-point multiply (long):	35.60	22.58	16.87	16.75
Floating-point divide (long):	72.15	30.18	22.65	22.35
Add decimal (10-digit packaged data)*	16.20	8.47	7.76	6.52
Compare decimal (10-digit packed data)*	15.90	5.07	4.06	3.63
Pack decimal (10 digits)*	22.50	6.41	5.22	4.23
Branch on condition	1.20	0.67-1.15	0.40-0.84	0.26-0.53
Load (32-bit binary)	2.10	1.22	0.92	0.55
Store (32-bit binary)	2.40	1.37	1.07	0.63
Load multiple (six 32-bit registers)	7.50	2.54	2.13	1.77
Move (16 bytes)*	11.70	3.58	3.01	2.17
Compare (16 bytes)*	15.30	3.62	2.97	2.50

*Storage-to-storage instructions.

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60 Level 64 processors. The 90/80-2 is competitive with the Digital Equipment DECsystem 1060 and the NCR V8575 systems, while the 90/80-3 competes with the Digital Equipment DECsystem 1090 and DECSYSTEM 2050, the IBM 370/158 and 4341, and the NCR V8585. The 90/80-4 falls within the performance range of Sperry Univac's 1100/61 H1, IBM's 3031, and Burroughs' 6817 systems.

USER REACTION

Eighteen users of Sperry Univac's 90/60 and 90/80 systems responded to Datapro's 1981 survey of general-purpose computer users. Out of a total of 19 CPU's, 7 were 90/60's and 12 were 90/80's. The average life of the 90/60 systems was 45.7 months. The 90/80 systems had been installed for an average of 15.5 months.

We asked the users to check off, from a list provided, the significant advantages of their systems and any significant problems encountered. The 90/60 and 90/80 systems received 65 specific mentions of advantages and 11 mentions of problems. The most frequently cited advantages, mentioned by 12 users each, were: "users are happy with response time," "system is easy to expand/reconfigure," "programs/data carried over from other systems are compatible, as vendor promised," and "productivity aids help us keep costs down." The only problem mentioned by more than two users was "vendor enhancements/changes to hardware/software hard to keep up with," which was cited by three users.

The table below summarizes the users' ratings of the 90/60 and 90/80 systems:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	7	9	2	0	3.3
Reliability of mainframe	10	6	2	0	3.4
Reliability of peripherals	2	12	4	0	2.9
Maintenance responsiveness	8	8	1	1	3.3
Maintenance effectiveness	3	10	4	1	2.8
Technical support:					
Trouble-shooting	5	8	5	0	3.0
Education	2	7	8	1	2.6
Documentation	1	10	7	0	2.7
Operating system	11	5	2	0	3.5
Compilers & assemblers	7	10	0	1	3.3
Applications programs	1	8	4	1	2.6
Ease of programming	5	13	0	0	3.3
Ease of conversion	5	10	3	0	3.1
Overall satisfaction	3	13	2	0	3.1

*Weighted Average on a scale of 4.0 for Excellent.

To obtain additional input from the survey respondents, we interviewed four of them in April 1981. One of these users had a 90/60 system, two had 90/80-2 systems, and one had a 90/80-3 system.

The 90/60 system, which was installed in 1975, was being used by a Southwestern service bureau that had converted from an IBM 370/115. The user said the conversion went "very smoothly," and commented that the

The above instruction timings have been calculated assuming no channel interference. Instruction timings for the 90/80-4 also assume a 90-percent buffer storage hit rate.

EMULATION: Emulation features are available for IBM System/360 and 370 DOS and for Sperry Univac Series 70 TDOS and DOS through the Spectra Mode of Operation (SMOOTH) hardware.

CONSOLE: The 90/60 system console consists of a keyboard with operator controls and a Uniscope 100 CRT display unit. The standard mode of operation provides for display of messages on the CRT screen; hard copy is provided by the console printer as an optional feature under VS/9, but is required for operation under OS/4. Under VS/9, those error messages which are printed on the console printer with OS/4 are written on direct-access storage for subsequent high-speed printing at the system manager's convenience. The hard-copy console printer operates at up to 30 cps and connects to the processor via the multiplexer channel; it uses one physical controller connection on the multiplexer. The system console can be switched by the multiple channel switch to operate on a selector channel for diagnostic purposes if required.

The 90/80 system console consists of a keyboard, a Uniscope 200 CRT 1920-character display unit, switches, and indicators housed in a cabinet that is separate from the peripheral processor. The system console communicates with the processor through the byte multiplexer channel, and includes all controls and indicators necessary to operate and monitor the operation of the system. The operator controls consist of an alphanumeric typewriter keyboard, cursor control keys, editing keys, control keys, and indicators.

As an optional feature, an incremental printer can be connected to the 90/80 system console to provide additional hard-copy output. It can be used to duplicate messages displayed on the visual display screen and to log informative messages that need not be displayed or responded to. The incremental printer, mounted in a separate cabinet, has a 96-character set (including upper case and lower case) and a 132-position print line, prints up to 200 characters per second, and has a paper feed rate of 30 lines per second.

INPUT/OUTPUT CONTROL

I/O CHANNELS: The basic *90/60* Processor has one standard multiplexer channel. It can physically connect up to 7 low-speed systems and a multi-channel communications controller (MCC) for a total of 15 subchannel addresses. Two subchannel expansion features provide an expansion capability of addressing up to 63 subchannels. The maximum aggregate multiplexer channel transfer rate is 175,000 bytes per second.

One selector channel is standard on the 90/60, and four additional selector channels can be added. The second selector channel is housed in the processor cabinet, and the third, fourth, and fifth require the channel expansion cabinet.

A Direct Control feature is available as an option supported by the user's own code. It is used to provide a special interface between two 90/60 or 90/80 processors and includes two instructions for transfer of control information between the processors.

The Peripheral Processor provides the I/O processing facilities for the *90/80* system. It permits a maximum of eight I/O channels. The minimum 90/80 system includes one

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VS/9 text editor automated much of the conversion process. This user also stated that the 90/60 provided considerable room for growth without software modifications. He summarized his experience with the 90/60 by saying, "If I had it to do over again, I would."

A Midwestern publishing firm had been using a 90/80-2 since January 1980. The system replaced a Sperry Univac Series 70 computer, and no special conversion problems were encountered. The user indicated that he was well satisfied with the 90/80-2 and would recommend it to others.

An Eastern manufacturer installed a 90/80-2 system in August 1979. The Sperry Univac system had replaced an IBM System/360. The user said the conversion "was a lot of work, but there were no special problems." This user planned on upgrading to a Sperry Univac 1100/60 system, but did not intend to add the 1100/60 Attached Virtual Processor. He had decided to convert his VS/9 programs to OS 1100 right from the beginning.

The fourth user interviewed represented a large university that had installed two 90/80-3 processors in 1980. This user said that he had experienced no problems with the hardware, but he would not recommend the 90/80 system because he thought the VS/9 operating system was "obsolete." He said the operating system "does not utilize the hardware as well as it should."

Of the 18 survey respondents, 11 said they would recommend their 90/60 or 90/80 system to others, 5 said they would not recommend the system, and 2 were undecided. Most of the users who said they would not recommend the system cited obsolescence as the primary reason. One user, however, had just installed his 90/80 system in February 1981 and felt it was too soon to fully evaluate the system.□

byte multiplexer channel and four block multiplexer channels. The maximum number of byte multiplexer channels is two per peripheral processor. The maximum number of block multiplexer channels is six, unless the second byte multiplexer channel is not selected; in this case, up to seven block multiplexer channels may be configured. Each block multiplexer channel has eight physical connections to which control units can be attached.

Data transfers between a 90/80 block multiplexer channel and main storage are 8-byte parallel. A block multiplexer channel, in conjunction with a control unit designed for block multiplexer operation, can disconnect and reselect devices between transfers of blocks of data within command chains. This operation permits concurrent execution of channel programs for several devices on one channel by multiplexing blocks of data. This capability applies only to nonshared subchannels of the block multiplexer channels; i.e., only one device is assigned per subchannel.

Subchannel storage in the 90/80 peripheral processor is pooled for block multiplexer channels and is expandable from the basic 240 subchannels up to 496 subchannels through the subchannel storage expansion feature. The subchannel storage pool provides 16 shared subchannels and 224 nonshared subchannels, expandable up to 480. Shared subchannels are assigned to devices at installation time. Nonshared subchannels are dynamically assigned as I/O operations are being initiated. Operations for which no subchannel storage is available are initiated and executed as if to a selector channel.

When operating with a shared subchannel, the channel does not disconnect for command chaining as is the case with the selector channel. However, when ending status is presented, the channel disconnects and becomes available to other channel devices. When the pool of nonshared subchannels has been exhausted or the block multiplexing control bit in control register 0 is zero, and a START-I/O instruction is executed on the block multiplexer channel, the channel operates as a selector channel. The channel remains busy until the pending interrupt conditions are accepted by the instruction processor.

The 90/80 peripheral processor has one byte multiplexer channel provided with the basic system configuration. A second byte multiplexer channel can be added. Each byte multiplexer channel has eight physical connections to which standard control units (for such devices as a card reader, card punch, or line printer) and a multichannel communications controller can be attached. The number of physical connections to each byte multiplexer channel can be expanded to 16. Each byte multiplexer channel provides 256 nonshared subchannels, 128 for communications devices. The byte multiplexer has two modes of operation: multiplexer and control-unit-force-burst. In the multiplexer mode, the channel facilities are shared by a number of concurrently operating I/O devices, with the I/O interface being assigned to a control unit only long enough to transfer one byte of data. Upon completion of this data exchange, the I/O interface is available to another control unit requesting service, with this operation continuing until all units requesting service have been serviced. The operation repeats itself until all units are completely serviced. In the control-unit-forced-burst mode, the control unit stays connected to the I/O interface until normal termination is signaled by the control unit for the device (i.e., until the byte count goes to zero or the end of the record is detected). Data transfers between a byte multiplexer channel and main storage are 4-byte parallel.

CONFIGURATION RULES: On the 90/60, high-speed peripheral devices (tape and disk drives) must be connected to a selector channel. Up to eight control units can be connected to each selector channel, and up to 8 or 16 drives can be connected to each control unit. Low-speed devices, including the multi-channel communications controller, card readers, line printers, and the system console, are normally connected to the multiplexer channel, which can accommodate up to 16 control units and 63 subchannel addresses.

On the 90/80, high-speed peripheral devices must be connected to a block multiplexer channel, and low-speed devices to a byte multiplexer channel. Each block multiplexer channel connects up to eight high-speed subsystems. Up to seven block multiplexer channels are available (one standard and six optional). The byte multiplexer channel connects up to eight subsystems, including the operations console, and is expandable through an option to connect up to 16 subsystems. A second byte multiplexer is optionally available. The seventh block multiplexer channel and the second block multiplexer channel are mutually exclusive.

SIMULTANEOUS I/O OPERATIONS: Concurrently with computing, the 90/60 processor can control multiple I/O operations with a combined data rate of up to 175,000

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bytes/second on the multiplexer channel, plus one I/O operation with a data rate of up to 1.1 million bytes/second on each selector channel.

In the 90/80 system, the microprocessor of the 90/80 Peripheral Processor controls channel operations. Once the Instruction Processor initiates an I/O operation, the channel is able to execute this operation independently. Data transfers between peripheral devices and main storage can be performed by all channels concurrently. Control logic is provided to monitor the data transfers among the channels and to assist in servicing the many conditions that can occur during the transfer of data. The maximum aggregate I/O data transfer rate of a peripheral processor is 8 million bytes per second. The maximum byte multiplexer channel data transfer rate is an aggregate of 183,000 bytes per second. The maximum block multiplexer channel transfer rate is 1.5 million bytes per second.

MASS STORAGE

8405 FIXED-HEAD DISK SUBSYSTEM: Provides fast access to data stored on non-removable head-per-track disks. Each 8405-00 disk unit can store 6,193,152 bytes of information on 12 recording surfaces. Each 8405-04 disk unit can store 3,096,576 bytes of data on 6 recording surfaces. There are 72 tracks per recording surface (including 8 spare tracks) and 864 tracks per spindle (including 96 spares). Each track has a capacity of 8192 bytes. The average rotational delay is 8.34 milliseconds, and the data transfer rate is 622,000 bytes per second.

The 8405 Disk Subsystem uses the microprogrammed 5039 control unit, which can control a mixture of 8405 fixed-head disks and 8430 and 8433 disk pack drives. An F2076 8405 fixed-head disk feature is required for attachment of up to eight 8405 units in single-unit increments. The 5039 control unit performs command retry and automatic error detection and correction.

8430 DISK SUBSYSTEM: Provides large-capacity random-access storage on removable disk packs with storage capacities comparable to the standard-density (100-million-byte) IBM 3330 disk storage subsystem. Each disk pack stores up to 100,018,280 bytes of data. Data is recorded on 404 tracks per surface (plus 7 spares). Each track can contain up to 13,030 bytes. There are 19 read/write heads (one for each recording surface) in each comb-type access mechanism. Average head movement time is 27 milliseconds, average rotational delay is 8.3 milliseconds, and the data transfer rate is 806,000 bytes per second.

From two to eight 8430 disk pack drives can be attached to a 5039 control unit in combination with up to eight 8405 fixed-head disk drives. The 8430 disk pack drives can also be intermixed with 8433 disk storage drives on the 5039 control unit. A sixteen-drive expansion feature expands the capability of the 5039 control unit to up to sixteen 8430 and/or 8433 disk storage drives. A dual-access feature and a second 5039 control unit permit simultaneous read and write operations on any two 8430 disk drives. The 8430 features a command retry facility and error correction coding circuitry.

8433 DISK SUBSYSTEM: Provides random-access to very large quantities of data stored on removable "double-density" 3330-type disk packs. Each industry-standard disk pack contains 200,036,560 bytes in free-format recording mode or 190,279,680 bytes in VS/9 format. There are 808 tracks (plus 7 spares) on each of the 19 recording surfaces. The average head positioning time is 30 milliseconds, and the average rotational delay is 8.3 milliseconds (3600 rpm). Data transfer rate is 806,000 bytes per second.

From two to eight 8433 disk pack drives can be connected to a 5039 control unit for a total of 1.6 billion bytes per subsystem. A sixteen-drive expansion feature expands the capability of the 5039 control unit to up to 16 drives, or 3.2 billion bytes. The 8433 and 8430 disk pack drives can be intermixed on one 5039 control unit up to the maximum of 8 or 16 drives. In addition, 8433 and 8430 disk pack drives can be intermixed with 8405 fixed-head disk drives. A second 5039 control unit and the dual access feature permit simultaneous read/write operations to be performed on any two drives. The 8433 includes a command retry facility and error correction coding circuitry.

8450 DISK SUBSYSTEM: Employs sealed, fixed media and provides up to 336 megabytes in free format or up to 307 megabytes in VS/9 format. The non-removable disks provide 15 recording surfaces, each having two zones of 555 tracks (plus 5 spares) and serviced by two read/write heads. Up to 1 megabyte of fixed-head storage can be added to each unit. The average head-positioning time is 23 milliseconds, and the average rotational delay is 8.3 milliseconds (3600 rpm). Data transfer rate is 1,260,000 bytes per second.

The 8450 disk drives connect to the processor through the 5040 storage control unit (SCU), which permits the drives to be intermixed with 8430 and 8433 disk drives. The 5040 SCU can control up to 8 disk drives in its basic configuration and up to 16 drives if an expansion feature is added. Additional features of the 5040/8450 subsystems include rotational position sensing, error correction facilities, and enhanced command retry. The 8450 subsystem is available on the 90/80 only.

INPUT/OUTPUT UNITS

UNISERVO 14 MAGNETIC TAPE UNIT: Reads and records data on standard ½-inch tape in IBM-compatible phase-encoded or NRZI formats. Available in both 9-track or 7-track versions. Tape speed is 60 inches per second, forward or backward. The standard 9-track version has a recording density of 1600 bpi (in phase-encoded mode) and a data rate of 96,000 bytes per second. The optional dual density feature permits operation at 800 bpi (in NRZI mode) at a data rate of 48,000 bytes per second, while the 7-track NRZI version operates at 200, 556, or 800 bpi, with data rates of 12,000, 33,400 or 48,000 characters per second.

The Uniservo 14 magnetic tape units use the 5045 control unit, which includes the controller and housing for two magnetic tape units. A maximum of eight tape units can be attached to each 5045 control unit. Features available with the Uniservo 14 include automatic tape loading, dustproof wraparound tape cartridges, single-capstan drive, and a dual-channel option that permits non-simultaneous operation on two channels on a single processor or shared operation between two central processors.

UNISERVO 16 MAGNETIC TAPE UNIT: A high-speed tape drive that reads and records data on standard ½-inch tape in IBM-compatible phase-encoded or NRZI formats. Available in both 9-track and 7-track versions. Tape speed is 120 inches per second, forward or backward. The standard 9-track version has a recording density of 1600 bpi (in phase-encoded mode) and a data rate of 192,000 bytes per second; the optional dual density feature permits operation at 800 bpi (in NRZI mode) at a data rate of 96,000 bytes per second. The 7-track version operates at 200, 556, or 800 bpi, with corresponding data rates of 24,000, 66,720, or 96,000 characters per second.

From 1 to 16 Uniservo 16 tape units can be connected to a Uniservo 16 control, and up to 8 tape controls can in turn

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be connected to each selector channel. Optional features enable the tape control to be connected to two selector channels, permitting simultaneous read/read, read/write, or write/write tape operations.

UNISERVO 22/24 MAGNETIC TAPE UNITS: High-performance tape drives that match the performance of the IBM 3420 Model 7. Both models are 9-track, 800/1600-bpi tape drives designed for NRZI and PE recording. The Uniservo 22 has a transfer rate of 120,000 bytes per second at 1600 bpi and 60,000 bytes per second at 800 bpi. The Uniservo 24 transfers data at 200,000 bytes per second at 1600 bpi and 100,000 bytes per second at 800 bpi. Tape speed is 75 ips on the Uniservo 22 and 125 ips on the Uniservo 24. Operational conveniences include a power window, automatic tape threading, and wrap-around tape cartridge loading. The Uniservo 22 subsystem consists of 1 to 8 Uniservo 22 or 24 drives with at least one Uniservo 22 drive. The Uniservo 24 subsystem consists of 1 to 8 Uniservo 22 or 24 drives with at least one Uniservo 24 drive. A dual-access subsystem can be configured by adding a second control unit and installing the Dual Access feature in each tape unit.

UNISERVO 30 SERIES TAPE UNITS: High-performance units that record data on ½-inch tape in IBM-compatible formats. There are five models in the series, three of which use Group Coded Recording (GCR) at a density of 6250 bits per inch. All five models use the Uniservo 5042 control unit, and Uniservo 30 series tape units can be intermixed in any combination on the same subsystem, provided the proper control unit is included to accommodate the various tape unit types. The basic control unit can handle one to eight Uniservo 30 series tape units. Optional features in the control unit and the addition of a second control unit, also with appropriate features, permit communication with up to 16 tape units in a dual-access mode.

All of the models in the Uniservo 30 series, with one exception, can be used with 90/60 and 90/80 systems; the Uniservo 36 model is available for use only with the 90/80 system. The five models in the Uniservo 30 series and their characteristics are as follows:

Uniservo 30 (7-track)—a conventional NRZI unit with a transfer rate of 160,000 bytes/second at 800 bpi, 111,200 bytes/second at 556 bpi, or 40,000 bytes/second at 200 bpi. Tape speed is 200 inches/second.

Uniservo 30 (9-track)—a unit designed for NRZI and PE (phase encoded) recording. The transfer rate is 320,000 bytes/second at 1600 bpi or 160,000 bytes/second at 800 bpi. Tape speed is 200 inches/second.

Uniservo 32—a 9-track unit designed for GCR and PE recording. The transfer rate is 470,000 bytes/second at 6250 bpi or 120,000 bytes/second at 1600 bpi. Tape speed is 75 inches/second.

Uniservo 34—a 9-track unit designed for GCR and PE recording. The transfer rate is 780,000 bytes per second at 6250 bpi or 200,000 bytes per second at 1600 bpi. Tape speed is 125 inches/second.

Uniservo 36—a 9-track unit designed for GCR and PE recording. The transfer rate is 1,250,000 bytes/second at 6250 bpi or 320,000 bytes/second at 1600 bpi. Tape speed is 200 inches/second. This model is available only for the 90/80 system.

0716-95 CARD READER: Reads 80-column cards serially by column at 600 cpm. Can be equipped to read 51- or 66-column short cards or Sperry Univac 90-column cards. Reads in either EBCDIC or card-image mode. Has a 2400-card feed hopper and two 2000-card stackers; ASCII translate is optional. Multi-read error checking is a standard feature.

0716-99 CARD READER: Identical with the 0716-95 card reader, except that it reads cards at 1000 cpm.

0604-99 CARD PUNCH: Punches 80-column cards in row-by-row fashion at 250 cpm, in either EBCDIC or card-image mode. Has a 1000-card feed hopper and two 1000-card output stackers, with program control of stacker selection. Can be equipped with a pre-punch read station, giving the unit read/punch capabilities.

0770 PRINTERS: Printing speeds for 48-character sets are 800 lines per minute for Model 0770-00, 1400 lines per minute for Model 0770-02, and 2000 lines per minute for Model 0770-04. The respective skipping speeds for these three models are 50, 75, and 100 inches per second. All can have character sets from 24 to 384 characters in size, and all have 132 print positions as standard. An optional feature for all models can increase the number of print positions to 160 without affecting the printing speed. All have a single-space print time of 8.75 milliseconds, line spacings that are operator-selectable at 6 or 8 lines per inch, and forms dimensions from 3 to 22 inches wide and up to 24 inches long. The printers use a new horizontal print band technique. Their control units have a standard Series 90 interface.

The three 0770 Printers have the following features in common: all use interchangeable print band cartridges; all can identify the cartridge type under program interrogation to ensure that the operator has placed the proper band in the printer for the run; all use a program-loaded vertical format buffer in place of a paper tape format loop; and all have swing-out print carriages, easy ribbon replacement without rewinding, simplified line finding, lighted print areas, automatic print gap (forms thickness) adjustment, powered, program-controlled top covers, automatic power forms stackers, and enhanced acoustical covers to reduce operating noise.

0776 PRINTERS: Three versions of the 0776 band printer are offered: the 760-lpm Model 0776-00, the 900-lpm Model 0776-02, and the 1200-lpm Model 0776-04. The printers feature 136 print positions, a full-line buffer, and interchangeable print cartridges with 24 to 384 characters. An F2245-00 print expansion option is required for print arrays greater than 64 characters. The forms advance rate is 22 inches per second, and the total forms advance time produced by any one command is limited to a maximum of 1.2 seconds to prevent paper runaway. Line spacing can be either 6 or 8 lines per inch and is software-selectable.

The 0776 printers will accept multipart forms with a pack start thickness up to 0.018 inch. Thicker form packs can be used, but with reduced print quality. Form widths can range from 4 to 18.75 inches, and form length can be up to 24 inches. Vertical formatting is under control of a software-loaded buffer that contains space for up to 192 skip/stop positions, equivalent to a 24-inch form at 8 lines per inch.

COMMUNICATION CONTROLS

MULTI-CHANNEL COMMUNICATIONS CONTROLLER (MCC): The MCC is a programmable communications control unit that is designed to relieve the host processor of line and terminal polling. Applications supported by the MCC include remote job entry or remote batch processing, interactive program development, transaction processing, inquiry/response, data collection, and message switching.

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The MCC is available in three versions. Model 1 can handle a maximum of 16 half-duplex or full-duplex lines, Model 1A accommodates up to 32 half- or full-duplex lines, and Model 2 can be configured with up to 64 full-duplex or 128 half-duplex lines. The MCC supports line speeds ranging from 45.45 to 56,000 bits per second, with a maximum total throughput capacity of 25,000 characters per second. It operates under control of the host central processor and performs character sequence detection and insertion, code translation, and cyclic, longitudinal, and vertical redundancy character generation and checking.

A Test Assistance Program allows individual lines, line adapters, modems, and terminals to be tested off-line without disrupting production processing. Software support for the communications network is created through a system generation procedure designed to facilitate the addition of new lines and line types.

TERMINALS: The following Sperry Univac devices, described elsewhere in DATAPRO 70, are supported for use as remote terminals with the Series 90 systems: UTS 400 (Report 70D1-877-01), and the Univac 1900 Computer Aided Data Entry System (Report 70D4-877-31).

SOFTWARE

OPERATING SYSTEMS: Originally, two operating systems were available for the 90/60 and 90/80 systems: OS/4, an enhanced version of the Sperry Univac 9400 Disk Operating System; and VS/9, an enhancement of the original VMOS (Virtual Memory Operating System) that was developed for Series 70 systems. VS/9 is now the principal operating system. OS/4 is no longer being enhanced, but is still maintained at its current level for the convenience of those customers using it.

VS/9: Announced in February 1975, VS/9 offers functional capabilities for concurrent processing, data communications, and interactive processing. The virtual memory features of VS/9 allow programs to be located in memory in non-contiguous pages of 4,096 bytes each that are swapped in and out of main memory space of 8 million bytes, and its multiprogramming facilities can manage a theoretical limit of over 120 concurrent tasks.

The allocation of processor resources among tasks is accomplished by a supervisory scheduling algorithm, a hardware interval timer, and a system table of task queues. The tasks in the active queues compete for central processor time, with interactive tasks and those with higher priorities receiving larger time slices than batch tasks and lower-priority tasks. Input/output-bound tasks are given attention before compute-bound tasks. Priority levels can be dynamically adjusted during execution to bias the system toward batch or interactive processing.

VS/9 supports Class I and Class II problem programs. Class I programs remain resident in contiguous main memory locations and are not paged. Class II programs operate in the virtual memory mode, are allocated in 4K-byte pages, and require only the working set of each program to be resident in main memory for execution. Pages are paged out when they have been modified and the system requires pages of a higher priority. Pages that have been least used are paged out first if they have been modified, while those that have not been modified are simply overlaid.

Program scheduling is performed automatically by priority level on either a first-in, first-out or first-in, first-fit basis. After the expiration of a specified number of minutes, a first-in, first-fit program automatically reverts to first-in, first-out status. VS/9 makes extensive use of re-entrant input and output spooling routines, although user programs can also request dedicated card readers and printers.

The VS/9 File Management System automatically allocates files to mass storage devices and maintains a System File Catalog of file use and current and previous generations of files. Files can be assigned to public or private volumes and can be classified by owners as shared or non-shared. Both read-only or read-write access to files can be specified, with optional password protection. Data is allocated to disk in blocks of 2,048 bytes. File access methods supported include SAM, ISAM, PAM (Primary Access Method for random access), EAM (Evanescent Access Method for temporary files), BTAM (Basic Tape Access Method), and RAM (Relative Access Method).

VS/9 reliability and recovery capabilities include a Hardware Error Recovery System (HERS) that analyzes mainframe errors and attempts to recover from transient errors. The Basic Processor Exerciser (IHBPXR) exercises internal CPU logic in an on-line environment to detect malfunctions primarily associated with arithmetic logic. The Virtual Interactive Machine Test Program (VIMTPG) allows on-line generation and execution of input/output test programs.

VS/9 accounting functions include the collection of data on the utilization of system resources identified by user and/or account number, a billing routine to generate a report based on that data, and a SNAP (System Net Activity Program) that monitors CPU, I/O, and paging activity and maintains statistics on response times, system load, task scheduling, and task page-size characteristics and the availability of file paging space.

Interactive processing capabilities provided by VS/9 include Extended BASIC, FAST FORTRAN for fast compilation and immediate execution of FORTRAN programs, APL/90, a Virtual Memory Editor for file creation, deletion, and modification, a COBOL Program Development System (CODE), a Desk Calculator mode of operation, Sort/Merge, and the Interactive Debugging Aids.

VIRTUAL INTEGRATED COMMUNICATIONS ACCESS METHOD (VICAM): VICAM is a set of sharable generalized software components that provide a wide range of functions for user applications. A set of prescribed procedures in the form of macro instructions affords the user an interface to remote devices and message files. The communications network (lines, terminals, buffers, and queues) is defined by an assembly process. This network definition is loaded dynamically in response to a user program request and is placed in an area within the executive called the communications control area (CCA). Functional components of VICAM are the Message Control Program (MCP) and the Communications User Program (CUP).

VICAM memory space is protected as part of the Executive. It operates at Executive priority and not as a user program.

The MCP is a modular software package that is capable of supporting either simple or complex communications environments. A single MCP provides concurrent support for multiple user message processing programs that use a variety of terminals and line types. MCP prevents conflicting facility assignments and releases facilities when jobs terminate. User programs are provided with macro programs that control table generation, handle data transfers to and from user-specified buffer areas, initialize and control communication facilities, and perform dynamic terminal and poll table entry alterations in the communications control areas.

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The part of VICAM that Sperry Univac calls the Communications User Program (CUP) is the user-generated coding that processes incoming messages and generates any applicable response messages. This program interfaces with the Message Control Program through macro instructions provided for this purpose. These macros control the sending and receiving of messages, message routing and switching, time and date stamping, sequencing and sequence checking, source ID validation, message queue maintenance, destination validation, length checking, and priority control. Multiple message processing programs can operate concurrently under VS/9, subject to the availability of system resources. Program-oriented networks operating under control of a message processing program are able to create files of information that can be processed concurrently on another network by another message processing program.

COMMUNICATIONS-ORIENTED SOFTWARE (COS): COS is maintained for compatibility with the Sperry Univac Series 70 systems. It has been superseded by VICAM, and no future enhancements are planned. COS is a modular communications system that handles message communications traffic, code translation, queuing on intermediate storage, message logging, and transferring of messages to and from Communications User Programs.

COBOL: Sperry Univac offers three COBOL compilers for use under VS/9: American National Standard (ANS) 74 COBOL, ANS 68 COBOL, and BGCOB. In addition, the ANS 68 COBOL compiler runs under OS/4.

All of the VS/9 compilers are pageable programs. Source input can be retrieved from a cataloged file on disk, from a card deck, from a remote terminal, or from a disk-resident COBOL source library file. The compilers generate Class II programs, and the generated object modules are written on disk.

ANS 74 COBOL functional processing levels include: Nucleus—Level 2, Table Handling—Level 2, Sequential I/O—Level 2, Relative I/O—Level 2, Sort-Merge—Level 1, Segmentation—Level 1, Library—Level 1, Debug—Level 2, and Interprogram Communication—Level 2.

ANS 68 COBOL functional processing levels include: Nucleus—Level 2, Table Handling—Level 3, Sequential Access—Level 2, Direct Access—Level 2, Sort—Level 2, Segmentation—Level 2, and Library Functions—Level 2. This compiler also features a fully functional report writer facility that is not compatible with the ANS standard.

The BGCOB compiler is designed to be compatible with IBM F-level COBOL and with Sperry Univac Series 70 COBOL.

FORTRAN: VS/9 FORTRAN (BGFOR) is an extension of ANS FORTRAN IV that is compatible with IBM H-level FORTRAN and produces optimized object code. It also provides comprehensive program error diagnostic and debugging facilities, and optionally produces a diagnostic file that can be interrogated by a post-compilation diagnostic utility.

VS/9 FAST FORTRAN is designed primarily to provide fast compilation of source programs, followed by immediate execution. It also provides a comprehensive set of error diagnostics to catch many common programming errors. The language acceptable to FAST FORTRAN is highly compatible with VS/9 FORTRAN.

REPORT PROGRAM GENERATOR: The VS/9 RPG II compiler is functionally compatible with Sperry Univac OS/3, OS/4, and Series 70 RPG compilers, as well as with IBM RPG II. The RPG II compiler generates an object program and automatically allocates the necessary storage locations, provides linkage to I/O operations, and includes constants and other designated information.

BASIC: An extended BASIC is offered under the VS/9 Operating System. The Sperry Univac BASIC language is similar to the original language developed at Dartmouth College, but contains extensions to the arithmetic and control statements, file processing, and matrix commands. BASIC source programs can be catalogued for subsequent compile-and-execute operation.

ASSEMBLER: The OS/4 Assembler is directly compatible with 9400 BAL and is very similar to, although not totally compatible with, the Assembler languages for the Sperry Univac 9200/9300 systems and the IBM System/360. The VS/9 Assembler supports predefined sets of macro variable symbols, allows macros to be defined anywhere in source programs, and permits multiple levels of sublists in macro-instruction operands.

INFORMATION MANAGEMENT SYSTEM (IMS/90): IMS/90 is an interactive, transaction-oriented file management system designed for use by nontechnical personnel. It requires no restructuring or reformatting of existing data files and uses DMS/90 (below) to access data base files. The IMS/90 data definition processor assists users in defining the format and valid data values for each field and also in defining which files can be modified.

Each file defined to IMS/90 can be secured against unauthorized access by assigning it a password. The password can be altered readily from day to day. Data is also protected from destruction by an automatic recovery/rollback feature and the automatic generation of a journal file for use by recovery routines.

One component of IMS/90, defined record management, constructs each record dynamically, just before delivering it to the action program that requested it. There is one data definition record for each data definition; therefore, each data definition record can describe several subfiles along with the defined files. The defined file/subfile concept eases the problem of system enhancements. New applications can be added which require expansion to existing disk records, yet new data definitions can include definitions of the old subfiles, so that the action programs and the terminal operator procedures invoked in the old applications can be used unchanged.

The Uniform Inquiry Update Element (UNIQUE) query language provides a file inquiry and update capability. For each input message submitted, the terminal operator receives an answer so that he is quickly and constantly informed of the results of his commands. These commands are OPEN, CLOSE, DISPLAY, DELETE, OK, CANCEL, ADD, NEXT, CHANGE, LIST, MORE, DETAIL, ASSIGN, and SHOW.

IMS/90 also provides two sets of terminal commands, one for remote terminals and one for the master terminal. Remote terminal commands can be used to resolve various administrative or operational problems, or for educational purposes. The master terminal commands enable control of the communications network and assist in monitoring the system.

DATA MANAGEMENT SYSTEM (DMS/90): DMS/90 operates on the 90/60 and 90/80 under the VS/9 Operating System. DMS/90 is designed in conformance with the CODASYL Data Base recommendations and represents a subset of these specifications. Its functional capabilities, therefore, are similar to those provided by DMS 1100, the data base management system for the Sperry Univac 1100 Series computers, although there is no compatibility

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between the two systems at the machine level. DMS/90 is described in detail in Report 70E-877-01.

VS/9 UTILITY ROUTINES: The VS/9 utility routines are single-purpose programs which perform utilitarian tasks required in the day-to-day operation of a computer facility. These routines can be grouped into five categories: precompilation routines, postcompilation routines, linkage editors and loaders, media conversion routines, and system support utilities.

Precompilation routines are programs used to maintain libraries of source language programs or elements of programs. The source language library facilities are designed to aid the programmer in program preparation and to lend efficiency to the development of large programming projects. The specific routines and their functions are:

COBOL Library Update (COBLUR)—used for the maintenance of a COBOL source library on direct-access devices.

Macro Library Update (MLU)—used to create, update, or delete entries on a direct-access resident library of assembler macros.

Source Library Update (SLU)—used in conjunction with the assembler, this routine permits creating, updating, and deleting entries from a direct-access resident library of assembly-language source statements.

Postcompilation routines are programs designed to aid in achieving error-free compilations and to preserve the resultant object modules. The specific routines and their functions are:

Assembler Diagnostic Routine (ADIAG)—provides the user with the facility for interrogating, from a terminal, the error file created by the Assembler during the assembly process.

Background Compiler Diagnostic Routine (BDIAG)—provides the facility for interrogating the error file created for the FORTRAN and COBOL compilers. The compilers write the program and diagnostic listings to VS/9's SYSLST file.

Library Maintenance Routine (LMR)—provides the facilities necessary to create, update, delete, copy, and modify object modules in disk-resident libraries.

The *linkage editor and loader routines* are used to bind object modules into programs, load the programs, and, optionally, to provide the structure needed internally to support interactive debugging and (IDA) operations.

System support utilities are system service programs designed primarily for use by the system administrator in performing his function of administering, controlling, and maintaining viable computer system operations. They provide such facilities as file backup, system updating, volume initialization, and tape maintenance. The functions of these routines are as follows:

FILSAV—provides a tape-oriented file maintenance facility that can be used in a batch or interactive mode. The system administrator can use this routine to maintain system files on a magnetic tape, usually for backup. All users can utilize the routine for saving and restoring catalogued files on tape.

VS/9 Self-Loading System (SLS)—a multipurpose utility that runs in a self-contained environment. The heart of the SLS is the self-loading I/O handler (SLIOH) and a number of VS/9 error recovery modules that, when linked together, make up a mini-operating system that can run one job at a time. The SLS provides the user with the facilities to build system residence, initialize volumes, copy VS/9 volumes from disk to tape or tape to disk, dump virtual memory and system files, and print the contents of a resident emergency dump tape.

Media conversion routines give the user additional facilities for displaying all or parts of files or volumes on a terminal (in an interactive task) or on a printer (for large volumes). The user can dump direct-access data to tape, reload direct-access data from tape, or copy data from one direct-access volume to another. In addition, he can initialize direct-access volumes for use by the file management system. A comprehensive set of utilities enables the user to perform device-to-device conversion for his files.

VS/9 INTERACTIVE SERVICE PROGRAMS: The VS/9 interactive service programs provide functions and facilities designed to simplify the user's task of interfacing with his data files and programs. These programs include the Virtual Storage Editor (EDT), Interactive Debugging Aid (IDA), the COBOL Program Development System (CODE) and Test File Generator (TFG), the Desk Calculator, and Sort/Merge.

EDT can be executed in either the batch or interactive mode, and will read or write SAM or ISAM files wholly or in part. With this editor it is possible to create, copy, delete, compare, and concatenate files, and to add, delete, and modify text within files. It also provides comprehensive facilities for defining procedures and for searching and restructuring files. EDT operates on text in virtual storage, and therefore makes very few references (or accesses) to physical storage devices.

IDA provides the user with the facility for testing and modifying programs written in assembler, COBOL, or FORTRAN without having to include the debugging statements at compilation or assembly time. The user can use the same symbols for debugging that were used in writing the program. IDA can be used in batch or interactive mode. Commands are provided to start, stop, and resume execution of the object program; to examine the program and its results; and to modify the contents of virtual storage. IDA supports an audit mode that records the recent branches a program has taken.

CODE provides facilities through which the COBOL programmer, with a minimum command set, is able to utilize all the power of the system without having to learn every software component involved in the effort. All files required for the program are automatically maintained by the subsystem. Using a set of 28 commands, the programmer can create, modify, edit, and delete source program statements; maintain and update source program files; define his own abbreviations or use standard abbreviations for language elements; verify syntax and compile the program; retrieve and analyze compiler-generated diagnostic messages and correct the source; load and execute the program; save the compiled program in an object module library; debug the program using symbolic IDA facilities while applying corrections directly to the source program; and use the TFG to create test data for debugging the program.

The Test File Generator (TFG) is an enhancement to CODE. It uses its own set of CODE-oriented commands to allow the programmer to create public disk files of any record description containing virtually any combination of test data. Files created by the generator can also be used as data files by the assembler, FORTRAN, or RPG programs, with only a skeletal COBOL compilation as the prerequisite for producing them.

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The Desk Calculator utility provides remote terminal users with the arithmetic functions of a conventional desk calculator. Users can break from a program, enter the Desk Calculator mode, and resume the program at the point of interruption. Calculated results are displayed at the terminal.

The VS/9 Sort/Merge (DSORT) runs as a Class II pageable program. It may run as either a batch or interactive task. The user defines control fields and specifies various options for a sorting or merging application in sort/merge control statements. The program may be invoked by other user programs that require a sort/merge capability. The major options available to the user include: full record sort, record selection sort, tag sort, and file merge. User-written subroutines can be incorporated to tailor the program for individual requirements such as nonstandard input files. All input and output operations are performed using the VS/9 file management system.

APPLICATIONS PROGRAMS: Application programs currently available under VS/9 include: UNIS 90 (Univac Industrial System); WIMS (Wholesale Inventory Management System); Management Control System 90 (planning and scheduling, cost control, and reporting); Mathematical Programming System 90 (linear programming, mixed integer programming, etc.); AUTOFORM (Automatic Text Formatting System); Statistical Analysis (biomedical statistics); FINAN-9 (Financial Series); Interactive Management Science Series (linear programming, critical path scheduling, and exception reports); Engineering Design and Interactive Analysis Series (electronic circuit analysis, continuous systems simulation, etc.); and ICES (Integrated Civil Engineering System).

PRICING

EQUIPMENT: All necessary control units and adapters are included in the indicated prices for the following configurations, and the quoted one-year rental prices and five-year lease prices include equipment maintenance.

BASIC 90/60 SYSTEM: Consists of 512K-byte 90/60 processor (with one multiplexer channel, two selector channels, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm 0716-99 card reader with control, 250-cpm 0604-99 card punch, 1400-lpm 0770-02 printer, 600 megabytes of 8433 disk storage, and four Uniservo 16 96KBS, 1600-bpi tape units. Purchase price is $676,608, monthly rental on a one-year contract is $23,208, and the monthly rate on a five-year lease is $18,632.

MEDIUM 90/60 SYSTEM: Consists of 1024K-byte 90/60 processor (with one multiplexer channel, two selector channels, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm 0716-99 card reader, 250-cpm 0604-99 card punch, 1400-lpm 0770-02 printer, 1000 megabytes of 8433 disk storage, and four Uniservo 16 192KBS, 1600-bpi tape units. The purchase price is $796,844, monthly rental on a one-year contract is $29,334, and the monthly rate on a five-year lease is $22,357.

MEDIUM 90/80-3 SYSTEM: Consists of 2048K-byte 90/80 processor (with four block multiplexer channels, one byte multiplexer channel, floating-point hardware, storage protection, console, and VS/9 software), 1000-cpm 0776-99 card reader, 250-cpm 0604-99 card punch, two 1400-lpm 0770-02 printers, six Uniservo 24 200KBS, 1600-bpi tape units, and 1200 megabytes of 8433 disk storage. The purchase price is $1,566,206, monthly rental on a one-year contract is $50,783, and the monthly lease charge on a five-year lease is $39,570.

TYPICAL 90/80-4 SYSTEM: Consists of a 90/80-4 processor (with 6 megabytes of main memory, 32K bytes of high-speed buffer memory, peripheral processor, byte multiplexer channel, five block multiplexer channels, operator console, and motor/alternator), a 2028-megabyte disk storage subsystem consisting of four 307-megabyte 8450 disk drives, four 200-megabyte 8433 disk drives, and a dual-access disk control; a dual-access magnetic tape subsystem consisting of four 780KBS Uniservo 34 magnetic tape units, four 470KBS Uniservo 32 magnetic tape units, and a dual-channel controller; two 2000-lpm 0770-04 line printers; a 1000-cpm 0716-99 card reader; and a 250-cpm 0604-99 card punch. Purchase price is $2,274,728, monthly rental on a one-year lease is $77,005, and monthly rental on a five-year lease is $58,902.

SOFTWARE AND SUPPORT: Sperry Univac software is still largely "bundled," and the equipment prices listed above include most of the software described in this report and all normal educational courses and professional assistance. However, the UNIS (Univac Industrial System) application program is separately priced. Monthly charges for the UNIS modules are listed under "Software Prices" at the end of this report.

CONTRACT TERMS: The standard Sperry Univac use and service agreements allow unlimited use of the equipment (exclusive of the time required for remedial and preventive maintenance). There are no extra-use charges. The basic maintenance charge covers maintenance of the equipment for nine consecutive hours a day between the hours of 7 a.m. and 6 p.m., Monday through Friday. Extended periods of maintenance are available at premium rates. The premiums for additional coverage are a percentage of the base maintenance rate and are as follows:

	Hours of Coverage								
	4	8	9	10	12	16	18	20	24
Monday through Friday	—	—	0	10	20	25	35	40	45
Saturday	5	8	9	—	11	12	—	14	15
Sunday and Holidays	7	10	12	—	14	16	—	18	20

Maintenance service performed outside the contracted maintenance period is subject to the following rates:

	Monday through Saturday	Sunday and Holidays
Min. charge per call	$112	$132
Each add'l. hour	56	66
Max. charge per call	280	330

For users who elect not to contract for maintenance with Univac, the following per-call rates apply:

	Monday through Friday	Overtime and Saturday	Sunday and Holidays
Min. charge	$100	$112	$132
Each add'l. hour	50	56	66

On-call maintenance is also subject to travel time and expense charges.

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Sperry Univac 90/60 and 90/80

Sperry Univac offers reduced maintenance rates for multiple-processor installations. The percent premiums listed below apply to installations containing two or more processors or systems of the same type and located at the same address.

	Two-Processor Installation Hours of Coverage		
	9	16	24
Monday through Friday	0	15	27.5
Saturday	6	8	10
Sunday and Holidays	7.5		12.5

	Three or More Processors Hours of Coverage		
	9	16	24
Monday through Friday	0	12	22
Saturday	5	6.5	8
Sunday and Holidays	6	8	10

LONG-TERM LEASES: In addition to the basic one-year and five-year leases shown in the accompanying price list, Sperry Univac offers a seven-year lease to state and local governments and to educational institutions. Educational institutions are eligible for an additional 10 percent discount. The discount does not apply to maintenance service charges.

EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
90/60 PROCESSOR AND MAIN STORAGE					
3024-91	90/60 Processor with 524,288 bytes of main storage, one multiplexer channel, one selector channel, general register stack, floating-point controls, channel programming, storage protection, and two interval timers; expandable to 2,097,152 bytes	$ 284,184	$1,391	$ 8,289	$ 6,710
3024-89	90/60 Processor; same features as 3024-91 processor, but with 1,048,576-byte memory; expandable to 2,097,152 bytes	349,700	1,900	11,586	8,250
7025-81	Storage Expansion; 262,144 bytes; expands main storage from 524,288 to 786,432 bytes	27,965	254	934	658
7025-79	Storage Expansion; 524,288 bytes; expands main storage from 1,048,576 to 1,572,864 bytes	36,805	509	1,766	866
90/60 PROCESSOR FEATURES					
F2629-00	Performance Enhancement Option; increases instruction execution speed of 90/60 processor by 25 percent	9,000	32	263	210
F2007-01	Performance Enhancement Option; increases instruction execution speed by additional 15 percent; requires F2629-00	5,570	32	173	130
F1519-00	Expanded Interface; expands multiplexer to 15 subsystems (16 if F1518-00 is present)	5,364	24	156	125
F1518-00	Subchannel Expansion; expands multiplexer up to 31 channels	1,800	7	53	43
F1518-01	Subchannel Expansion; 32 additional multiplexer channels; requires F1518-00	2,160	14	63	51
F1337-99	Selector Channel; up to 1,111KBS; maximum of three; selector channels 3 and 4 require 1916-00 channel expansion cabinet	8,748	40	255	205
F1337-02	Selector Channel; adds fifth selector channel; requires F1337-99 and 1916-00 channel expansion cabinet	8,748	40	255	205
1916-00	Channel Expansion Cabinet for third, fourth, and fifth F1337 selector channels	8,568	40	250	203
F1335-00	Direct Control; interface for another 90/60 processor	3,564	14	104	85
F1591-00	Programmable Emulator; provides programmable control for SMOOTH operation using special hardware instructions	9,900	83	289	235
4014-99	System Console; includes Uniscope 100 CRT	20,268	117	591	480
0772-00	Console Printer; 30 cps	9,900	75	290	248
90/80 PROCESSORS AND MAIN STORAGE					
3044-99	90/80-2 Processor with 1,048,576 bytes of main storage, peripheral processor with one byte multiplexer channel and four block multiplexer channels, key-in storage protection, system console, power distribution panel, and motor alternator; expandable to 2,097,152 bytes	798,250	2,669	21,802	16,353
3044-91	90/80-2 Processor; same as 3044-99, but can be upgraded to a 3044-90	798,250	2,669	21,802	16,353
F2756-01	90/80-2 to 90/80-3 Upgrade Option for 90/80-2 processor with 2,097,152 bytes of main storage; requires F2672-99 storage expansion; subsequent expansion must be as a 90/80-3	25,750	128	702	528
F2672-99	Storage; expands 90/80-2 storage from 1,048,576 to 2,097,152 bytes	45,064	149	1,230	924
3044-97	90/80-3 Processor with 2,097,152 bytes of main storage, peripheral processor with one byte multiplexer channel and four block multiplexer channels, key-in storage protection, system console, power distribution panel, and motor alternator; expandable to 4,194,304 bytes	1,019,700	3,432	27,852	20,889

*Lease prices do not include equipment maintenance.

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Sperry Univac 90/60 and 90/80

EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
90/80 PROCESSORS AND MAIN STORAGE (Continued)					
3044-90	90/80-3 Processor; same as 3044-97, but can be upgraded to a 90/80-4	869,064	2,946	23,733	17,804
F2672-98	Storage; expands 90/80-3 storage from 2,097,152 to 3,145,728 bytes	45,064	149	1,230	924
F2672-97	Storage; expands 90/80-3 storage from 3,145,728 to 4,194,304 bytes; requires F2672-98	45,064	149	1,230	924
F2743-99	90/80-3 to 90/80-4 Upgrade Option for 3044-90 processor	103,000	763	2,812	2,110
3044-89	90/80-4 Processor with 2,097,152 bytes of main storage, 32K-byte buffer storage, one byte multiplexer channel, four block multiplexer channels, two-way memory interleave, and system console; expandable to 8,388,606 bytes	972,064	3,709	26,544	19,914
F2672-96	Storage; expands 90/80-4 storage from 2,097,152 to 4,194,304 bytes	90,128	300	2,460	1,848
F3319-00	Virtual Accelerator Module; increases the performance of the 90/80-3 or 90/80-4 processor by as much as 20 percent	41,200	87	1,071	844
90/80 PROCESSOR FEATURES					
0782-99	Console Printer; 30 cps	9,900	75	330	244
F1920-03	Fifth Block Multiplexer Channel	15,840	41	348	295
F1920-04	Sixth Block Multiplexer Channel; requires F1920-03; last channel position must be a block multiplexer channel; cannot be used with F1920-05, F1922-00, F1922-01, or F1922-02	15,840	41	348	295
F1920-05	Sixth Block Multiplexer Channel; requires F1920-03 and F1922-01; used when a second byte multiplexer has been installed; cannot be used with F1920-04, F1920-06, or F1922-00	15,840	41	348	295
F1922-00	Sixth Block Multiplexer Channel; requires F1920-03; last channel position must be a byte multiplexer channel; cannot be used with F1922-01, F1920-04, or F1920-05	15,840	41	348	295
F1920-06	Seventh Block Multiplexer Channel; requires F1920-04; cannot be used with F1920-05, F1922-00, F1922-01, or F1922-02	15,840	41	348	295
F1922-01	Second Byte Multiplexer Channel; cannot be used with F1922-00, F1922-02, F1920-04, or F1920-06	16,800	44	369	317
F1922-02	Second Byte Multiplexer Channel; requires F1922-00 block multiplexer channel; cannot be used with F1922-01, F1920-04, F1920-05, or F1920-06	16,800	44	369	317
F2011-00	Extended Interface; expands byte multiplexer channel interface to provide capability for up to 16 subsystems	2,160	5	47	40
F1921-00	Subchannel Expansion; provides 256 additional block multiplexer subchannels	1,440	5	32	26
F1914-00	Direct Control; provides an interface between a 90/80 and a 90/60 or another 90/80; requires comparable feature in other processor	4,800	12	106	90
F1915-01	90/60 Mode; provides capability for 90/80 to operate as a 90/60 processor; required for operation with OS/4	4,800	12	106	90
F1916-01	370 Mode; provides capability for 90/80 to operate as an IBM 370	10,200	95	211	211
8508-99	Motor Alternator	18,000	25	493	369
MASS STORAGE					
8405-00	Fixed-head Disk; 6.2 megabytes; requires F2076-00	38,400	555	976	633
8405-04	Fixed-head Disk; 3.1 megabytes; requires F2076-00	23,040	332	586	380
F1664-00	Dual Access; provides dual access and simultaneous read/write on any two 8405 disk drives; required on each 8405 in the subsystem; also requires two 5039 control units	2,160	5	55	36
5039-97	Control Unit; controls up to eight 8430 or 8433 disk drives; minimum of two drives per system; can control up to eight 8405 drives via F2076-00	57,600	374	1,385	900
F2047-00	16-Drive Expansion; provides the capability to connect up to 16 8430 or 8433 disk drives to a 5039 control; excludes the use of F2076-00	5,760	51	195	127
F2076-00	8405 Capability; enables 5039 control unit to control up to eight 8405 disk drives; excludes the use of F2047-00	2,160	5	55	36
8430-99	Disk Drive; 100 megabytes; minimum of two required	18,720	162	633	411
F2020-00	8430 Dual Access; provides dual access and simultaneous read/write operations on any two 8430 drives; required on both drives in the subsystem; also requires two 5039 controls and two selector channels	2,160	5	52	34
F2046-00	Dual Channel; provides non-simultaneous access to one 5039 control from two selector channels	3,460	21	90	76
F1230-00	Disk Pack; 100 megabytes	1,440	0	49	32
F2342-00	8430 to 8433 Upgrade	8,640	75	290	190
8433-00	Disk Drive; 200 megabytes	27,360	237	923	601
F1223-00	Disk Pack; 200 megabytes	1,820	0	61	40
F2021-00	8433 Dual Access; provides dual access and simultaneous read/write operation on any two 8433 drives; required on both drives in the subsystem; also requires two 5039 controls	1,630	5	55	36

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Sperry Univac 90/60 and 90/80

EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
MASS STORAGE (Continued)					
8450-99	Dual Disk Drive; 307 megabytes	66,600	288	2,258	1,466
8450-97	Dual Disk Drive; 307 megabytes; includes one megabyte of fixed-head storage	74,600	318	2,521	1,677
F2717-99	8450 Fixed-Head Conversion; converts an 8450-99 to an 8450-97	13,600	31	264	211
F2718-99	8450 Dual Access; provides dual access and simultaneous read/write operations on any two 8450 drives; requires two 5040 controls	2,688	17	59	44
5040-95	Control Unit; controls up to eight 8450 disk drives; can control up to eight 8430/8433 drives with F2836-00	102,000	509	2,700	1,800
5040-93	Dual Control for 8450 drives; also provides two controls for 8430/8433 drives via F2836-00	176,448	889	5,015	3,260
F2836-00	8430/8433 Capability; provides the capability to connect up to eight 8430 or 8433 drives to the 5040-95 control in addition to the basic eight 8450 drives; mutually exclusive with F2719-01	2,400	12	60	42
F2719-01	8450 Expansion; provides capability for adding eight additional 8450 drives to 5040-95 control; mutually exclusive with F2836-00	7,680	51	160	120
F2835-00	Dual Channel; provides non-simultaneous access to a 5040 control from two block multiplexer channels	4,080	21	85	72
MAGNETIC TAPE UNITS					
0870-03	Uniservo 14 Magnetic Tape Unit; 9-track, 1600 bpi, PE, 96KBS	14,880	110	344	264
0870-04	Uniservo 14 Magnetic Tape Unit; 9-track, 1600/800 bpi, PE, 96/48KBS	16,080	120	371	285
0870-05	Uniservo 14 Magnetic Tape Unit; 7-track, 800/556/200 bpi, NRZI, 48/33/12KBS	14,880	110	344	264
F2194-00	Dual Density; adds 9-track NRZI to 0870-03 tape unit; requires F0826-01 in control unit	1,200	7	27	21
F2194-02	Converts 0870-05 7-track unit into a 9-track PE unit ($106 field installation charge)	0	0	0	0
F2194-03	Converts 0870-05 7-track unit into a 9-track PE/NRZI unit; requires F0826-01 in control unit	1,200	7	27	21
5045-99	Uniservo 14 Control; controls up to eight Uniservo 14 tape units; includes cabinet space for two tape units	21,168	153	463	355
5045-02	Auxiliary Cabinet; provides power distribution and space for one or two additional Uniservo 14 tape units	1,296	5	30	24
F0825-00	Dual Channel; permits non-simultaneous operation on two channels of one processor or on one channel on each of two processors	4,416	31	102	82
F0823-89	7-Track NRZI for 5045-99 control	5,760	31	133	111
F0826-01	9-Track NRZI for 5045-99 control	5,760	31	133	111
F1028-15	9-Track NRZI for F0823-89 or F1753-97	4,176	19	96	74
F1028-16	7-Track NRZI plus data conversion for F0826-01	4,176	19	96	74
F1028-84	7-Track NRZI native mode plus data conversion for F0826-01	3,654	14	86	69
F1753-97	Provides capability to add 7-track tape units to 5045-99 control; excludes the use of F0826-01	5,760	25	126	101
0862-00	Uniservo 16 Magnetic Tape Unit; 9-track, 1600 bpi, 192KBS	22,032	209	559	390
0862-02	Uniservo 16 Magnetic Tape Unit; 7-track, 200/556/800 bpi, 24/66.72/96KBS	22,032	209	559	390
F0936-99	Simultaneous Feature for Uniservo 16 tape units; requires two controls	914	0	22	17
F0937-00	Dual Density Feature for 0862-00 tape units; control must contain 0826-00 or F1028-96	2,284	0	54	40
F1040-00	7- to 9-Track Non-Simultaneous Conversion Feature for 0862-02 tape units; converts to 0862-00	0	0	0	0
5017-00	Uniservo 16 Non-Simultaneous Control; controls up to 16 Uniservo 16 tape units	28,560	205	726	502
F0825-00	Dual Channel; permits non-simultaneous operation on two channels of one processor or on one channel on each of two processors	4,416	31	102	82
F0823-99	7-Track NRZI for 5017-00 control	5,760	31	133	106
F0826-00	9-Track NRZI for 5017-00 control	5,760	31	133	106
F1028-96	9-Track NRZI for F0823-99 or F1753-99	4,176	19	96	74
F1028-95	7-Track NRZI plus data conversion for F0826-00	4,176	19	96	74
F1028-92	7-Track NRZI native mode plus data conversion for F0826-00	3,654	14	86	66
F1753-99	Provides capability to add 7-track tape units to 5017-00; excludes use of F0826-00	5,760	25	126	96
F1029-00	Simultaneous Operation for 5017-00 control; provides second control module	18,960	121	415	335
0876-99	Uniservo 22 Magnetic Tape Unit and Control; 9-track, 1600/800 bpi, PE/NRZI; built-in control unit controls up to eight Uniservo 22 or 24 tape units	44,710	222	1,192	893
0876-97	Uniservo 22 Magnetic Tape Unit; 9-track, 1600/800 bpi, PE/NRZI, 120/60KBS	19,190	110	525	389

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Sperry Univac 90/60 and 90/80

EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
MAGNETIC TAPE UNITS (Continued)					
0876-95	Uniservo 24 Magnetic Tape Unit and Control; 9-track, 1600/800 bpi, PE/NRZI; built-in control unit controls up to eight Uniservo 22 or 24 tape units	46,735	233	1,244	1,008
0876-93	Uniservo 24 Magnetic Tape Unit; 9-track, 1600/800 bpi, PE/NRZI, 200/100KBS	21,215	121	694	532
F2800-99	Additional Control Unit for dual access operation; requires two channels and dual access feature	25,520	111	667	504
F3116-01	Dual Access Feature; provides simultaneous operation; requires two control units and two channels	2,450	15	53	42
F3132-00	Dual Channel; provides non-simultaneous operation of the control unit on two channels	4,415	28	95	79
F3136-04	Translation Feature; requires ASCII (processor) to EBCDIC (tape) translator	2,065	11	47	32
5042-00	Uniservo 30 Series Control; controls up to eight Uniservo 30, 32, 34, or 36 tape units	48,143	366	1,290	953
F2131-00	9-Track NRZI for 5042-00 control	3,171	24	84	63
F2132-99	7-Track NRZI for 5042-00 control	1,915	12	42	32
F2135-00	Dual Channel; provides additional I/O channel for 5042-00 control	5,229	40	138	104
F2137-00	16-Drive Addressing; must be added to all control units	835	5	22	15
0872-00	Uniservo 30 Magnetic Tape Unit; 9-track, 1600/800 bpi, PE/NRZI, 320/160KBS	30,335	230	860	601
0872-02	Uniservo 30 Magnetic Tape Unit; 7-track, 800/556/200 bpi, NRZI, 160/111/40KBS	30,335	230	860	601
F2123-00	7- to 9-Track Conversion; converts 0872-02 tape unit to 0872-00 tape unit	3,287	0	87	65
0873-00	Uniservo 32 Magnetic Tape Unit; 9-track, 6250/1600 bpi. GCR/PE, 470/120KBS	27,552	208	799	546
0873-02	Uniservo 34 Magnetic Tape Unit; 9-track, 6250/1600 bpi, GCR/PE, 780/200KBS	31,448	239	916	623
F2125-00	Tape Speed Conversion; converts a Uniservo 32 tape unit at 75 ips to a Universo 34 unit at 125 ips	4,011	31	106	80
0874-00	Uniservo 36 Magnetic Tape Unit; 9-track, 6250/1600 bpi, GCR/PE, 1250/320 KBS; for 90/80 processors only	33,674	256	982	667
PUNCHED CARD EQUIPMENT					
0604-99	Card Punch and Control; 250 cpm	26,640	230	615	496
F0875-00	Read/Punch Feature for 0604-99	7,152	87	156	130
0716-95	Card Reader and Control; 600 cpm	12,192	93	267	190
0716-99	Card Reader and Control; 1000 cpm	15,504	154	339	275
F1487-00	Short Card Feature; 51 columns	1,968	16	45	32
F1487-01	Short Card Feature; 66 columns	1,968	16	45	32
F1488-00	Validity Check Feature	816	0	18	14
F1498-00	Alternate Stacker Fill Feature	528	0	12	8
F1530-99	Dual Translate Feature; provides additional ASCII translator	1,104	5	25	18
F1529-00	1000-cpm Upgrade; upgrades 0716-95 card reader to 0716-99 card reader	3,312	61	72	50
PRINTERS					
0770-00	Line Printer; 800 lpm	56,304	341	1,300	1,041
0770-02	Line Printer; 1400 lpm	64,896	447	1,498	1,196
0770-04	Line Printer; 2000 lpm	86,686	681	2,951	1,920
F1533-00	160 Print Positions	4,416	24	102	82
F1534-00	Expanded Character Set Control; required for character sets with more than 48 characters	2,880	5	66	53
F2230-00	Speed Upgrade; upgrades 0770-00 to 1400 lines per minute	8,592	106	198	155
F2230-01	Speed Upgrade; upgrades 0770-00 to 2000 lines per minute	30,382	228	1,159	559
F2230-02	Speed Upgrade; upgrades 0770-02 to 2000 lines per minute	21,790	122	961	404
	Print Cartridges:				
F1536-00	48-character alphanumeric Business	462	0	24	19
F1536-01	48-character alphanumeric Scientific	462	0	24	19
F1537-00	94-character ASCII	462	0	24	19
F1537-03	68-character universal ISO OCR-B	462	0	24	19
F1537-04	68-character universal OCR H-14	462	0	24	19
F1537-05	58-character COBOL-FORTRAN-Business	462	0	24	19
F1537-06	177-character International	462	0	24	19
F1537-09	24-character Numeric	462	0	24	19
F1537-11	68-character universal OCR-A	462	0	24	19
F1537-12	68-character universal OCR-B	462	0	24	19
F1537-13	68-character universal 77L	462	0	24	19
F1537-14	63-character modified FORTRAN	462	0	24	19
F1537-15	63-character modified ASCII	462	0	24	19

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EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
PRINTERS (Continued)					
0776-00	Line Printer; 760 lpm	36,570	261	958	765
0776-02	Line Printer; 900 lpm	41,340	312	1,080	864
0776-04	Line Printer; 1200 lpm	52,150	356	1,363	1,090
F2217-00	Speed Upgrade; upgrades 0776-00 to 900 lines per minute	4,770	51	122	100
F2245-00	Expanded Character Set Control; required for character sets with more than 64 characters	1,910	5	50	40
	Print Cartridges:				
F2216-00	48-character alphnaumeric Business	1,270	0	34	26
F2216-01	48-character alphanumeric Scientific	1,270	0	34	26
F2216-07	24-character Numeric	1,270	0	34	26
F2216-08	63-character modified FORTRAN	1,270	0	34	26
F2216-09	63-character modified ASCII	1,270	0	34	26
F2216-10	48-character OCR-A	1,270	0	34	26
F2215-00	94-character ASCII	1,270	0	34	26
F2215-03	68-character universal ISO OCR-B	1,270	0	34	26
F2215-05	58-character COBOL-FORTRAN-Business	1,270	0	34	26
F2215-06	177-character International	1,270	0	34	26
F2215-11	68-character universal OCR-A	1,270	0	34	26
F2215-12	68-character universal OCR-B (ECMA-11)	1,270	0	34	26
F2215-13	68-character universal 77L	1,270	0	34	26
F2215-20	94-character optimized ASCII	1,270	0	34	26
F2215-21	68-character optimized ISO OCR-B	1,270	0	34	26
F2215-23	128-character OCR-A	1,270	0	34	26
MULTI-CHANNEL COMMUNICATIONS CONTROLLER					
8579-82	Multi-Channel Communications Controller 1 (MCC 1); includes processor with 32K bytes of storage expandable to 128K bytes, real-time clock, power protect, interface to CPU, multiplexer channel, operator console with CRT and keyboard, and Scanner 1 for attachment of up to 16 half- or full-duplex lines	52,416	246	1,092	820
8579-81	Multi-Channel Communications Controller 1A (MCC 1A); same as MCC 1 except includes Scanner 1 Expansion F2262-99	61,872	288	1,289	966
8579-80	Multi-Channel Communications Controller 2 (MCC 2); same as MCC 1 except includes Scanner 2 for control of 16 half- or full-duplex lines, expandable to a maximum of 128 half-duplex or 64 full-duplex lines	78,816	361	1,642	1,230
F2262-99	MCC 1 to MCC 1A Expansion	9,456	41	197	150
F1800-01	Manual Channel Switch; provides capability to switch an MCC between multiplexer channels of two Series 90 host processors	4,305	17	83	62
F1793-99	16K-byte Storage Expansion; expands MCC 2 storage from 32K to 48K bytes	10,300	40	250	195
F1793-98	16K-byte Storage Expansion; expands MCC 1 or MCC 1A storage from 32K to 48K, 64K to 80K, or 96K to 112K bytes; expands MCC 2 storage from 64K to 80K or 96K to 112K bytes	10,300	40	250	195
F1793-97	16K-byte Storage Expansion; expands MCC 1, MCC 1A, or MCC 2 storage from 48K to 64K, 80K to 96K, or 112K to 128K bytes	10,300	40	250	195
F2264-01/ -99	64-Port Parameter Module; provides MCC 2 with high-speed register storage for up to 64 half-duplex or 32 full-duplex lines; maximum of one per MCC 2; excludes use of F2264-02 and -98	2,496	10	52	39
F2264-02/ -98	128-Port Parameter Module; provides MCC 2 with high-speed register storage for up to 128 half-duplex or 64 full-duplex lines; maximum of one per MCC 2; excludes use of F2264-01 and -99	3,456	14	72	54
F2263-00	Line Adapter Chassis; expands number of line adapter positions of MCC 2 from 32 to 64 or from 96 to 128; maximum of 2 per MCC 2	2,360	11	59	44
F2263-02	Line Adapter Chassis Expansion; expands number of line adapter positions of MCC 2 from 64 to 96; F2263-00 is prerequisite	1,120	4	28	21
F1825-02	Line Indicator—Type II; provides visual display of line activity on up to 16 half-duplex or 8 full-duplex lines; maximum of 8 per MCC 2, which is prerequisite	440	2	11	9
F1801-01	Line Base II; provides interface and control for up to 16 line adapters on MCC 2; maximum of 7 per system	600	3	15	11
F1796-00	Dual Dial Adapter—Type I; provides interface to two Bell 801 ACU's; maximum of four per MCC 1 or eight per MCC 1A	872	5	23	18
F1798-00	Line Adapter—Asynchronous Type I; contains two full- or half-duplex serial modem interfaces (RS-232C and CCITT-V24); attaches to MCC 1 or 1A	630	4	18	14
F1798-01	Line Adapter—Asynchronous Type I; compatible with MIL-STD-188C	630	4	18	14
F1799-00	Line Adapter—Synchronous Type I; contains two full- or half-duplex serial modem interfaces (RS-232C and CCITT-V24) for MCC 1 or 1A	900	4	24	19
F1799-01	Line Adapter—Synchronous Type I; compatible with MIL-STD-188B/C	900	4	24	19

*Lease prices do not include equipment maintenance.

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Sperry Univac 90/60 and 90/80

EQUIPMENT PRICES

		Purchase	Monthly Maint.	1-Year Lease*	5-Year Lease*
MULTI-CHANNEL COMMUNICATIONS CONTROLLER (Continued)					
F1814-00	Wide-Band Adapter—Type I; provides capability to connect two synchronous full-duplex lines for operation at up to 66K bps	1,734	14	45	35
F1866-01	Active Line Indicator I; displays the line activity on data sets connected to MCC 1 or 1A; includes capacity for 16 displayed lines	528	2	12	9
F2371-00	TWX Line Adapter—Type I	1,320	7	33	25
F2373-00	Telex Interface—Type I; provides dual interface between F1798-00 Line Adapter and Telex lines in the United States; requires 8591-00 and F1798-00 on MCC 1 or MCC 1A	1,520	7	38	29
8591-00	Line Adapter Expansion Cabinet—Type I; provides power and housing for F2373-00	4,524	23	113	85
F1828-00	Asynchronous Line Adapter—Type II; provides full- or half-duplex interface to asynchronous data sets conforming to RS-232C or CCITT-V24 and -V28	600	7	15	13
F1828-01	Asynchronous Line Adapter—Type II; same as F1828-00, but also provides a reverse channel of up to 5 bps asynchronous for Bell 202 type modems	760	8	19	16
F1828-02	Asynchronous Line Adapter—Type II; same as F1828-00, but also provides a supervisory channel of up to 150 bps asynchronous	920	10	23	20
F1829-00	Asynchronous Line Adapter—Type II; provides a full- or half-duplex interface for compliance with MIL-STD-188C and MIL-STD-188-100 low-level interface	600	7	15	13
F1826-00	Synchronous Line Adapter—Type II; provides a full- or half-duplex interface to synchronous data sets conforming to RS-232C and CCITT-V24 and -V28	760	8	19	16
F1826-01	Synchronous Line Adapter—Type II; same as F1826-00, but also provides a supervisory channel of up to 150 bps asynchronous	1,160	10	29	25
F1827-00	Synchronous Line Adapter—Type II; provides a full- or half-duplex interface for compliance with MIL-STD-188C and MIL-STD-188-100 low-level interface	760	8	19	16
F1832-00	Asynchronous Relay Line Adapter—Type II; provides an asynchronous full- or half-duplex interface optionally compatible with either 20-75 mA neutral or 10-40 polar telegraph lines	600	7	15	13
F1830-00	Wideband Line Adapter—Type II; provides capability to connect one synchronous full- or half-duplex line for operation at 19.2, 50, or 90.8K bps; used with AT&T 300 Series Data Sets	920	10	23	20
F1834-00	Wideband Line Adapter—Type II; same as F1830-00, but conforms to CCITT-V35	920	10	23	20
F1831-00	Dial Adapter Single—Type II; provides interface to one Bell 801 ACU	600	7	15	13
F1836-00	Telex Line Adapter—Type II	600	7	15	13
F1835-00	TWX Line Adapter—Type II	600	7	15	13

SOFTWARE PRICES

		Monthly Rental
6530-00	APL/90	$200
6130-01	UTS 400 COBOL (VS/9)	83
6201-01	UTS 400 EDIT	44
6504-00	UNIS 90 OS/4 Master Data Processor	75
6504-02	UNIS 90 OS/4 Inventory Management	75
6504-04	UNIS 90 OS/4 Production Planning and Scheduling, and Work Order Management; requires 6504-00 and 6504-02	125
6513-00	UNIS 90 VS/9 Master Data Processor	150
6513-02	UNIS 90 VS/9 Inventory Management	300
6513-04	UNIS 90 VS/9 Production Planning and Scheduling, and Work Order Management; requires 6513-00 and 6513-02	300
6513-97	UNIS 90 VS/9 Master Data Processor and Inventory Management	450
6513-98	UNIS 90 VS/9 Inventory Management, Production Planning and Scheduling, and Work Order Management	600
6513-99	UNIS 90 VS/9 Master Data Processor, Inventory Management, Production Planning and Scheduling, and Work Order Management	750■

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