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UNIVAC 90/60 and 90/70

MANAGEMENT SUMMARY

Introduced in October 1973, the UNIVAC 90/60 and 90/70 computers are designed to provide a compatible upgrade path for users of UNIVAC's maturing 9000 Series and Series 70 (ex-RCA) systems. In addition, with the Series 90 announcement UNIVAC adopted a more aggressive marketing stance, aiming the two processors at the large number of IBM System/360 Model 30 and Model 40 computers that have been pursued by IBM with its 370/135 and 370/145 systems.

The 90/70 incorporates the architectural features of the earlier UNIVAC 9700 system, but is equipped with metal oxide semiconductor (MOS) main memory in place of the plated wire memory originally supplied with the 9700. MOS main memory first appeared in the UNIVAC product line in the 9840 computer, announced in March 1973, and has since also replaced plated wire technology in the main memories of the newer models of UNIVAC's popular large-scale 1100 Series computers.

At the time of the announcement of the 90/60 and 90/70 systems, UNIVAC also announced plans to introduce three additional models in the new Series 90 line-up at six-month intervals. In June 1974, just about on target, the small-scale 90/30 joined the Series 90 family, aimed at the aging UNIVAC 9200/9300 accounts as well as small-scale IBM systems. No other models have been announced to date, but Datapro believes there is at least one larger Series 90 system in the wings to provide a growth path for users of large Series 70 computers.

With the announcement of the Series 90 family, UNIVAC indicated that for the time being growth for its byte-oriented 9000 Series and Series 70 customers will be provided in the form of an enhanced 9000 Series systems architecture, and that the products that will merge the small-to-medium-scale byte-oriented products with the incompatible large-scale, word-oriented 1100 Series computers are still somewhere off in the future.

During the past year UNIVAC has announced significant modifications to both the software and hardware ➤



This view of a fairly small, disc-oriented UNIVAC 90/70 configuration shows the CRT-equipped System Console in the foreground and the Central Processor at left rear.

The 90/60 and 90/70 are the largest current members of the UNIVAC Series 90, a family of byte-oriented IBM-compatible systems designed as a growth path for UNIVAC 9000, UNIVAC Series 70, and IBM 360/30 and 360/40 users. Both systems run under the VS/9 virtual memory operating system. The 90/60 and 90/70 are priced to compete with the IBM 370/135 and 370/145, respectively.

CHARACTERISTICS

MANUFACTURER: Sperry Univac Division, Sperry Rand Corporation, P.O. Box 500, Blue Bell, Pa. 19422. Telephone (215) 542-4011.

MODELS: UNIVAC 90/60 and 90/70.

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: Optional 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 63. A guard digit is carried by the hardware for intermediate "place holding" during addition/subtraction, multiplication, comparison, and halving.

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

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▷ configuration possibilities of the two systems. Early in 1975 UNIVAC surprised many industry observers by announcing the end of OS/7 development efforts in favor of adopting the most recent release of the ex-RCA Virtual Memory Operating System, renamed VS/9, as software support for the 90/60 and 90/70 systems.

The VS/9 announcement necessarily involved some modifications to the Series 90 central processors and I/O facilities. The relocation hardware and indirect addressing features required to support basic functions of the OS/7 Operating System have been replaced by a Dynamic Address Translation feature to support the virtual address translation activities of VS/9. The new DAT hardware was offered at no additional charge to current 90/60 and 90/70 installations, and resulted only in modest increases in the purchase and rental prices of new central processors. Other hardware modifications resulting from the switch to VS/9 include elimination of the Operating System Storage Facility (OSSF) in favor of modular units of the 8405 Fixed-Head Disc Subsystem to be used as a backing store for VS/9 in both 90/60 and 90/70 systems, and the substitution of a communications controller that performs functionally like the Series 70 Communications Controller Multi-Channel (CCM) in place of the earlier Communications Intelligence Channel (CIC) to support the VS/9 communications software. Finally, the maximum number of Selector Channels was increased to four for the 90/60 central processor and five for the 90/70 central processor.

Six months later, in July 1975, UNIVAC also added 200-million-byte removable disk pack drives and an attractively priced medium-speed magnetic tape drive to the array of peripheral devices available for 90/60 and 90/70 systems.

THE UNIVAC 90/70

The UNIVAC 90/70 was originally announced as the UNIVAC 9700 in November 1971 and was first delivered one year later, in Austria. Its reception in the U.S. was delayed somewhat as prospective users tended to hold off until the 90/70 could be delivered with OS/7, the advanced operating system that was intended to fully utilize the computer's hardware features.

Targeted at the IBM System/370 Model 145, the 90/70 can be equipped with up to 1048K bytes of semiconductor main memory and has an instruction set comparable to that of the System/360 Model 50, including floating-point arithmetic.

The basic performance of the 90/70 central processor can be roughly judged by commercial instruction mix comparisons calculated by UNIVAC. On a scale that ranks the IBM System/360 Model 50 as 1, the 370/145 equals about 2, and the 90/70 rates about 2.2 to 2.3. The 90/70 thus ranks as a somewhat less costly alternative to the IBM 370/145. But the 90/70 is only about 10 to 15 percent more powerful than the UNIVAC Series 70/6, making it an unlikely contender for upgrading many of the installed ex-RCA Series 70/6 and 70/7 computer systems. Datapro expects the not-so-distant future to hold an even more powerful member of the Series 90 to supply the horsepower necessary to move these users into the mainstream of the UNIVAC product line.

▶ **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 131,072 to 524,288 bytes in eight sizes: 131K, 163K, 196K, 229K, 262K, 327K, 393K, or 524K. 90/70—From 131,072 to 1,048,576 bytes in nine sizes: 131K, 196K, 262K, 393K, 524K, 655K, 786K, 917K, or 1,048K bytes.

CYCLE TIME: 0.6 microsecond per 4-byte access in both models.

CHECKING: Parity bit with each byte is generated during writing and checked during reading, with additional parity generation and checking provided on the channels and memory busses.

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 others' address space.

RESERVED STORAGE: The first 640 bytes of main storage 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, now standard in all 90/60 and 90/70 central processors, translates virtual storage addresses into real main memory addresses as each instruction is executed. The DAT feature is identical in both the 90/60 and 90/70 processors and incorporates a Content Addressable Memory (CAM) consisting of eight 32-bit registers. 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 byte 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 is comprised of 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 CAM maintains the real page addresses for the eight most recently referenced pages, all of which can be examined concurrently within 30 nanoseconds. If a "CAM hit" occurs (in which the block, segment, and page designators of the instruction match a real page address in the CAM), the CAM 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 the CAM. 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. UNIVAC estimates that the three memory accesses can be executed within 1.8 microseconds.

CONTROL STORAGE: In addition to main storage, a fast writeable control storage of from 2K to 6K 72-bit words (16K to 48K bytes) is available for the microprograms used ▶

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▷ As it was originally announced, the 90/70 incorporated advanced features such as writeable control storage, relocation hardware, and indirect addressing. The relocation and indirect addressing features became redundant and were replaced by Dynamic Address Translation hardware when UNIVAC replaced OS/7 with the virtual memory operating system, VS/9. The 90/60-90/70 "DAT box" is based on the design of the original Content Addressable Memory (CAM) independent in the 70/7 and uses a 24-bit address consisting of a 4-bit block designator, a 4-bit segment designator, a 4-bit page designator, and a 12-bit byte designator to address any byte in main memory. Since the high-speed CAM maintains translation information on the eight most recently referenced pages, a "CAM hit" can be processed in 30 nanoseconds on either processor. According to UNIVAC studies, some 99 percent of all address translations are made in the CAM without main storage access. The writeable control storage is used for the microprograms that implement the system's emulation capabilities as well as its expanded instruction set and differs from that of the System/370 in that it does not use up any main storage capacity.

THE UNIVAC 90/60

The UNIVAC 90/60 is basically a scaled-down version of the 90/70 and is intended to serve as an upgrade system for users of smaller UNIVAC 9000 Series and Series 70 systems, such as the UNIVAC 9400 and Series 70/35, 70/45, and 70/2, for which the 90/70 would represent too large a jump in performance and cost. In terms of processor performance, the 90/60 offers an estimated 2.2 times the performance of the 9480 and is approximately 40 percent slower than the 90/70, with a comparable reduction in central processor price. However, the 90/60 uses the same MOS memory as the 90/70 and supports nearly the same complement of peripherals.

In addition to its orientation toward smaller members of the UNIVAC customer base, the 90/60 is aimed directly at the thousands of System/360 Model 30's and 40's remaining in the IBM customer base. Based on UNIVAC commercial instruction mix comparisons, the 90/60 is estimated to provide approximately 60 percent more processing power than its primary competitor, the IBM 370/135, at approximately the same cost on a one-year lease. UNIVAC offers additional savings in the form of attractive 5-year lease prices plus a still primarily bundled software policy.

Like the 90/70, the 90/60 offers an instruction repertoire that includes the complete IBM 360/50 set of instructions. The 90/60 also incorporates the same architectural features as the 90/70, including the DAT feature, writeable control storage, and MOS main memory. Main memory capacity, however, is half that of the 90/70, ranging from 131K to 524K bytes.

In addition to slower instruction execution speeds, the 90/60's input/output capabilities are slightly more curtailed than those of the 90/70. One multiplexer channel is standard, but the optional Expanded Interface feature, which allows the number of physical controllers on the multiplexer channel to be increased to 16, is available only for the 90/70. A total of four selector channels, one standard and three optional, are available on the 90/60, compared to the 90/70's maximum of five. ▷

▷ to support integrated emulation, floating-point hardware, microdiagnostics, and the native-mode instruction set; UNIVAC has priced each of these to include the control storage required for its own microprogram support. The floating-point hardware is included in the basic 90/60 and 90/70 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 UNIVAC support personnel.

INSTRUCTION REPERTOIRE: 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 and decimal arithmetic using variable-length operands in packed formats, and include instructions for packing and unpacking, radix conversion, editing, loading, storing, comparing, shifting, branching, and logical operations, as well as instructions for handling ASCII or EBCDIC characters.

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

	90/60	90/70
Binary add/subtract (32 bits):	3.0	1.50
Floating-point add/subtract (short):	7.08	5.58
Floating-point multiply (short):	13.10	11.60
Floating-point divide (short):	30.00	28.50
Floating-point add/subtract (long):	7.73	6.23
Floating-point multiply (long):	36.50	35.00
Floating-point divide (long):	73.05	71.55
Decimal add (2-address, on signed 5-digit fields):	13.20	11.70
Compare (RX)	3.0	1.5
Branch on condition (RX)	1.2	1.2
Move (SI)	3.6	2.1
Load (RX)	3.3	1.5
Store (RX)	3.3	1.8
Supervisor call (RR)	0.3	0.3

EMULATION: Emulation features are available for IBM System/360 DOS and UNIVAC Series 70 TDOS, DOS, 301, and 501 systems.

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 UNIVAC 90/60, and three additional selector channels can be added. The 90/60 selector channels perform in the same manner as the 90/70 selector channels (below). The second selector channel is housed in the processor cabinet, and the third and fourth require the Channel Expansion Cabinet.

One multiplexer channel is standard on the 90/70. It can physically connect up to 7 low-speed subsystem controllers and a Multi-Channel Communications Controller (MCC) for an aggregate of 15 subchannel addresses. The Subchannel Expansion feature provides an additional 16 subchannels. A second Subchannel Expansion feature provides 32 more subchannels for a total of 63 subchannel addresses. The Expanded Interface feature can be added to provide up to 8 additional physical controller connections for a total of 16 controllers if the Subchannel Expansion feature has been added; otherwise, up to 7 additional controllers can be attached, not to exceed 15 physical subsystems. The maximum aggregate multiplexer channel transfer rate is 175,000 bytes per second. ▷

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➤ The move from a 90/60 to a 90/70 is clear-cut and facilitated by liberal UNIVAC upgrade policies. The step up from a 90/60 to a 90/70 central processor merely involves the field installation of the 90/70 Upgrade Feature, which can be performed without penalty under any UNIVAC contract.

PERIPHERAL EQUIPMENT

Since the original announcement of the two current top-of-the-line Series 90 systems, UNIVAC has added an attractive selection of fixed-head and removable disc pack drives to the 90/60 and 90/70 product line-up. The new random-access storage devices are manufactured by UNIVAC's ISS subsidiary and are also available for UNIVAC's large-scale 1100 Series equipment. The original Model 8405 Fixed-Head Disc was announced in January 1975 as a replacement for the earlier 90/70 OSSF and has a capacity of 3.1 million bytes per fixed disc or 24.8 million bytes per eight-drive subsystem. In contrast to the OSSF, the 8405 subsystem is available for both 90/60 and 90/70 systems, primarily for use as high-performance paging storage for VS/9.

The IBM 3330-equivalent 8430 Removable Disc System was also announced for 90/60 and 90/70 systems in January 1975, while the double-density (200-million-byte) 8433 Removable Disc System was announced for the 90/60 and 90/70 in July 1975, with initial customer delivery scheduled for January 1976. Along with the new large-capacity 8433 discs, UNIVAC also announced a double-capacity version of the fixed-head disc drive, the 9405-00 Fixed-Head Disc Subsystem, which can store 6.3 million bytes of data per unit. All of the new direct-access devices are served by a common microprogrammed control unit that allows various combinations of fixed-head and removable disc storage to be configured to suit each installation's direct access storage requirements and also supports state-of-the-art features such as command retry and automatic error detection and correction.

In addition to the 8405 Fixed-Head Disc, which can be used as an extremely fast dedicated backing store for VS/9, the 8425, 8430, and 8433 Disc Drives can also be used as VS/9 backing stores. When moving-arm direct-access storage devices are used, paging storage and data storage can be intermixed on the same disc drive and paging storage can be spread over several devices to minimize contention.

The medium-speed UNISERVO 14 Magnetic Tape Unit was announced for the UNIVAC 90/30 computer system in March 1975 and joined the 90/60-90/70 peripheral line-up in July 1975. It has a data transfer rate of 96,000 bytes per second when recording in the 1600-bit-per-inch phase-encoded mode and a rental price of \$1,393 (including maintenance) for a 9-track dual-drive subsystem, approximately 10 percent less than a two-drive UNISERVO 12 configuration.

UNIVAC has also made substantial modifications to the communications capabilities of the 90/60 and 90/70 systems as a result of the release of VS/9 for these computers. At the time of the initial announcement of VS/9, UNIVAC released versions of the Series 70 CCM (Communications Controller Multi-Channel) to support ➤

➤ One selector channel is standard on the UNIVAC 90/70, and four more can be added. Eight high-speed device controllers can be attached to each selector channel for a maximum throughput of 1.11 million bytes per second per channel on a data path 4 bytes wide. Each control unit can attach up to 16 I/O devices. Only one device can transfer data to or from main memory along a given selector channel at a time. Thus, simultaneous access of two or more high-speed devices requires that each be connected to a different selector channel. The second selector channel is housed in the processor cabinet, and selector channels 3, 4, and 5 require the Channel Expansion Cabinet.

A Direct Control feature (not supported under OS/4) is used to provide a special interface between two UNIVAC 90/60 or 90/70 processors and includes two instructions for transfer of control information between the processors.

CONSOLE: The Series 90 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 9000 Series Channel Adapter, which provides either a multiplexer or selector interface to a UNIVAC 9200/9300/9400 or 90/60 or 90/70 subsystem, is housed in the System Console.

A Multiple Channel Switch (MCS) is available to provide a capability for switching a subsystem or string of subsystems from a multiplexer or selector channel on one processor to the same type of channel on another processor or the same processor. Included with the basic MCS is cabinetry, a power supply, an operator's panel, and space for 5 additional MCS Expansion switches.

CONFIGURATION RULES: High-speed peripheral devices, such as Uniservo 12, 16, or 20 Magnetic Tape Units or 8405, 8414, 8425, 8430, or 8433 Disc 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.

SIMULTANEOUS I/O OPERATIONS: Concurrently with computing, the 90/60 and 90/70 Processors can control multiple I/O operations with a combined data rate of up to 175,000 bytes/sec on the multiplexer channel, plus one I/O operation with a data rate of up to 1.11 million bytes/sec on each selector channel.

MASS STORAGE

8405 FIXED-HEAD DISC SUBSYSTEM: Provides very fast access to up to 50.3 million bytes per subsystem stored on non-removable head-per-track discs. The average rotational delay is 8.34 milliseconds, and the maximum is 16.67 milliseconds. Each 8405-00 disc unit can store 6,291,456 bytes of information on 12 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 8,192 bytes. The data transfer rate is 622,000 bytes per second.

The 8405 Disc Subsystem uses the microprogrammed 5039 Control Unit, which can control a mixture of 8405 Fixed-Head Discs and 8430 and 8433 Disc Pack Drives. An F2076 8405 Fixed-Head Disc Feature is required for ➤

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➤ VS/9 communications software on the Series 90 systems. The CCM, however, had a limited capacity of 48 half-duplex lines and a maximum transmission speed of 300 bits per second. Then, in July 1975, UNIVAC announced a new Multi-Channel Communications Controller (MCC) as a replacement for the CCM. The new MCC is actually a version of the UNIVAC 3760 Controller that emulates the functions of the CCM and supports up to 59 half-duplex or 29 full-duplex communication lines. The MCC also 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 biggest news associated with the 90/60 and 90/70 computers during the past year was the substitution of the former RCA Virtual Memory Operating System (VMOS) for OS/7 as the primary operating system support for the 90/60 and 90/70. OS/7 was announced in November 1971 along with the original UNIVAC 9700 system and was scheduled for delivery in March 1973. But the development efforts encountered numerous difficulties, causing the operating system's delivery to be slipped by nearly a year. A version of OS/7 was demonstrated on the 90/60 system when it was announced in October 1973, but the full-fledged operating system with complete implementation of all its promised features was still somewhere off in the future. For the most part, new 90/60 and 90/70 accounts were started off with the OS/4 Operating System, which is essentially an expansion of the UNIVAC 9400/9480 Disc Operating System.

In the meantime, work was continuing at UNIVAC on the VMOS Operating System, and the ultimate announcement of a virtual memory operating system for Series 90 computers was considered only a matter of time. That time came in January 1975, when UNIVAC disclosed that further development of OS/7 was to be abandoned and that Release 11 of VMOS, renamed VS/9, would be supplied to all new 90/60 and 90/70 installations, although customers running OS/7 would continue to receive support at its then-current level. VS/9, thus, now serves as the ultimate upgrade operating system, not only for UNIVAC 9000 Series computers, but also for Series 70 DOS systems and Series 70 Model 45 and Model 6 installations operating under versions of the TDOS operating system.

UNIVAC claims that VS/9 provides nearly all the functions of IBM's OS/VS2 Release 2 at a substantially lower cost in hardware overhead. VS/9 can execute in a minimum of 262K bytes of main memory, although UNIVAC estimates that most VS/9 systems will operate with from 393K to 524K bytes of memory. Resident supervisor sizes are estimated at 18 4096-byte pages (72K bytes) for batch operation and 22 to 24 4096-byte pages (88 to 92K bytes) for batch and interactive execution.

UNIVAC acquired the VMOS operating system with the takeover of the RCA customer base in January 1972. VMOS is an outgrowth of the original Time-Sharing Operating System (TSOS) released for the RCA Spectra 70/46 in 1967 and for the Spectra 70/61 two years later. With the announcement of the RCA Series computers in 1970, the name was changed from TSOS to Virtual ➤



The UNIVAC 90/60, designed and priced to be an attractive alternative to the IBM 370/135, offers from 131K to 524K bytes of MOS main memory with a cycle time of 600 nanoseconds per 4-byte access. The same memory is used in the faster UNIVAC 90/70.

➤ attachment of up to eight 8405 units in single-unit increments. The 5039 Control Unit performs command retry and automatic error detection and correction. The current 8405 was announced for 90/60 and 90/70 computers in July 1975 and is scheduled for first customer delivery for these systems in January 1976.

An earlier version of the 8405, the 8405-04 Disc Subsystem, which has a storage capacity of 3.1 million bytes per fixed disc, is also available.

8425 DISC DRIVE: A double-density version of the earlier 8414 Disc Drive, the 8425 stores 58 million bytes per disc pack. Each IBM 2316-compatible pack has 406 tracks on each of the 20 surfaces used for data recording. Each track can contain up to 7,294 eight-bit bytes. Average arm positioning time is 30 milliseconds, average rotational delay is 12.5 milliseconds, and the data transfer rate is 312,000 bytes per second. A 5024-99 Controller is used to control up to eight drives, for an on-line capacity of 466 million bytes. Options for the 8425 include Dual Access (which is used on each drive when two controllers on separate selector channels are employed) to provide read/write simultaneity on any two drives), and Dual Channel (two channel connections for the same controller, with access controlled by an operator's switch).

8430 DISC SUBSYSTEM: Provides large-capacity random-access storage on removable disc packs with storage capacities comparable to the standard-density (100-million-byte) IBM 3330 Disc Storage Subsystem. Each disc 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. ➤

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➤ Memory Operating System to add a new fillip to RCA's marketing campaign—since RCA's product line included virtual memory capabilities that were not yet available for the IBM System/370 computers. Since the demise of the RCA computer operation, UNIVAC states that along with maintaining the operating system for some 44 current VMOS users, it has enhanced the system's reliability, added new recovery techniques, tuned the scheduling algorithm, and improved its memory management facilities.

In contrast to the delays that accompanied the early development efforts on OS/7, VS/9 was ready for delivery for Series 90 systems at the time of its announcement and, in fact, was already installed and running in a 90/60 customer site.

VS/9 includes two levels of communications software support, the Communications Access Method (CAM) and the Communications Oriented Software (COS). CAM is essentially a set of reentrant software routines to facilitate the implementation of simple inquiry/response programs, while COS is a user-tailored communications system that can supervise up to six user programs and provide support for communications applications ranging from inquiry/response to full store-and-forward message switching.

The higher-level languages that were operational on Series 70 computers under VMOS were brought over to the 90/60 and 90/70 under VS/9. These include an ANS-68 COBOL compiler (with an ANS-74 COBOL planned for future release), FORTRAN IV, RPG, BASIC, the VS/9 Assembler, and facilities for interactive program development and file manipulation.

Information management software, which is making a significant contribution to the marketing success of the UNIVAC 1100 Series systems, is also receiving strong emphasis in the Series 90 software product line. DMS/90, a generalized data base management system based on CODASYL specifications, was originally introduced for the 90/60-90/70 computers in 1973 and now executes under VS/9. IMS/90, an on-line storage and retrieval system, is planned for release under VS/9 as a standalone system in January 1976 and is scheduled for merger with the DMS/90 data base management system for operation under VS/9 in July 1976.

COMPATIBILITY

With an instruction set comparable to that of the IBM System/360 Model 50, both the 90/60 and 90/70 offer a high degree of compatibility with the targeted IBM 360/30 and 360/40 computers. Compatibility with the System/360 is also achieved through compatible source languages that are essentially the same as their System/360 counterparts. Differences in "privileged" instructions between the System/360 and Series 90 operating systems can be handled by the System/360 emulator, which is supported on the 90/60 and 90/70 as a standalone function and provides an interim solution for System/360 users with requirements for additional processing power.

UNIVAC states that the architectural similarities between the Series 70/7 and the 90/60 and 90/70 will permit programs to be interchanged among these systems under ➤

➤ 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 Disc Drives. The 8430 Disc Pack Drives can also be intermixed with 8433 Disc 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 Disc Storage Drives. A dual-access feature and a second 5039 Control Unit permit simultaneous read and write operations on any two 8430 Disc Drives. The 8430 features a command retry facility and error correction coding circuitry. The 8430 was announced with the UNIVAC 90/60 and 90/70 systems in January 1974 for delivery in September 1975.

8433 DISC SUBSYSTEM: Provides random access to very large quantities of data stored on removable "double-density" 3330-type disc packs. Each industry-standard disc 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. Data transfer rate is 806,000 bytes per second.

From two to eight 8433 Disc 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 Disc Pack Drives can be intermixed on one 5039 Control Unit up to the maximum of 8 or 16 drives. In addition, 8433 and 8430 Disc Pack Drives can be intermixed with 8405 Fixed-Head Disc Drives. A second 5039 Control Unit and the dual access feature permit simultaneous read/wrote operations to be performed on any two drives. The 8433 includes a command retry facility and error correction coding circuitry.

The 8433 Disc Drive was announced for 90/60 and 90/70 systems in July 1975. First customer shipments are scheduled for January 1976.

8440 DISC SUBSYSTEM: Provides fairly rapid random access to very large quantities of data stored in interchangeable 11-disc packs. Each pack stores up to 119.3 million bytes. Data is recorded in 406 tracks on each of the 20 recording surfaces. Average head movement time is 30 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 624,000 eight-bit bytes/second. Record lengths are variable, with each track capable of holding up to 14,910 bytes. Standard features include Angular Position Sensing, which increases channel availability by reducing delays during record search times; Programmed Servo Offset, which permits the heads to be moved slightly away from their normal positions in attempts to recover data during search and read operations; and Error Correction Code, which permits automatic correction of many recording errors.

An 8440 subsystem consists of a control unit and from one to four 8440 Disc Storage units, each containing two independent disc drives. A dual-access subsystem can be configured by adding a second control unit and installing a Dual Access feature in each 8440 Disc Storage unit.

INPUT/OUTPUT UNITS

UNISERVO 12 MAGNETIC TAPE UNIT: A medium-speed tape drive that reads and records data on standard ½-inch tape in IBM-compatible phase-encoded or NRZI format. Available in both 9-track and 7-track versions. Tape speed is 42.7 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 68,320 bytes per second; the optional Dual Density feature permits operation at 800 bpi (in NRZI mode) at a data rate of 34,160 bytes per second. The 7-track version can operate at 200, 556, or 800 cpi, with corresponding data rates of 8,540, 23,740, or 34,160 characters per second. The Data Conversion feature, for 7-track drives, converts each group of four 6-bit characters from tape into three 8-bit bytes in main storage, and vice versa. ➤

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➤ the VS/9 Operating System. According to the vendor, conversions from smaller Series 70 systems can be accomplished with relative ease by recompiling programs written in the COBOL, RPG, and FORTRAN languages, which UNIVAC estimates are nearly 99 percent compatible with their VS/9 counterparts. In addition, the Series 70 Mode of Operation Through Hardware (SMOOTH) emulates Series 70 TOS, TDOS, and DOS environments.

An Assembly translator is provided to convert Series 70 TDOS and DOS source programs and user-written macros to equivalent VS/9 Assembly source language. Series 70 magnetic tape files are compatible with VS/9 and are acceptable as input to VS/9 and to user programs. UNIVAC provides utilities to transcribe Series 70 disc files to magnetic tape and to reload the data on discs in a format acceptable to VS/9 data management routines and VS/9 programs. Transportability of Series 70 communications programs to VS/9 is facilitated through the availability of the functional capabilities of the TDOS and DOS Communications Oriented Software (COS) and CCM-equivalent hardware.

The subject of upward compatibility of OS/4 with VS/9 was addressed by UNIVAC in November 1975 with the announcement of a series of software conversion aids. UNIVAC has approximately 750 of its 9400/9480 systems installed, and although many are on 5-year lease contracts, at least one version of the contract allows upgrading to a larger system without penalty. The OS/4 to VS/9 conversion aids include source-language translators for OS/4 COBOL and Assembly-language programs and COBOL COPY library modules. Both translators produce optional before and after source listings and translation diagnostics.

OS/4 FORTRAN and RPG II programs can be recompiled for execution under VS/9. A Virtual Memory Editor (EDT) can also be used for modifying source-language programs stored in VS/9 files in sequential or indexed sequential format. EDT supports a comprehensive repertoire of commands for creating, deleting, inserting, copying, moving, modifying, and prefixing and suffixing of lines and text within lines. The Editor can also scan programs for specified character strings and modify the strings according to user directives. OS/4 magnetic tape files are directly acceptable as input to VS/9 software, while utilities are available to dump OS/4 disc files and reload them in VS/9-acceptable format. Finally, a Library Transcriber is provided for translating OS/4 Source, Proc, and COBOL COPY libraries into VS/9 program files for use by VS/9 program preparation components.

Until now, UNIVAC has remained one of the most fully bundled computer manufacturers, supplying all systems software, compilers and assemblers, file and data base management systems, and applications programs free of charge to its computer customers. Some small modification of that posture first appeared at the time of the 90/30 announcement in June 1974, when the company imposed separate monthly license fees on selected applications programs in what was designated a "visible pricing" policy. In July 1975 separate monthly license fees were placed on each of the four modules that comprise the UNIVAC Industrial System (UNIS) for 90/60 and 90/70 systems as well as for the 90/30 and 9480. It is probably safe to assume that UNIVAC is ➤

➤ From 1 to 16 Uniservo 12 Tape Units can be connected to a Uniservo 12 tape control, and up to 8 controls can in turn be connected to each UNIVAC Series 90 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, with bimodal (7- or 9-track) compatibility.

With addition of the Uniservo 16 Capability option, any combination of up to sixteen Uniservo 12 and Uniservo 16 drives may be connected to the Uniservo 12 Control. A Uniservo 12/16 Control is also available which includes the Uniservo 16 Capability as a standard feature.

UNISERVO 14 MAGNETIC TAPE UNIT: Reads and records data on standard 1/2-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 cpi, 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. The Uniservo 14 Magnetic Tape Units were announced for 90/60 and 90/70 systems in July 1975 and are scheduled for first customer delivery for those systems in January 1976.

UNISERVO 16 MAGNETIC TAPE UNIT: A high-speed tape drive that reads and records data on standard 1/2-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 12 and Uniservo 16 Tape Units can be connected to a Uniservo 12/16 Control, or any combination of 1 to 16 Uniservo 12, 16, or 20 Tape Units can be connected to a Uniservo 20 Control, and up to 8 tape controls can in turn 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 20 MAGNETIC TAPE UNIT: A high-speed tape drive that reads and records data on standard 1/2-inch tape in IBM-compatible formats. Available in a 9-track version only. Tape speed is 200 inches per second, forward or backward. The Uniservo 20 has a recording density of 1600 bpi (in phase-encoded mode) and a data rate of 320,000 bytes per second. Standard features include a power window, automatic tape threading, and a wrap-around cartridge.

From 1 to 16 nine-track, 800 or 1600 bpi Uniservo 12, 16, and/or 20 Tape Units can be connected in any combination to the Uniservo 20 Control Unit, and up to 8 tape controls can in turn be connected to each selector channel. With the 7-Track Capability and 9-Track Addition feature, Uniservo 12 and 16 Tape Units in the Uniservo 20 subsystem may be 7- or 9-track. Two or more control units may be used in the Uniservo 20 Subsystem to provide simultaneous dual access for read/write, read/read, and write/write operations on any appropriately equipped Uniservo 16 or 20 Tape Units ➤

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➤ seriously considering following the lead of most other computer manufacturers in establishing separate charges for at least some of its software products.

USER REACTION

The UNIVAC 90/60 and 90/70 systems were represented by six responses in Datapro's 1975 survey of users of general-purpose computer systems. Four of these were 90/60 systems and two were 90/70 systems, and the length of time installed ranged from just two months to two years. All of these systems were engaged solely in business data processing, with four also performing some data communications functions. The number of remote batch terminals per system ranged from 7 to 14.

Two 90/60's and one 90/70 were upgrades of UNIVAC 9400/9480 systems. Two of these were running under the OS/4 Operating System, and one 90/60 installation was in the early stages of implementing VS/9 and testing production programs. Of the remaining three systems, one 90/60 replaced an IBM 370/135 and was running under OS/4, one 90/60 was upgrading an RCA installation and was executing SMOOTH as well as implementing VS/9, and the remaining 90/70 was exclusively devoted to System/360 emulation in an IBM 360/65 site. Cost/performance and IBM/RCA compatibility were the two most-mentioned reasons for the selection of the 90/60-90/70 equipment, in addition to the simplicity of moving OS/4 programs from the 9400 to the Series 90 computers.

These users' ratings and their remarks on their experiences with the systems can be summarized as follows:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	2	4	0	0	3.3
Reliability of mainframe	1	5	0	0	3.2
Reliability of peripherals	1	5	0	0	3.2
Maintenance service:					
Responsiveness	3	3	0	0	3.5
Effectiveness	2	3	1	0	3.2
Technical support	2	2	1	1	2.8
Manufacturer's software:					
Operating system	2	2	0	0	3.5
Compilers and assemblers	2	2	0	0	3.5
Applications programs	0	1	0	0	3.0
Ease of programming	2	2	0	0	3.5
Ease of conversion	3	2	0	0	3.6
Overall satisfaction	1	4	0	0	3.2

*Weighted Average on a scale of 4.0 for Excellent.

All of these users expressed a high level of satisfaction with the central processor hardware, citing raw processor speed and the high degree of IBM compatibility as distinct advantages of the hardware. The capability for growth through expansion of main memory and peripherals was also mentioned as a desirable feature of the systems.

The users' comments on the software varied somewhat depending on which UNIVAC software was being evaluated. In addition, two users decided that they hadn't had enough experience with the operating systems to supply performance ratings, although they did comment on their experiences thus far with the software.

Two of the three OS/4 users were well satisfied with the capabilities of the operating system and the smooth ➤

➤ connected to the control units. Each control unit in a simultaneous dual access system has its own power supply and independent access path to provide increased reliability. Individual tapes cannot be switched off-line without removing all the tapes connected to that controller from service.

600-CPM CARD READER: Reads 80-column cards serially by column at 600 cpm. Can be equipped to read 51- or 66-column short cards or 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. Connected via a shared multiplexer subchannel. Multi-read error checking is a standard feature.

1000-CPM CARD READER: Identical with the 600-cpm unit except for its greater speed.

250-CPM CARD PUNCH, 0604-99: Punches 80-column cards in row-by-row fashions 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. Connected via the multiplexer channel.

PAPER TAPE SUBSYSTEM: Consists of a 300-char/sec F1033-02 reader, 110-char/sec F1032-02 punch, and 0920-02 control unit in a single cabinet. Reads and punches 5-, 6-, 7-, or 8-level tape. Spoolers are optional for both the reader and punch take-up. Connected via the multiplexer channel.

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 that 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.

2703 OPTICAL DOCUMENT READER: Reads printed numeric data from individual documents ranging from 2.75 to 4.25 inches in height and 2.00 to 8.75 inches in length. Basic speed of 300 six-inch documents per minute can be increased to 600 dpm by an optional feature. Other options permit reading of vertical pencil marks and of standard 80-column punched cards. The Modulus-10 Check Digit option compares a computed modulus-10 check digit with a check digit printed on the document. Character set consists of the digits 0-9 and four special symbols, in either UNIVAC H-14, OCR-A, or OCR-B (ECMA) font. Has a 2000-document feed hopper and three 1000-document stackers. Connected via the multiplexer channel.

90/60 CHANNEL ADAPTERS: Permit any of the following small-to-medium-scale UNIVAC data processing systems to be connected to the 90/60 via their respective multiplexer or selector channels: 1004/1005, 9200, 9200 II, 9300, 9300 II, 9400, 9480, 90/60, or 90/70. Supported under OS/4 only. ➤

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▷ transition from the 9400 to the Series 90 equipment, although one stated that he might consider converting to VS/9 in order to have better communications capabilities. The third OS/4 user stated that although the software is running well now, it was initially difficult to bring up; this user was so dissatisfied with the UNIVAC technical support that he rated the category as "poor" in our survey.

One VS/9 user also described initial difficulties with bugs, but he added that when the software is working well it is "super," especially for compute-bound programs. This user cited one case in which a program that required 11 hours to execute on a Series 70/45 computer could be executed in 3 hours under VS/9. The second VS/9 user, who is currently running production programs in test mode, described the operating system as "excellent."

Other features that also generated a great deal of satisfaction among these respondents were the SMOOTH capability for executing Series 70 programs and the System/360 emulation. SMOOTH was described as an "excellent software product," while the 90/70 account that is emulating IBM System/360 programs stated that the System/360 emulation capability works well and that the 90/70 matches the performance of a 360/50 despite the emulation overhead.

As you can see, the 90/60-90/70 systems earned high ratings for their performance in nearly all of the 12 categories in the 1975 Datapro survey. The only sore point that surfaced in these interviews was dissatisfaction on the part of two accounts with UNIVAC technical support, which led to the lone rating lower than "good" earned by the 90/60-90/70 systems in this survey. Overall, however, the medium-scale Series 90 computers earned high ratings from this sample of users. In terms of cost and performance, the users agreed that UNIVAC has delivered what was promised and that the 90/60 and 90/70 systems have considerable potential for success in the computer marketplace. □

► **90/70 CHANNEL ADAPTERS:** Permit any of the following small-to-medium-scale UNIVAC data processing systems to be connected to the 90/70 for communication via their respective multiplexer or selector channels: 9200, 9200 II, 9300, 9300 II, 9480, 90/60 or 90/70. Supported under OS/4 only.

9200 II, 9300, 9300 II, 9480, 90/60 or 90/70. Supported under OS/4 only.

Each attachable processor can function as an I/O subsystem providing peripheral capabilities. For details of the Series 9000 computer systems, please refer to Report 70C-877-01.

COMMUNICATION CONTROLS

MULTI-CHANNEL COMMUNICATIONS CONTROLLER: Announced in July 1975, the Multi-Channel Communications Controller (MCC) operates under the VS/9 Operating System and emulates the earlier Communications Controller Multichannel (CCM), the Series 70 communications controller that was transferred to 90/60 and 90/70 systems with the announcement of VS/9. In addition, the new MCC supports a larger number of communications lines, can handle higher line speeds, and can accommodate a variety of line speeds and communications protocols, including UNIVAC and other industry-standard terminals, plus computer-to-computer communications.

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 29 full-duplex or 59 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. First customer deliveries of the MCC are scheduled for November 1975.

DATA COMMUNICATIONS SUBSYSTEMS: Remote communications devices can also be connected to a UNIVAC Series 90 system by means of from one to four Data Communications Subsystems. The DCS-1, DCS-1C, DCS-4, and DCS-16 subsystems can accommodate 1, 1, 4, and 14 half-duplex or full-duplex lines, respectively. Each DCS is connected directly to a multiplexer subchannel. Any combination of up to 4 DCS's can be connected to a UNIVAC 90/60 or 90/70, subject to a limit of 30 lines maximum. The DCS hardware is supported only under OS/4.

Each DCS consists of a single Line Terminal Controller, plus a Line Terminal and Communications Interface for each connected line. Numerous models of line terminals and interfaces permit asynchronous and/or synchronous transmission over a wide range of communications services at speeds of 75 to 250,000 bits per second. The DCS-1C is a Binary Synchronous Data Communications Subsystem that enables a Series 90 computer to communicate with an IBM System/360 computer, using either EBCDIC or ASCII code and either Transparent or Nontransparent mode. The free-standing 8577-02 DCS Cabinet used with the DCS-1 or DCS-1C houses up to 4 of these units in any combination. The DCS-4 or DCS-16 includes its own free-standing cabinet and power supply.

TERMINALS: The following UNIVAC devices, most of which are described elsewhere in DATAPRO 70, are supported for use as remote terminals with the Series 90 systems: DCT 475 and DCT 500 (Report 70D-877-02), DCT 524, DCT 1000 (Report 70D-877-03), DCT 2000 (Report 70D-877-01), Uniscope 100 (Report 70D-877-05), Uniscope 200, the Series 600 Tape Cassette System (for the Uniscope 100 or Uniscope 200), and the UNIVAC 1900 Computer Aided Data Entry System (Report 70D-877-31).

SOFTWARE

OPERATING SYSTEMS: Two operating systems are available for the UNIVAC 90/60 and 90/70: OS/4, an enhanced version of the UNIVAC 9400 Disc Operating System; and VS/9, an enhancement of the original VMOS (Virtual Memory Operating System) that was developed for Series 70 (ex-RCA) systems.

OS/4: Provides essentially the same facilities as the UNIVAC 9400 DOS and is disc-oriented; no tape-oriented version is available. Enhancements which have been made to 9400 DOS consist of modifications to support the Series 90 console and the extra channels and larger memory of the Series 90. OS/4 requires at least two disc drives, a processor with 131K bytes of main memory, a card reader, and a printer (or a smaller UNIVAC computer connected as an I/O subsystem). Minimum resident memory requirement for OS/4 is about 24K bytes.

The system control facilities of OS/4 are divided into four main categories: Supervisor, Job Control, Data Management, and Message Control.

The Supervisor resides in main storage and schedules and coordinates all activities within the system. Its functions include interrupt handling, I/O scheduling and initiation, job time allocation, operator communication, job accounting, and control of multiprogrammed operations. Up to five independent programs can be executed concurrently if sufficient memory and peripherals are available. The Super- ▶

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► visor provides five different priority levels, three of which are available for users' programs.

The OS/4 Job Control routine controls transitions between job steps, suspension or cancellation of jobs, restarting of jobs, and termination of jobs. It receives its instructions from control cards which constitute a "job stream." Job streams can be stored in disc files for subsequent selection and execution.

Data Management provides comprehensive input/output control facilities, including record blocking and unblocking, I/O buffering, data validation, and label processing. These facilities are provided by subprograms which are generated as part of the operating system and referenced by macro-instructions in users' programs. Nonsequential files in disc storage can be accessed by either the Direct (random) Access Method, in which the user must specify the relative or absolute address of the desired disc record, or the Indexed Sequential Access Method, in which the user need only specify the key of the desired record. In a multiprogramming environment, the Data Management routines can be shared by all programs, thereby reducing main storage requirements.

The OS/4 Message Control Program provides macro-instructions that enable the user to generate custom-tailored message control and message processing routines to handle communications input/output. Messages of fixed or variable length can be queued in main and/or disc storage, and the generated routines can perform functions such as code translation, message sequencing, time stamping, and error checking. Main memory requirements for the Message Control Program routines range from 20K bytes for an entry-level system to 36K bytes for use of the complete facilities, not including buffering.

VS/9: Announced in February 1975, VS/9 is now the principal operating system for UNIVAC 90/60 and 90/70 systems. VS/9 offers functional capabilities for concurrent processing of local and remote batch programs, transaction processing, data communications, and interactive processing. The virtual memory features of VS/9 allow programs to be located in memory in noncontiguous pages of 4,096 bytes each that are swapped in and out of main memory on a demand basis. VS/9 supports a total virtual 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 Data 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 disc 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), and BTAM (Basic Tape 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 Statistical Historical I/O Error Rates (SHIOR) utility monitors the activity of designated peripherals and accumulates data on peripheral errors. The Basic Processor Exerciser (IHBPXR) exercises internal CPU logic in an on-line environment to detect malfunctions primarily associated with arithmetic logic.

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, a Virtual Memory Editor for file creation and deletion and modification, a COBOL Program Development System (CODE), a Desk Calculator mode of operation, Sort/Merge, and the Interactive Debugging Aids.

COMMUNICATIONS ACCESS METHOD (CAM): CAM consists of a group of re-entrant subroutines for establishing communications between a VS/9 problem program and one or more remote terminals. When multistation lines are employed, an extension to CAM provides a polling facility that uses user-supplied directives to establish the sequence and frequency of the polling cycle. For single-station lines, CAM interfaces with the executive routines of VS/9 for physical terminal interfacing. Multiple programs, each interfacing with one or more terminals, can be supported. CAM is used primarily for implementation of simple inquiry/response applications.

COMMUNICATIONS ORIENTED SOFTWARE (COS): 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. COS consists of three major components, the Communications Interrupt Analysis (CIA), the Communications Control Program (CCP), and one or more Communications User Programs. The Communications Interrupt Analysis component is an extension of the operating system that analyzes each communications interrupt and initiates the appropriate Communications Control Program function to process it. The Communications Control Program services all communications interrupts; performs communications line handling, message queuing, internal buffering, error handling, and code translation; and handles batched output and message switching functions. The CCP also serves as an interface to from one to six installation-written Communications User Programs which execute user-specified message-processing functions. Messages are transferred to and from the CUP's by means of GET and PUT macro-instructions.

COBOL: UNIVAC offers two COBOL compilers for use under OS/4. Basic COBOL requires a system with 131K bytes of main storage and includes the minimum American National Standard COBOL language facilities (i.e., Level 1 of the Nucleus, Sequential Access, Segmentation, and Table Handling modules). Extended COBOL requires a system with 131K bytes of main storage and two disc drives. It includes the following facilities of ANS COBOL: Level 2 of the Nucleus, Sequential Access, and Table Handling modules, and Level 1 of the Random Access, Sort, and Segmentation modules. ►

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► **VS/9 COBOL** is an implementation of ANS-1968 COBOL that includes Level 2 of the Nucleus, Sequential Access, Random Access, Sort, Segmentation, and Library Modules and Level 3 of the Table Handling module. The ANS-68 COBOL compiler requires 80K bytes of main memory. Also available is a BGC0B COBOL compiler that provides a high degree of compatibility with IBM COBOL F.

FORTRAN: An OS/4 FORTRAN compiler is available for operation on the minimum 131K UNIVAC 90/60 or 90/70 system. It includes all the language facilities of full American National Standard FORTRAN, and is 360 FORTRAN F compatible. In addition, there are more than 20 useful language extensions, such as direct-access I/O statements and the ability to handle arrays of up to 7 dimensions.

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.

REPORT PROGRAM GENERATOR: The OS/4 RPG is designed to accept UNIVAC 9200/9300/9400 RPG source programs for generation and execution on a 90/60 or 90/70. It is available for the minimum UNIVAC 90/60 or 90/70 with 131K bytes of main storage. The generated RPG object programs can be recorded on tape, disc, or punched cards to eliminate the need for re-generation of the program before subsequent report runs. The object programs are relocatable modules that can be linked to other programs and stored in disc or tape libraries.

The VS/9 RPG II Compiler is functionally equivalent to IBM RPG II and is a superset of OS/4 RPG.

BASIC: An Extended BASIC is offered under the VS/9 Operating System. The 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 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): Scheduled for release under VS/9 in January 1976, IMS/90 was originally announced for the UNIVAC 9480 system and was first installed in August 1974. IMS/90 is an on-line information retrieval system for inquiry and update-oriented file processing applications. IMS/90 currently uses the indexed sequential (ISAM) and sequential (SAM) data management routines of the host operating system to access user data files. It is scheduled for integration with the DMS/90 data base management system in mid-1976. IMS/90 is described in detail in Report 70E-877-01.

DATA MANAGEMENT SYSTEM (DMS/90): DMS/90 is UNIVAC's data base management system for its 90/30, 90/60, and 90/70 computers. It operates on the 90/60 and 90/70 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 UNIVAC 1100 Series computers, although there is no compatibility between the two systems at the machine level. DMS/90 is described in detail in Report 70E-877-01.

OS/4 UTILITY ROUTINES: An OS/4 Sort/Merge program capable of using disc and/or tape drives is available. It can sort fixed or variable-length records in either ascending or

descending sequence, and includes provisions for the user's own coding. Disc-only sorts require enough disc capacity to hold all the records to be sorted plus sort control information. Tape-only sorts require 3 to 14 tape units, with no more than 6 tapes used for string collating. Tape/disc sorts use the disc drives to increase the length of the strings before collation is done on tape. The program's operation can be controlled by parameters entered either when the sort is generated or at run time. Up to 255 noncontiguous keyfields can be specified, using shared input devices, if desired, and reserved output devices. The COBOL SORT verb generates a linkage to the Sort/Merge utility program.

A Linkage Editor combines object modules produced by the COBOL, FORTRAN, RPG, or Assembly language translators into "load modules" which are suitable for loading and execution under OS/4 control.

Library Service routines facilitate the creation and maintenance of various types of libraries on tape and disc for OS/4.

Other available utility programs for the OS/4 operating system include data transcription routines, comprehensive data utilities to copy data from any input device to any output device, file maintenance routines, a dynamic (snapshot) dump, a terminal (postmortem) dump, and tape and disc listing programs.

VS/9 UTILITY ROUTINES: The VS/9 Sort/Merge runs as a pageable program as either a batch or interactive task, and may be invoked by other user programs. Options available include full-record sort, record selection sort, tag sort, and file merge. Input and output operations can be performed using any suitable peripheral device supported by VS/9 data management routines, although disc storage must be used for work areas. Both control fields and various options for sorting and merging operations can be specified in Sort/Merge control statements.

VS/9 linkage editor services and program loading are performed by three routines: the Linkage Editor, the Static Loader, and the Dynamic Linking Loader. The Linkage Editor binds program object modules into executable programs and optionally generates Interactive Debugging Aid symbolic dictionaries. The Linkage Editor also generates statistics, reference resolutions, and load address assignments on a map listing and a cross-reference listing. Output of the Linkage Editor is loaded by the Static Loader, which assigns the required virtual and real memory and sets up the IDA symbolic dictionary if requested. In addition, a Dynamic Linkage Loader can dynamically link Class II (virtual memory) object modules for load-and-go processing and for dynamic inclusion of object modules from a disc-based library into an executing program.

Other utilities are available under VS/9 for maintaining libraries of source and object-code program modules in direct-access storage libraries.

An Assembler Diagnostic Routine and a Background Compiler Diagnostic Routine provide facilities for interrogating error files created by the Assembler and the COBOL and FORTRAN compilers. In addition, VS/9 provides a comprehensive set of media conversion routines plus system support utilities to provide for saving, updating, and restoring catalogued files and performing dumps in response to an unrecoverable error condition or an operator command.

APPLICATIONS PROGRAMS: Applications programs available under OS/4 include a Pert Management Control System, Linear Programming, UNIS (bill of material, inventory control, planning, and scheduling), APT (automatically programmed tools), PROFITS (on-line savings and loan processing), LINC0 III (typesetting and line justification), NEWSCOMP (on-line newspaper text editing and typesetting), WIMS (Wholesale Inventory Management System), UPACS (UNIVAC Patient Accounting System), and Biomedical Programs (a collection of general-purpose statistical and mathematical programs).

Applications programs currently available under VS/9 include STAT-9 (statistical programs written in BASIC); ►

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► Biomedical Statistical Series; Engineering Series (including Coordinate Geometry System, Continuous Systems Simulation, Electronic Circuit Analysis, etc.); Financial Series (including Bond Pricing and Bond Yield, Cash Flow Analysis, Investment Analysis, Depreciation Analysis, Loan or Purchase Analysis, Loan Interest Rate Analysis, Loan Repayment, Mortgage Fact Finder, Proforma Statement Analysis, and Return on Investment); Industrial Series (including Jobfit, Pallet, and Princeton Interactive Automatically Programmed Tools); Integrated Civil Engineering System (ICES); Management Sciences (including Exponential Smoothing, Forecasting, Linear Programming, and Critical Path Scheduling); Mathematical Series (including differential equations, integration, functional evaluation, function approximation, matrix operations, roots of functions, etc.); Scientific Subroutine Series (algorithms programmed in FORTRAN for inclusion in user programs through FORTRAN CALL statements); Test of Hypothesis Series; and AUTOFORM automatic text formatting system.

UNIS/90 (Univac Industrial System) is scheduled for release under VS/9 at the end of 1976, and WIMS (Wholesale Inventory Management System) is scheduled for release under VS/9 in mid-1976.

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 include equipment maintenance.

UNIVAC 90/60 SMALL TAPE/DISC SYSTEM (using OS/4): Consists of 131K 90/60 Processor (with standard DAT feature, selector channel, multiplexer channel, floating-point hardware, and storage protection), console, 600-cpm card reader, 250-cpm card punch, 1400-lpm printer, two Uniservo 14 (96KB) tape units with control, and two 8425 disc drives (58 million bytes each) with control. Monthly rental and purchase prices are approximately \$14,700 and \$608,100, respectively.

UNIVAC 90/60 MEDIUM TAPE/DISC SYSTEM: Consists of 262K 90/60 Processor, console with console printer, second selector channel, 600-cpm card reader, 250-cpm card punch, 2000-lpm printer, four Uniservo 14 (96KB) tape units and control, and three 8430 (100 million bytes each) disc drives and control. Monthly rental and purchase prices are approximately \$19,800 and \$814,000, respectively.

UNIVAC 90/60 LARGE TAPE/DISC SYSTEM: Consists of 343K 90/60 Processor, console with console printer, second selector channel, 600-cpm card reader, 250-cpm card punch, 2000-lpm printer, four Uniservo 14 (96KB) tape units and control, one 8405 fixed-head disc (6 million bytes) and four 8430 (100 million bytes each) disc drives

and control. Monthly rental and purchase prices are approximately \$23,800 and \$957,600, respectively.

UNIVAC 90/70 TYPICAL TAPE/DISC SYSTEM: Consists of 393K 90/70 Processor (with standard DAT feature, selector channel, multiplexer channel, storage protection, and floating-point hardware), console with console printer, two additional selector channels, 1000-cpm card reader, two 1400-lpm printers, 250-cpm card punch, six Uniservo 16 (192KB) tape units and control, one 8405 fixed-head disc (6 million bytes), and six 8430 (100 million bytes each) disc drives and control. Monthly rental and purchase prices are approximately \$33,700 and \$1,249,800, respectively.

UNIVAC 90/70 LARGE TAPE/DISC SYSTEM: Consists of 786K 90/70 Processor, console with console printer, two additional selector channels, two 1000-cpm card readers, two 1400-lpm printers, eight Uniservo 20 (320KB) tape units and control, one 8405 fixed-head disc (6 million bytes) and four 8433 (200 million bytes each) disc drives and control. Monthly rental and purchase prices are approximately \$41,400 and \$1,700,600, respectively.

SOFTWARE AND SUPPORT: UNIVAC has not "un-bundled" to date, so the equipment prices listed above include most of the UNIVAC software described in this report and all normal educational courses and professional assistance. However, in July 1975, UNIVAC released separate monthly rental prices for the UNIS (UNIVAC Industrial System) application program for 90/60 and 90/70 systems operating under OS/4. Monthly charges for the UNIS modules are as follows: UNIS Master Data Processor—\$75; UNIS Production Planning and Scheduling—\$100; UNIS Inventory Management—\$75, and UNIS Work Order Management—\$25.

CONTRACT TERMS: The standard 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, Monday through Friday. Extended periods of maintenance are available at extra cost.

LONG-TERM LEASES: In addition to the basic 1-year agreement, UNIVAC offers an extended-term 5-year lease for 90/60 and 90/70 systems at significantly lower monthly rates. Under the 5-year "level-payment" agreement, the monthly equipment charge is 85% of the 1-year rental rate shown in the accompanying price list. Under a 5-year "reducing-payment" agreement, the monthly charge is 95% of the 1-year rental rate during the first year, 90% the second year, 85% the third year, 80% the fourth year, and 75% the fifth year. Maintenance is not discounted under these plans. ■

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EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maintenance</u>	<u>Rental (1-year lease)*</u>
90/60 PROCESSOR AND MAIN STORAGE				
3024-93	90/60 Processor (includes DAT Feature, Multiplexer Channel, 2 Interval Timers, Storage Protection, a Selector Channel, Floating Point Control, and 131,072-byte Memory)	336,048	728	7,007
7025-85	Storage; 32,768 bytes (expands main storage from 131,072 to 163,840 bytes)	17,640	66	357
F1775-97	Storage; 32,768 bytes (expands main storage from 163,840 bytes to 196,608 bytes, from 196,608 bytes to 229,376 bytes, or from 229,376 bytes to 262,144 bytes)	17,640	66	357
7025-84	Storage; 65,536 bytes (expands main storage from 262,144 to 327,680 bytes)	32,760	105	663
F1775-96	Storage; 65,536 bytes (expands main storage from 327,680 to 393,216 bytes)	32,760	105	663
7025-97	Storage; 131,072 bytes (expands main storage from 393,216 to 524,288 bytes)	65,520	210	1,326
F2007-00	90/70 upgrade; converts a 90/60 Processor to a 90/70 Processor	195,024	418	4,064
90/70 PROCESSOR AND MAIN STORAGE				
3024-95	90/70 Processor (includes DAT Feature, Multiplexer Channel, 2 Interval Timers, Storage Protection, a Selector Channel, Floating Point Control, and 131,072-byte Memory)	531,072	1,146	11,064
7025-99	Storage; 65,536 bytes (expands main storage from 131,072 to 196,608 bytes)	35,280	131	714
F1775-98	Storage; 65,536 bytes (expands main storage from 196,608 to 262,144 bytes)	35,280	131	714
7025-98	Storage; 131,072 bytes (expands main storage from 262,144 to 393,216 bytes)	65,520	210	1,326
7025-97	Storage; 131,072 bytes (expands main storage from 393,216 to 524,288 bytes)	65,520	210	1,326
7025-96	Storage; 131,072 bytes (expands main storage from 524,288 to 655,360 bytes)	65,520	210	1,326
7025-95	Storage; 131,072 bytes (expands main storage from 655,360 to 786,432 bytes)	65,520	210	1,326
7025-94	Storage; 131,072 bytes (expands main storage from 786,432 to 917,504 bytes)	65,520	210	1,326
7025-93	Storage; 131,072 bytes (expands main storage from 917,504 to 1,048,576 bytes)	65,520	210	1,326
90/60 AND 90/70 PROCESSOR FEATURES				
F1519-00	Expanded interface; expands multiplexer to 15 subsystems (16 if F1518-00 is present). Available on 90/70 Processor only.	7,152	18	149
F1518-00	Subchannel Expansion; expands multiplexer up to 31 subchannels	2,400	6	50
F1337-00	Selector Channel; 833 KB (includes channel programming and storage protection; Selector Channels 3, 4, and 5 require 1916-00 Channel Expansion Cabinet)	11,664	243	29
F1337-02	Selector Channel 5	11,664	243	29
1916-00	Channel Expansion Cabinet (for third and fourth F1337-00 Selector Channels)	11,424	29	238
F1335-00	Direct Control; interface for another 9000 Series processor plus 2 instructions for transfer of control information	4,752	11	99
F1591-00	Programmable Emulator; provides programmable control for any one of the following emulators using special hardware instructions: 301, SMOOTH, 360, or 1400	13,200	60	275
4014-99	System Console; includes Uniscope 100 CRT; may be expanded by addition of one 0772-00 Printer and up to 6 multichannel switches	27,024	84	563
0772-00	Console Printer; 30 cps (reduced for OS/4)	13,200	54	275
2519-00	Multiple Channel Switch; 1 switch plus cabinetry for five F1541-00 expansion switches	9,024	24	188
F1541-00	MCS Expansion; one switch	4,464	11	93
F1001-00	Channel Adapter for 9000 Series Subsystem; provides 9000 Series subsystem interface through respective multiplexer or selector channels	4,464	17	93
MASS STORAGE				
8405-00	Fixed-Head Disc (single 8405 disc with a storage capacity of 6,193,152 bytes; F2076-00 is prerequisite)	76,800	400	1,600
8405-04	Fixed-Head Disc (single 8405 disc with a storage capacity of 3,096,576 bytes; F2076-00 is prerequisite)	46,080	240	960
F1664-00	Dual Access (provides dual access and simultaneous read/write operation on any two 8405 disc drives; required on each 8405 disc in the subsystem; also requires two 5039 control units)	2,160	5	45
5039-97	Control Unit (controls up to eight 8433 and/or 8430 Disc Storage Drives. Minimum of two 8433 or two 8430 drives required per subsystem. May be expanded to control up to sixteen 8433 and/or 8430 Disc Drives via F2076-00, or to control up to eight 8405-00/04 Fixed Head Disc Drives via F2076-00)	57,600	300	1,200
F2047-00	16-Drive Expansion (provides the capability to attach up to sixteen 8433 and/or 8430 Disc Storage Drives to a 5039 Control)	7,680	130	520
F2076-00	8405 Capability (adds capability to control up to eight 8405-00/04 Fixed Head Disc Drives)	2,160	5	45
8430-00	Disc Storage (provides a single disc drive, 100 MB)	24,960	130	520
F2020-00	8430 Dual Access (provides dual access and simultaneous read and write operations on any two disk drives; required on both disc drives in the subsystem; also requires two Model 5039 Control Units and two selector channels)	2,160	5	45
F2046-00	Dual Channel (provides non-simultaneous access to one Model 5039 Control Unit from two selector channels)	4,080	15	85
F2047-00	16-Drive Expansion (provides the capability to attach up to 16 Model 8430 Disc Drives to one Model 5039 Control Unit)	7,680	40	160
F1230-00	Disc Pack (provides up to 100 million bytes of removable storage; maintenance contract is not available)	750	—	40
8433-00	Disc Storage (provides a single drive, 200 MB)	36,480	190	760
F1223-00	Disc Pack (200 MB; maintenance contract not available)	1,150	—	50

* Rental prices do not include equipment maintenance.

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		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
MASS STORAGE (Continued)				
F2021-00	8433 Dual Access (provides dual access and simultaneous read/write operation on any two 8433 Disc Drives. Required on each 8433 disc unit in the subsystem. Also requires two 5039 control)	2,160	5	45
5024-99	8424/8425 Disc Control	57,072	326	1,189
F1043-00	Dual Channel	4,416	17	92
F1771-01	Dual Access (per 8425-00 unit)	4,536	10	92
8425-00	Disc Storage (58 million bytes)	17,664	90	368
F1214-01	Disc Pack (for 8425 drives)	382	-	22
INPUT/OUTPUT UNITS				
0861-00	Uniservo 12 Master Tape Unit; 9-track; 1600 bpi, 68.32 KB/second	18,336	120	382
F0934-99	Simultaneous Single-Density Feature (for 0861-00); requires 2 controls	4,080	18	85
F0934-01	Simultaneous Dual-Density Bi-Modal Feature (for 0861-00); requires F0934-99 and F0935-00 to give simultaneous access to dual density bi-modal (7- or 9-track) slaves attached to same master unit; control units each require F0826-00 and F1028-95)	4,608	18	96
F0935-00	Dual Density Bi-Modal Feature (for 0861-00); control must have F0823-99; if 7-track slaves are present, control must also have F1028-95	2,688	11	56
0861-01	Uniservo 12 Slave Tape Unit; 9-track; 1600 bpi, 68.32 KB/second (3 slaves may be used with 1 master unit)	14,688	83	306
0861-04	Uniservo 12 Master Tape Unit; 7-track; 200, 556, or 800 bpi; 8.54, 23.74, or 34.16 KB/second	16,936	120	332
F0934-98	Simultaneous Single-Density Feature (for 0861-04); requires 2 control units which each must contain F0823-99	4,080	18	85
F1041-00	7- to 9-track Conversion Feature (for 0861-04); converts to 0861-00	2,448	0	51
F1041-01	Simultaneous 7- to 9-Track Conversion Feature (for 0861-04 with F0934-98); converts to 0861-00 with F0934-99	2,448	0	51
0861-05	Uniservo 12 Slave Tape Unit; 7-track; 200, 556, or 800 bpi; 8.54, 23.74, or 34.16 KB/second (3 slaves may be used with 1 master unit)	13,056	83	272
F1042-00	7- to 9-Track Conversion Feature (for 0861-05); converts to 0861-01	1,632	0	34
5017-99	Uniservo 12 Non-Simultaneous Control (for up to 16 Uniservo 12 drives); 9-track; 1600 bpi	26,448	101	551
5017-00	Uniservo 12/16 Non-Simultaneous Control (for up to 16 Uniservo 12 and/or 16 drives); 9-track; 1600 bpi	28,560	111	595
F1131-99	Uniservo 16 Capability (for 5017-99)	2,112	11	44
F1029-99	Simultaneous Single-Density Access (for 5017-99); provides second control module	16,896	67	352
F1029-00	Simultaneous Single-Density Access (for 5017-00); provides second control module	18,960	78	395
F0823-99	7-Track NRZI (for 5017-00 or 5017-99)	5,760	17	120
F0826-00	9-Track NRZI (for 5017-00 or 5017-99)	4,416	17	92
F1028-95	Bi-Modal (7- or 9-Track) NRZI (for 5017-00 or 5017-99 with F0826-00)	4,176	11	87
F1028-96	Bi-Modal (7- or 9-Track) NRZI (for 1017-00 or 5017-99 with F0823-99)	4,176	11	87
F0825-00	Non-Simultaneous Dual Channel Feature (for 5017-00 or 5017-99)	4,416	17	92
0862-00	Uniservo 16 Magnetic Tape Unit; 9-track 1600 bpi; 192 KB/second (requires 5034-00 control)	22,032	116	459
0862-02	Uniservo 16 Magnetic Tape Unit; 7-track; 200, 556, or 800 bpi; 24, 66.72, or 96 KB/second (requires 5034-00 or 5017-00 control)	22,032	116	459
F0936-99	Simultaneous Feature (for 0862-00 or 0862-02); requires 2 controls	914	0	21
F0937-00	Dual-Density Feature (for 0862-00); control(s) must contain F0826-00 or F1028-96	2,284	0	51
F1040-00	7- to 9-Track Non-Simultaneous Conversion Feature (for 0862-02); converts to 0862-00	0	0	0
F1040-01	7- to 9-Track Simultaneous Conversion Feature (for 0862-02 with F0936-99); converts to 0862-00 with F0936-99	0	0	0
5045-99	Uniservo 14 Control; includes control and cabinet space for 2 Uniservo 14 Magnetic Tape Units	21,168	110	441
5045-02	Auxiliary Cabinet; for 1 or 2 additional Uniservo 14 Magnetic Tape Units	1,296	5	27
F0823-99	7-Track NRZI; for 5045-99 Control	5,760	17	120
F0825-00	Dual Channel; permits nonsimultaneous operation on 2 channels of 1 processor or 1 channel on each of 2 processors	4,416	17	92
F0826-00	9-Track NRZI; permits 9-track phase-encoded operation	5,760	17	120
F1028-96	Adds 9-track NRZI to F0823-99 or F1753-99	4,176	11	87
F1028-95	Adds 7-track NRZI plus data conversion to F0826-00	4,176	11	87
F1028-92	Adds 7-track NRZI native mode plus data conversion to F0826-00	3,654	10	82
F1753-99	Provides capability to add 7-track tape units to 5045-99 control	5,760	17	120
0870-03	Uniservo 14 9-track PE Magnetic Tape Unit	16,080	86	335
0870-05	Uniservo 14 7-track NRZI Magnetic Tape Unit	14,880	80	310
F2194-00	Dual Density; adds 9-track NRZI to Uniservo 14 PE Magnetic Tape Unit; requires F0826-00 in control	1,200	6	25
F2194-02	Converts 0870-05 7-track NRZI Magnetic Tape Unit into 9-track PE (\$106 field installation charge)	-	-	-
F2194-03	Converts 0870-05 7-track NRZI Magnetic Tape Unit into 9-track PE and NRZI	1,200	6	25
0864-00	Uniservo 20 Magnetic Tape Unit; 9-track; 1600 bpi, 320 KB/second	27,696	132	577
F1510-00	Dual Access and Simultaneous Feature (for 0864-00); requires 2 controls	2,448	10	51
5034-00	Uniservo 20 Non-Simultaneous Control (for up to 16 9-track; 1600 bpi (requires 2 controls for dual access))	36,720	95	765
F0823-98	7-Track NRZI (for 5034-00); adds bi-modal 7- or 9-track capability to control; may not be used with F0826-99	5,544	16	113
F0826-99	9-Track NRZI (for 5034-00); adds dual-density 800 or 1600 bpi to control; may not be used with F0823-98	6,552	21	133
F1028-97	Bi-Modal (7- or 9-track) NRZI (for 5034-00 with F0826-99)	4,536	10	92
F1028-98	Bi-Modal (7- or 9-track) NRZI (for 5034-00 with F0823-98)	5,544	16	113
0604-99	Card Punch and Control; 250 cpm	22,234	107	463
F0875-00	Read/Punch Feature (for 0604-99)	7,152	56	149

* Rental prices do not include equipment maintenance.

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INPUT/OUTPUT UNITS (Continued)		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
0716-96	Card Reader and Control; 600 cpm	12,192	61	254
0716-99	Card Reader and Control; 1000 cpm	15,504	101	323
F1487-00	Short Card Feature; 51 columns	1,968	11	41
F1487-01	Short Card Feature; 66 columns	1,968	11	41
F1488-00	Validity Check Feature	816	0	17
F1498-00	Alternate Stacker Fill Feature	528	0	11
F1530-99	Dual Translate; additional ASCII translator	1,104	5	23
0770-00	Printer, 800 lines per minute	56,304	234	1,173
0770-02	Printer, 1400 lines per minute	64,896	306	1,352
0770-04	Printer, 2000 lines per minute	86,686	390	1,806
F1533-00	160 Print Positions	4,416	17	92
F1534-00	Expanded Character Set Control (required for other than 1536-00 or -01 Print Cartridges)	2,880	5	60
F1536-00	48-character alphanumeric Business	462	—	22
F1536-01	48-character alphanumeric Scientific	462	—	22
F1537-00	94-character ASCII	462	—	22
F1537-03	64-character universal ISO OCR-B	462	—	22
F1537-04	64-character universal OCR H-14	462	—	22
F1537-05	58-character COBOL-FORTRAN-Business	462	—	22
F1537-06	177-character international	462	—	22
F1537-09	24-character Numeric	462	—	22
F1537-11	68-character universal OCR-A	462	—	22
F1537-12	68-character universal OCR-B	462	—	22
F1537-13	68-character universal 77L	462	—	22
2703-00	Optical Document Reader; 300 dpm	47,664	209	993
F1108-00	600-dpm Speed Upgrade (for 2703-00)	12,000	36	250
F1163-00	Modulus 10 Check Digit (for 2703-00)	1,104	5	23
F1106-00	Mark Read--EBCDIC (for 2703-00)	9,024	41	188
F1106-01	Mark Read--ASCII (for 2703-00)	3,024	11	63
F1149-00	Punch Card Read Feature (for 2703-00); requires F1106-00 or -01	3,024	11	63
F1154-00	Validity Check Feature (for 2703-00)	528	0	11

DATA COMMUNICATIONS SUBSYSTEMS

F1395-00	Voice-Grade Communications Interface (for Series 90 Processor); coordinates a BSC line and a 201A, 201B, 202C, or 202D type modem at up to 19,000 bits/second	768	5	16
F1395-01	Telpak Communications Interface (for Series 90 Processor); coordinates a BSC line and a 301B, 303B, 303C, or 303D type modem	2,064	5	43
8577-02	DCS Cabinet; provides power supply and housing for up to 4 DCS-1 or -1C	2,976	5	62
F1000-00	Line Terminal-1 (for DCS-1); controls 1 duplex line	4,799	17	113
8575-00	Line Terminal Control-4 (for DCS-4); controls 4 duplex lines	12,432	50	259
8575-01	Line Terminal Control-16 (for DCS-16); controls 14 duplex lines	26,208	107	546
F1357-00	Line Terminal Control 1C (for binary synchronous; not supported by UNIVAC software)	6,432	30	134

NOTE: Numerous line terminals, communications interfaces, and optional features enable the above controls to accommodate a wide range of communications facilities and equipment.

MULTI-CHANNEL COMMUNICATIONS CONTROLLER

8579-86	Multi-Channel Communications Controller (MCC 1) (includes processor with 32K bytes of storage expandable to 65K 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	177	1,092
8579-85	Multi-Channel Communications Controller (MCC 1A) (same as MCC 1 except includes Scanner 1 expansion F2262-99)	61,872	207	1,289
8579-84	Multi-Channel Communications Controller 2 (MCC 2) (includes processor with 32K bytes of storage expandable to 65K bytes, real-time clock, power protect, interface to CPU multiplexer channel, operator console with CRT and keyboard, and Scanner 2 for control of 16 half or full duplex communications lines, expandable to a maximum of 59 half duplex or 29 full duplex lines)	78,816	261	1,642
F2262-99	MCC 1 to MCC 1A Expansion (MCC 1 is prerequisite)	9,456	30	197
F1800-01	Manual Channel Switch (provides capability to switch an MCC between multiplexer channels of two Series 90 host processors)	4,305	13	83
F1793-00	16K-Byte Storage Expansion (maximum of two per MCC)	10,300	29	229
F2264-00	16-Port Parameter Module (provides MCC 2 with high-speed register storage for up to 16 half duplex or 8 full duplex lines. Maximum of one per MCC 2. Excludes F2264-01 and -02)	1,584	5	33
F2264-01	64-Port Parameter Module (provides MCC 2 with high-speed register storage for up to 59 half duplex or 29 full duplex lines. Maximum of one per MCC 2. Excludes F2264-00 and -02)	2,496	8	52
F2264-02	128-Port Parameter Module (provides MCC 2 with high-speed register storage for up to 59 half duplex or 29 full duplex lines. Maximum of one per MCC 2. Excludes F2264-00 and -01)	3,456	11	72
F2263-00	Line Adapter Chassis (expands number of line adapter positions of MCC 2 from 32 to 64. Maximum of one per MCC 2)	2,832	9	59
F2263-01	Line Adapter Chassis Expansion (expands number of line adapter positions of MCC 2 from 64 to 96 or from 96 to 128)	1,344	4	28
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 eight per MCC 2)	528	2	11
F1801-01	Line Base II (provides interface and control for up to 16 line adapters on MCC 2. Maximum of seven per system)	720	3	15
F1796-00	Dual Dial Adapter--Type 1 (provides interface to two Bell 801 ACU's. Maximum of four per MCC 1 or eight per MCC 1A)	872	5	21
F1798-01	Line Adapter--Asynchronous Type 1 (contains two full duplex or half duplex serial modem interfaces (RS-232-C and CCITT-V24). Attaches to MCC 1 or MCC 1A)	630	4	16

* Rental prices do not include equipment maintenance.

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MULTI-CHANNEL COMMUNICATIONS CONTROLLER (Continued)		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
F1799-00	Line Adapter—Synchronous Type 1 (contains two full duplex or half duplex serial modem interfaces (RS-232-C and CCITT-V24) for MCC 1 or MCC 1A)	900	4	22
F1799-01	Line Adapter—Synchronous Type 1 (compatible with MIL 188 B/C)	900	4	22
F1814-00	Wide-Band Adapter—Type 1 (provides capability to connect two synchronous full duplex or half duplex lines for operation at 19.2, 40.8, or 50 kilobits per second)	1,743	11	41
F1866-00	Active Line Indicator I (displays the line activity on data sets connected to the MCC 2 or MCC 2A. Includes capacity for 16 displayed lines. Maximum of one per MCC 1 or two per MCC 1A)	528	2	11
F1828-00	Asynchronous Line Adapter—Type II (provides full duplex or half duplex interface to asynchronous data sets conforming to RS-232-C and CCITT-V24 and V28)	720	6	15
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)	912	7	19
F1828-02	Asynchronous Line Adapter—Type II (same as F1828-00 but also provides a supervisory channel of up to 150 bps asynchronous)	1,104	8	23
F1829-00	Asynchronous Line Adapter—Type II (provides a full duplex or half duplex interface for compliance with MIL-STD-188C low-level interface)	720	6	15
F1826-00	Synchronous Line Adapter—Type II (provides a full duplex or half duplex interface to synchronous data sets conforming to RS-232-C and CCITT-V24 and V28)	912	7	19
F1826-01	Synchronous Line Adapter—Type II (same as F1826-00 but also provides a supervisory channel of up to 150 bps asynchronous)	1,392	8	29
F1827-00	Synchronous Line Adapter—Type II (provides a full duplex or half duplex interface for compliance with MIL-STD-188C low-level interface)	912	7	19
F1832-00	Asynchronous Relay Line Adapter—Type II (provides an asynchronous full duplex or half duplex interface optionally compatible with either 20-75 MA neutral or 10-40 polar telegraph lines)	720	6	15
F1830-00	Wideband Line Adapter—Type II (provides capability to connect one synchronous full duplex or half duplex line for operation at 19.2, 40.8, or 50 kilobits per second. Used with AT&T 300 Series Data Sets)	1,104	8	23
F1831-00	Dial Adapter, Single—Type II (provides interface to one Bell 801 ACU)	720	6	15
F1834-00	Wideband Line Adapter (same as F1830-00 but conforms to CCITT V35)	1,104	8	23
F1836-00	Telex Line Adapter	720	6	15
F1835-00	TWX Line Adapter	720	6	15
F1840-00	Telex Adapter—International	720	6	15

*Rental prices do not include equipment maintenance.