UNIVAC 90/60, 90/70, and 90/80

The UNIVAC 90/80, the newest and largest current member of the Series 90 family, offers from 524K to 4 million bytes of MOS main memory with a cycle time of 450 nanoseconds per 8-byte access. Instruction processing and I/O processing functions are segregated into two separate processors for increased efficiency.

The largest current members of the UNIVAC Series 90 family, these byte-oriented, IBM-compatible systems are designed to provide a growth path for UNIVAC 9000 Series and Series 70 users and to compete against the IBM System/370 Models 135 through 158. The primary operating system for these models is UNIVAC's VS/9 virtual memory system. Recent system enhancements and price reductions have ensured the continued viability of these systems against IBM's new Models 138 and 148.

MANAGEMENT SUMMARY

The UNIVAC 90/60 and 90/70 computers were introduced in October 1973, and the 90/80 followed in June 1976. In between, in June 1974, UNIVAC added another member to the Series 90 family, the small-scale 90/30 (see Report 70C-877-04).

The 90/60 and 90/70 systems were designed to provide a compatible upgrade path for users of UNIVAC's maturing 9000 Series and Series 70 (ex-RCA) systems, and were also aimed at the large number of IBM System/360 Model 30 and Model 40 users.

With the 90/80 system, the largest member of the family introduced to date, UNIVAC provided a clear path for its own users to upgrade from 90/60, 90/70, and large-scale Series 70 systems. At the time of the announcement, UNIVAC also declared that another primary marketing target was those IBM System/370 Model 135 and 145 users who were looking to upgrade to Model 158's.

IBM disrupted this marketing strategy, however. Less than a month after the UNIVAC 90/80 announcement, IBM announced the System/370 Models 138 and 148, which are bigger and more powerful systems than the 135 and 145, yet much lower in price.

CHARACTERISTICS

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

MODELS: UNIVAC 90/60, 90/70, and 90/80.

DATA FORMATS

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

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

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

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

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

MAIN STORAGE

STORAGE TYPE: MOS (metal oxide semiconductor).

CAPACITY: 90/60–From 524,288 to 2,097,152 bytes in 7 sizes: 524K, 786K, 1048K, 1310K, 1572K, 1835K, or 2097K bytes. 90/70–From 131,072 to 2,097,152 bytes in 13 sizes: 131K, 196K, 262K, 393K, 524K, 655K, 786K, 917K, 1048K, 1310K, 1572K, 1835K, or 2097K bytes. 90/80–From 524,288 to 4,192,000 bytes in 8 sizes: 524K, 1048K, 1572K, 2096K, 2620K, 3144K, 3668K, or 4192K bytes.

UNIVAC 90/60, 90/70, and 90/80

UNIVAC answered the IBM challenge within two months, in late August 1976. What's more, the UNIVAC answer was direct and to the point—and very encouraging to the industry. The 90 Series systems were enhanced significantly, memory configuration changes were made, and sizeable price reductions went into effect.

The 90/60 system was affected the most by the changes. The minimum memory capacity was increased from 131K to 524K bytes and the maximum from 524K to 2 million bytes, while the processor speed was increased by 25 percent. Moreover, memory prices were slashed to the point that the new basic 90/60 Processor, with 524K bytes of main memory, can be purchased for 15 percent *less* than the old 131K-byte basic processor. UNIVAC claims that the enhanced 90/60's performance will exceed that of the IBM Model 138, and says that on a long-term lease it will be priced within dollars a month of the new IBM system. A speed-up kit was also offered to existing 90/60 users—a move that parallels the IBM 135-3 and 145-3 announcement and provides these users with the 25 percent increase in processor speed.

The maximum memory capacity of the 90/70 system was doubled from 1 megabyte to 2 megabytes, and mainframe and memory prices were also significantly reduced.

Prices for the 90/80 were also reduced dramatically to offset the effects of the IBM announcement. The initially announced rental prices for the 90/80's 524K-byte increments of main storage were reduced by 42 percent. Purchase prices for the same increments were reduced by 57 percent.

All in all, UNIVAC unhesitatingly picked up the gauntlet and kept its medium-scale computers thoroughly competitive with the new IBM offerings. The 90/60 and 90/70 systems now fit into the price/performance gap between the IBM Model 138 and 148 systems, while the 90/80 provides performance capabilities approaching those of the IBM Model 158 at prices close to those of the Model 148.

The 90/60 and 90/70 incorporate the architectural features of the earlier UNIVAC 9700 system, but both are 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 9480 computer, announced in March 1973, and has since replaced plated wire technology in the main memories of the newer models of UNIVAC's popular large-scale 1100 Series computers.

With the 90/80, UNIVAC continued its use of MOS main memory and introduced some new architectural features. The 90/80 is the first UNIVAC computer to use multi-layered printed circuit boards and emitter coupled logic (ECL) circuitry, and its main storage has a self-correcting capability using an error correction code (ECC) technique.

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 eventually

CYCLE TIME: 600 nanoseconds per 5-byte access in 90/60 and 90/70. 450 nanoseconds per 8-byte access in 90/80.

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.

The 90/80 also has Error Checking and Correction Logic (ECCL) that provides for detection of multiple-bit errors. Unique notification is provided to the requesting processor when these errors occur.

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

RESERVED STORAGE: The first 604 bytes of main storage in the 90/60 and 90/70, and the first 1024 bytes in the 90/80, are reserved to hold specific operating information.

CENTRAL PROCESSORS

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

DYNAMIC ADDRESS TRANSLATION: This feature, 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.

In the 90/80 system, the content addressable memory is called the translation lookaside buffer (TLB), and consists of thirty-two 32-bit registers. The real page addresses are entered in the TLB in groups of four, as opposed to the single-page entry method used in the 90/60 and 90/70. In all other respects, the DAT feature is the same in all three systems.

CONTROL STORAGE: In addition to main storage, a fast writeable control storage is available for the microprograms used to support integrated emulation, floating-point

UNIVAC 90/60, 90/70, and 90/80

merge UNIVAC's small-to-medium-scale, byte-oriented products with the incompatible large-scale, word-oriented 1100 Series computers are still somewhere off in the future.

Two operating systems are available for the 90/60 and 90/70 systems: 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 the Series 70 (ex-RCA) systems. The UNIVAC 90/80 normally uses the VS/9 operating system exclusively, but with an optional hardware feature it can be run in 90/60 or 90/70 mode using OS/4. For all of these Series 90 systems, VS/9 is now designated as the primary operating system.

The virtual address translation activities of VS/9 are handled by the Dynamic Address Translation (DAT) feature. The DAT function is accomplished by incorporating specialized hardware logic and registers with a high-speed content addressable memory.

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 as prospective users tended to hold off until the 90/70 could be delivered with the OS/7 operating system, a new operating system announced for the 90/60 and 90/70 computers. Early in 1975, UNIVAC surprised most 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 the principal operating system for the 90/60 and 90/70.

The 90/70 can be equipped with up to 2 million bytes of semiconductor main memory and has an instruction set comparable to that of the IBM System/360 Model 50, including floating-point arithmetic.

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 Series 90 "DAT box" is based on the design of the original Content Addressable Memory (CAM) in the ex-RCA 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 most recently referenced pages, a "CAM hit" can be processed in 30 nanoseconds. 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, as a result of performance enhancements and price cuts announced in August 1976, now reportedly surpasses the IBM 370/138 in performance and nearly matches it in price. The 90/60 can have from 524K to 2 million bytes of MOS memory with a cycle time of 600 nanoseconds per 4-byte access.

hardware, microdiagnostics, and the native-mode instruction set. The floating-point hardware is included in the basic prices. The cycle time of this separate MOS memory is 80 nanoseconds per 72-bit word access. Data is loaded into the writeable control storage via a cassette prepared by UNIVAC support personnel. An additional control storage module is available to support SMOOTH.

INSTRUCTION REPERTOIRE: In the 90/60 and 90/70, all 132 nonprivileged instructions of the IBM System/360 instruction set are provided. Also included are an add immediate instruction, an emulation aid instruction, and floating-point instructions. The standard instructions handle fixed-point binary arithmetic, decimal arithmetic using variable-length operands in packed formats, packing and unpacking, radix conversion, editing, loading, storing, comparing, shifting, branching, and logical operations, as well as instructions for handling ASCII or EBCDIC characters.

The 90/80 system native instruction set is upward-compatible with the 90/60 and 90/70 instruction sets. In addition, the 90/80 native instruction set includes all nonprivileged instructions of the IBM System/370 universal instruction set, plus extended floating-point capabilities and instructions unique to the 90/80 system. In total, there are 187 standard instructions in the 90/80 set.

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

	90/60	90/70	90/80
Binary add/subtract (32 bits):	2.10	1.50	0.96
Floating-point add/subtract (short):	6.18	5.58	3.00
Floating-point multiply (short):	12.20	11.60	5.20

UNIVAC 90/60, 90/70, and 90/80

THE UNIVAC 90/60

When first introduced, the UNIVAC 90/60 was a scaled-down version of the 90/70, intended to serve as an upgrade system for users of smaller UNIVAC 9000 Series and Series 70 systems, such as the 9400 and the Series 70/35, 70/45, and 70/2, for which the 90/70 would represent too large a jump in performance and cost. In August 1976, however, the 90/60 was upgraded extensively to compete against the IBM System/370 Model 138. At the present time, there is little performance difference between the 90/60 and 90/70.

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. The memory range is different, however, in that the minimum is now 524K bytes on the 90/60 versus 131K bytes on the 90/70. Maximum memory capacity for both systems is 2 million bytes.

THE UNIVAC 90/80

The UNIVAC 90/80 was announced at the National Computer Conference in June 1976, with first deliveries scheduled for the fourth quarter of 1976. (A Japanese version of the 90/80 system, known as the OUK 90-800, had been introduced two months earlier in Tokyo.) With the introduction of the 90/80, UNIVAC expanded its family of virtual memory systems from medium-scale into the large-scale range.

The minimum main memory size of a 90/80 system is 524K bytes, and this can be expanded up to 4192K bytes in modules of 524K bytes. The error-correcting MOS memory has a cycle time of 450 nanoseconds per 8-byte access. The system is designed around two processors, an Instruction Processor and a Peripheral Processor, each with separate processing capabilities.

The Instruction Processor is the processing and control portion of the 90/80 system. It contains the sequencing and controls for interrupt action, timing facilities, initial program loading, and instruction execution.

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

In terms of performance, UNIVAC claims the 90/80 has 2.5 times the performance of the 90/70 and ranges between 2.6 and 2.8 times the performance of a System/370 Model 145.

PERIPHERAL EQUIPMENT

Since the original announcement of the Series 90 systems, UNIVAC has added an attractive selection of fixed-head and removable disk pack drives to the 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.

	90/60	90/70	90/80
Floating-point divide (short):	29.10	28.50	11.77
Floating-point add/subtract (long):	6.83	6.23	3.85
Floating-point multiply (long):	35.60	35.00	13.73
Floating-point divide (long):	72.15	71.55	21.50
Add decimal (10-digit packed data)*	16.20	15.60	5.16
Compare decimal (10-digit packed data)*	15.90	15.30	3.59
Pack decimal (10-digit packed data)*	22.50	21.90	4.72
Branch on condition	1.20	1.20	0.40
Load (32-bit binary)	2.10	1.50	0.92
Store (32-bit binary)	2.40	1.80	1.07
Load multiple (six 32-bit registers)**	7.50	6.90	2.07
Move (16 bytes)*	11.70	11.10	2.97
Compare (16 bytes)*	15.30	14.70	2.97

* Storage-to-storage instructions.
**Register-to-storage instruction.

EMULATION: Emulation features are available for IBM System/360 and 370 DOS and for UNIVAC Series 70 TDOS and DOS.

CONSOLE: The 90/60 and 90/70 System Console consists of a keyboard with operator controls and a Uniscope 100 CRT display unit. The standard mode of operation provides for display of messages on the CRT screen; hard copy is provided by the Console Printer as an optional feature under VS/9, but is required for operation under OS/4. Under VS/9, those error messages which are printed on the console printer with OS/4 are written on direct-access storage for subsequent high-speed printing at the system manager's convenience. The hard-copy Console Printer operates at up to 30 cps and connects to the processor via the multiplexer channel; it uses one physical controller connection on the multiplexer. The System Console can be switched by the Multiple Channel Switch to operate on a selector channel for diagnostic purposes if required.

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

As an optional feature, an incremental printer can be connected to the 90/80 System Console to provide additional hard-copy output. It can be used to duplicate messages displayed on the visual display screen and to log informative messages that need not be displayed or responded to. The incremental printer, mounted in a separate cabinet, has a 94-character set (including upper case and lower case) and a 132-position print line, prints up to 30 characters per second, and has a paper feed rate of 30 lines per second.

The 9000 Series Channel Adapter, which provides either a multiplexer or selector interface to a UNIVAC 9200/9300/9400 or 90/60, 90/70, or 90/80 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.

UNIVAC 90/60, 90/70, and 90/80

The 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 all Series 90 systems, primarily for use as a high-performance paging storage for VS/9. The IBM 3330-equivalent 8430 Removable Disc System was also announced in January 1975, while the double-density (200-million-byte) 8433 Removable Disc System was announced in July 1975. Along with the 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 larger Series 90 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.

In May 1976, the Uniservo 30 Series was introduced. These magnetic tape drives are high-performance units that feature Group Coded Recording (GCR) at a density of 6250 bits per inch, as introduced by IBM back in March 1973. There are five models in the series with data transfer rates ranging from 160,000 to 1,250,000 bytes per second.

UNIVAC has also made substantial modifications to the communications capabilities of the 90 Series systems as a result of the release of VS/9. At the time of the initial announcement of VS/9, UNIVAC released versions of the Series 70 CCM (Communications Controller Multi-Channel) to support 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 characters 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 128 half-duplex or 64 full-duplex communication lines. The MCC also has a peak throughput capacity of 25,000 characters per second and can concurrently support up to eight different line speeds ranging from 45 to 56,000 bits per second.

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 sprovides an additional 16 subchannels. A second Subchannel Expansion features 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.

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 is available as an option supported by the user's own code. It is used to provide a special interface between two UNIVAC 90/60, 90/70, or 90/80 processors and includes two instructions for transfer of control information between the processors.

The Peripheral Processor provides the I/O processing facilities for the *90/80* system. It permits a maximum of eight I/O channels, with a minimum of one byte multiplexer channel and one block multiplexer channel. The maximum number of byte multiplexer channels is two per Peripheral Processor. The maximum number of block multiplexer channels is six, unless the second byte multiplexer channel is not selected; in this case, up to seven block multiplexer channels may be configured. Each block multiplexer channel has eight physical connections to which control units can be attached.

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

Subchannel storage in the 90/80 Peripheral Processor is pooled for block multiplexer channels and is expandable from the basic 240 subchannels up to 496 subchannels through the subchannel storage expansion feature. The subchannel storage pool provides 16 shared subchannels and 224 nonshared subchannels, expandable up to 480.

UNIVAC 90/60, 90/70, and 90/80

SOFTWARE SUPPORT

When the 90/60 and 90/70 computers were introduced, the primary operating system was to be OS/7, which was announced in November 1971 and 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 all its features implemented 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 anouncement 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 Memory Operating System to add a new filip 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 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.

Shared subchannels are assigned to devices at installation time. Nonshared subchannels are dynamically assigned as I/O operations are being initiated. Operations for which no subchannel storage is available are initiated and executed as if to a selector channel.

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

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

CONFIGURATION RULES: On the 90/60 and 90/70, high-speed peripheral devices (tape and disk drives) must be connected to a selector channel. Up to eight control units can be connected to each selector channel, and up to 8 or 16 drives can be connected to each control unit. Low-speed devices, including the Multi-Channel Communications Controller, card readers, line printers, and the System Console, are normally connected to the multiplexer channel, which can accommodate up to 16 control units and 63 subchannel addresses.

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

SIMULTANEOUS I/O OPERATIONS: Concurrently with computing, the 90/60 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 1.1 million bytes/sec on each selector channel.

In the 90/80 system, the microprocessor of the 90/80 Peripheral Processor controls channel operations. Once the Instruction Processor initiates an I/O operation, the channel is able to execute this operation independently. Data transfers between peripheral devices and main storage can be performed by all channels concurrently. Control logic is provided to monitor the data transfers among the channels and to assist in servicing the many conditions that can

UNIVAC 90/60, 90/70, and 90/80

VS/9 includes three levels of communications software support: the Communications Access Method (CAM), the Communications Oriented Software (COS), and the Virtual Integrated Communications Access Method (VICAM) introduced with the UNIVAC 90/80. CAM is essentially a set of re-entrant software routines to facilitate the implementation of simple inquiry/response programs. 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. VICAM is a set of generalized software components that provide a wide range of functions for user applications. A set of prescribed procedures in the form of macro instructions affords the user an interface to remote devices and message files.

Information management software, which is making a significant contriubtion 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, was released under VS/9 early in 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 compatiblity with the 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 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

occur during the transfer of data. The maximum aggregate I/O data transfer rate of a Peripheral Processor is 8 million bytes per second. The maximum byte multiplexer channel data transfer rate is an aggregate of 183,000 bytes per second. The maximum block multiplexer channel transfer rate is 1.5 million bytes per second.

MASS STORAGE

8405 FIXED-HEAD 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 attachment of up to eight 8405 units in single-unit increments. The 5039 Control Unit performs command retry and automatic error detection and correction.

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.

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.

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

UNIVAC 90/60, 90/70, and 90/80

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-langauge 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.

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

USER REACTION

As of the deadline for this report, the UNIVAC 90/60 and 90/70 systems were represented by six responses in Datapro's 1976 survey of users of general-purpose computer systems. To broaden the sample size, six known users of these systems were contacted by telephone. Of the total of 12 users who participated in this survey, 8 had 90/60 systems and 4 had 90/70 systems. The length of time these systems had been installed ranged from 6 months to about 2½ years. All of these systems were engaged solely in business data processing, with five also performing some data communications functions. The number of remote batch terminals per system ranged from 4 to 10.

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.

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.

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.

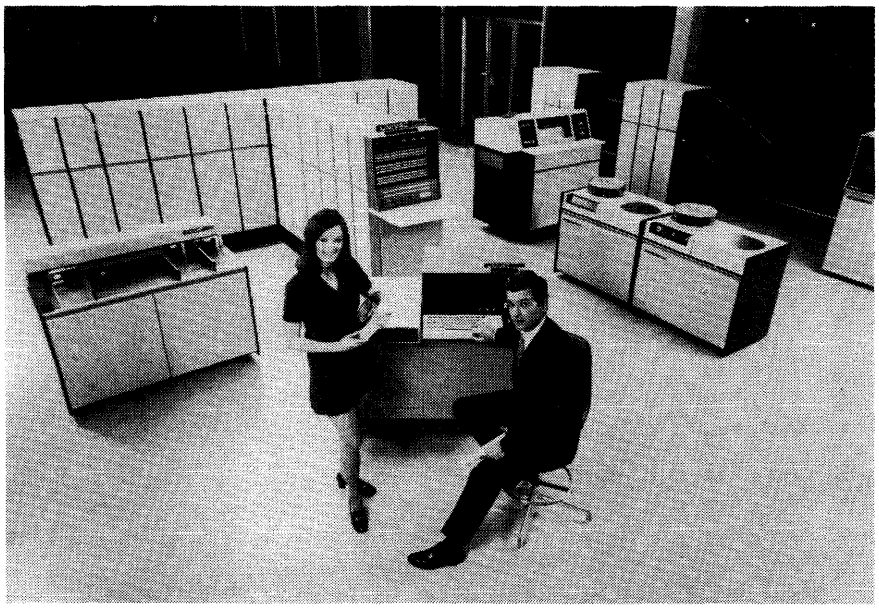
UNISERVO 14 MAGNETIC TAPE UNIT: Reads and records data on standard ½-inch tape in IBM-compatible phase-encoded or NRZI formats. Available in both 9-track or 7-track versions. Tape speed is 60 inches per second, forward or backward. The standard 9-track version has a recording density of 1600 bpi (in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

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 operation 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

UNIVAC 90/60, 90/70, and 90/80



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.

Three 90/60's had been installed as upgrades for UNIVAC 9400/9480 systems. One user was running under the OS/4 operating system, one under VS/9, and the third was in the process of converting from OS/4 to VS/9 and currently using both systems equally. Two 90/60 systems had replaced IBM System/360 computers; one of these was running under OS/4 and the other under VS/9. Four 90/70 systems were upgrades of Series 70 systems and were running under the VS/9 operating system. Each of the remaining three users indicated that this was the first computer installed at his site, and all three were running under VS/9.

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	3	7	0	2	2.9
Reliability of mainframe	6	2	1	3	2.9
Reliability of peripherals	2	7	2	1	2.8
Maintenance service:					
Responsiveness	7	4	1	0	3.5
Effectiveness	5	4	2	1	3.1
Technical support	2	6	4	0	2.8
Manufacturer's software:					
Operating system	3	3	3	2	2.6
Compilers and assemblers	3	5	1	2	2.8
Applications programs	2	3	0	3	2.5
Ease of programming	3	7	1	1	3.0
Ease of conversion	4	5	2	1	3.0
Overall satisfaction	2	6	2	2	2.7

*Weighted Average on a scale of 4.0 for Excellent.

Of the 12 users whose ratings are reflected in the above table, two were very unhappy with their systems and rated them extremely low in almost all categories. The other ten users all appeared reasonably well satisfied with their systems.

One of the dissatisfied users had a 90/60 system running under OS/4. He was particularly unhappy with the data communications aspect of the system. He felt that in order to use the data communications facilities effectively, one had to have a staff of "very experienced systems programmers" and "someone really knowledge-

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 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.

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

All of the models in the Uniservo 30 series, with one exception, can be used with 90/60, 90/70, and 90/80 systems; the Uniservo 36 model is available for use only with the 90/80 system. The five models in the Uniservo 30 series and their characteristics are as follows:

UNIVAC 90/60, 90/70, and 90/80

able in assembly programming." He did not feel that he should be required to have this level of expertise on his staff, and he admittedly did not have it.

The other primary area of dissatisfaction cited by this user was technical support. The nearest UNIVAC office that he could contact was about 350 miles away, and as the user put it, the people he had to talk to were "almost always out." He further stated that quite frequently when he sent data concerning a bug to the office he would get a request for supplemental documentation of the problem.

The other unhappy user had a 90/60 and was using the VS/9 operating system; the system had been installed in April 1974. This user also had a Series 70 running under the DOS operating system, which was installed about ten years ago. The user was particularly unhappy with all of the manufacturer's 90/60 software. He rated the operating system, the compilers and assemblers, and the applications programs of the 90/60 as poor, and ease of programming as only fair. In contrast, he gave a rating of good in all these categories to the Series 70 system.

This user felt that VS/9 was not a good system for him because "it was not designed for a batch processing environment." He felt that he could do much more with his 262K Series 70 system under DOS than he could do with his 393K 90/60 system using VS/9.

The VS/9 documentation was also cited as poor by this user. He claimed that error messages were missing, erroneous, and often incomplete in that they said nothing to enable him to identify the problem. Summing up his complaints, the user stated: "Each problem taken individually is minor. Taken all together, and in conjunction with the poor documentation, the situation has been a major headache for us." The problems that he has been having have been recognized by Univac, the user said, and the company is taking steps to correct the situation. Univac has sent a team of specialists from the home office to observe the problems first-hand. While he was still not happy, he was at least encouraged by the fact that some positive action was being taken.

On the positive side, several users cited the cost/performance ratio, the multiprogramming capability, the reliability of the hardware, and the VS/9 operating system as strong points of their 90/60 and 90/70 systems. All of the users who offered complimentary comments had at least 393K bytes of memory and were using the VS/9 operating system. Notable quotes included "well-designed operating systems," "better than 98 percent uptime," "does everything it's supposed to do," "excellent support," and "no negative comments."

Overall, after talking with these 90/60 and 90/70 users and reviewing all of their comments, Datapro feels that the 90 Series systems have the potential to be real winners for UNIVAC. The power is there, and the price is right. And while VS/9 may be a bit too much for the smaller, batch-processing-oriented user, there are a great many other users in the marketplace who will be very happy with its strong interactive capabilities.□

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

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

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

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

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

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. 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.

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. Supported under OS/4 only.

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.

UNIVAC 90/60, 90/70, and 90/80

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. Supported under OS/4 only.

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, 90/70, or 90/80. Supported under OS/4 only.

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.

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 64 full-duplex or 128 half-duplex lines. The MCC supports line speeds ranging from 45.45 to 56,000 bits per second, with a maximum total throughput capacity of 25,000 characters per second. It operates under control of the host central processor and performs character sequence detection and insertion, code translation, and cyclic, longitudinal, and vertical redundancy character generation and checking.

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

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 and 200 (Report 70D-877-05), Series 600 Tape Cassette System (for the Uniscope 100 or Uniscope 200), UNIVAC 1900 Computer Aided Data Entry System (Report 70D-877-31), and the UTS 400 and UTS 700 Universal Terminal Systems (Reports 70D-877-06 and 70D-877-07, respectively.

SOFTWARE

OPERATING SYSTEMS: Two operating systems are available for the UNIVAC 90/60, 90/70, and 90/80 systems: 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 Supervisor 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,

UNIVAC 90/60, 90/70, and 90/80

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 offers functional capabilities for concurrent processing, data communications, and interactive processing. The virtual memory features of VS/9 allow programs to be located in memory in 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.

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

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

The components that make up the MCP are:

Channel Control Routine (CCR)—provides the physical I/O interface for the remote device handlers to the communications controller and the specific types of communications subsystems.

Remote Device Handlers (RDH)—provide the software logic and control required to interface the unique characteristics of specific remote devices to the other VICAM components.

Communications Network Controller (CNC)—coordinates message storage queues.

Communications Control Area (CCA)—contains all of the tables required to define and control a specific communications network configuration.

Message User Service Transcriber (MUST)—provides a message staging service that isolates a user program from the device dependence that is usual in data communications programs.

Deferred User Service Transients (DUST)—perform those functions that are not time-dependent or that are used infrequently, such as MCP initialization, CCA initialization, line connect and auto dialing, and program termination.

Message queuing—stacks complete messages in main storage while they are waiting to be serviced by a communications line handler or a message processing program.

Activity scheduling and priority control—performs activity scheduling with an optional priority suspension and scheduling capability.

UNIVAC 90/60, 90/70, and 90/80

Timer service–provides a centralized timing service for control of active data buffers and scheduling of activities for use by all MCP software elements.

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

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.

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 BGCOB 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.

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

REPORT PROGRAM GENERATOR: The 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): Originally announced for the UNIVAC 9480 system, IMS/90 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.

DATA MANAGEMENT SYSTEM (DMS/90): DMS/90 is UNIVAC's data base management system for its 90/30, 90/60, 90/70, and 90/80 computers. It operates on the 90/60, 90/70, and 90/80 under the VS/9 Operating System. DMS/90 is designed in conformance with the CODASYL Data Base recommendations and represents a subset of these specifications. Its functional capabilities, therefore, are similar to those provided by DMS 1100, the data base management system for the 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

UNIVAC 90/60, 90/70, and 90/80

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

Precompilation routines are programs used to maintain libraries of source language programs or elements of programs. The existence of source language library facilities is a valuable aid to the programmer in program preparation and lends efficiency to the development of large programming projcects. The specific routines and their functions are:

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

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

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

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

Assembler Diagnostic Routine (ADIAG)–provides the user with the facility for interrogating, from a terminal, the error file created by the assembler during the assembly process. This file contains the same listing and diagnostic messages that are written to the system printer. Commands are provided for reformatting the listings, printing the listings, and accessing the diagnostic messages. The routine is also designed to aid in the definition of causes of the error flags received.

Background Compiler Diagnostic Routine (BDIAG)–provides the facility for interrogating the error file created for the FORTRAN and COBOL compilers. The compilers write the program and diagnostic listings to VS/9's SYSLST file. The user can request that a copy of the diagnostic messages be retained in the system. Using this routine, the diagnostics can be retrieved and printed at a terminal, allowing immediate determination of the accuracy of the program modules created.

Library Maintenance Routine (LMR)–provides the facilities necessary to create, update, delete, copy, and modify object modules in disc-resident libraries. The routine maintains a directory of the library in the front of the file to speed searching by the linkage editor and dynamic linking loader.

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

The linkage editor's primary function is to construct a loadable program from a set of object modules designated by the user. All addresses, external references, entry points, page alignment, read-only attributes, references to common areas, IDA symbolic dictionaries, and overlay and region structures are resolved in one operation. The routine generates statistics, reference resolutions, and load address assignments on a map listing and a cross-reference listing.

The static loader is a control program component that loads the programs created as output of the linkage editor. The loader obtains the virtual storage for programs and resident storage for Class I programs, and establishes the environment for execution. The symbolic dictionary is constructed for interaction with IDA, if requested by the loader.

The dynamic linking loader is a control program component that provides the capability for dynamically linking Class I object modules into a loadable program. The dynamic linking loader does not encompass all the functions of the linkage editor, nor does it provide load program map listings. However, it facilitates both load-and-go operation in a test environment and the dynamic inclusion of object modules into an executing program.

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

FILSAV is a program that provides a tape-oriented file maintenance facility to the system administrator and other users. The system administrator can use this routine to maintain system files on a magnetic tape, usually for backup. All users can utilize the routine for saving and restoring catalogued files on tape. The routine copies files from disc storage or magnetic tape, duplicates tapes, updates saved-tape files, and restores tape files to disc. The program may be used in a batch or interactive mode.

The VS/9 Self-Loading System (SLS) is a multipurpose utility that runs in a self-contained environment. The heart of the SLS is the self-loading I/O handler (SLIOH) and a number of VS/9 error recovery modules that, when linked together, make up a mini-operating system that can run one job at a time. Linked to this mini-operating system is the direct-access volume support (RAVS) package and the emergency dump (EDUMP) system. The SLS provides the user with the facilities to build system residence, initialize volumes, copy VS/9 volumes from disc to tape or tape to disc, dump virtual memory and system files, and print the contents of a resident emergency dump tape. With the exception of dumping virtual memory and system files, these functions can also be performed during a standard VS/9 version.

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

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

EDT can be executed in either the batch or interactive mode, and will read or write SAM or ISAM files wholly or in part. With this editor it is possible to create, copy, delete, compare, and concatenate files, and to add, delete, and

UNIVAC 90/60, 90/70, and 90/80

modify text within files. It also provides comprehensive facilities for defining procedures and for searching and restructuring files. EDT operates on text in virtual storage, and therefore makes very few references (or accesses) to physical storage devices. While processing the data in virtual storage, the originating data file, if any, is closed, serving as a backup file fully protected from any system failure that might cause an opened file to become inaccessible for the session. EDT also supports an edit-on-disc mode for very large files.

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

CODE provides facilities through which the COBOL programmer, with a minimum command set, is able to utilize all the power of the system without having to learn every software component involved in the effort. All files required for the program are automatically maintained by the subsystems. The programmer can terminate at any time during the development of a program and return later. CODE automatically handles all interfaces with other VS/9 software components, allowing the programmer to concentrate on the immediate task of designing a program. Using a set of 28 commands, the programmer can create, modify, edit, and delete source program statements; maintain and update source program files; define his own abbreviations or use standard abbreviations for language elements; verify syntax and compile the program; retrieve and analyze compiler-generated diagnostic messages and correct the source; load and execute the program; wave the compiled program in an object module library; debug the program using symbolic IDA facilities while applying corrections directly to the source program; and use the TFG to create test data for debugging the program.

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

The VS/9 Desk Calculator is a facility that simulates the operation of a conventional desk calculator for users at remote terminals. The user can BREAK from a program, use the Desk Calculator, and resume the program at the point of interruption. The facility provides all arithmetic functions plus a limited set of elementary trigonometric and algebraic functions, offering an expanded set of operations over the conventional device. Calculated results are displayed immediately, unless multiple calculations are entered in one statement. In the latter case, results appear two-per-line until complete.

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

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), LINCO 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); 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; AUTOFORM automatic text formatting system; UNIS/90 (Univac Industrial System); and WIMS (Wholesale Inventory Management System).

PRICING

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

UNIVAC 90/60 BASIC SYSTEM: Consists of 524K-byte 90/60 Processor (with virtual storage, one multiplexer channel, two selector channels, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm card reader with control, 250-cpm card punch, 1400-lpm printer, 600 megabytes of disc storage, and four 96KB, 1600-bpi, phase-encoded tape units. Purchase price is $677,200, monthly rental on a one-year contract is $19,588, and the monthly rate on a five-year lease is $17,134.

UNIVAC 90/60 MEDIUM SYSTEM: Consists of 1048K-byte 90/60 Processor (with virtual storage, one multiplexer channel, two selector channels, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm card reader, 250-cpm card punch, 1400-lpm printer, 1000 megabytes of disc storage, and four 192KB, 1600-bpi, phase-encoded tape units. Purchase price is $878,462, monthly rental on a one-year contract is $25,397, and the monthly rate on a five-year lease is $22,217.

UNIVAC 90/70 LARGE SYSTEM: Consists of 1572K-byte 90/70 Processor (with virtual storage, one multiplexer channel, four selector channels, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm card reader, 250-cpm card punch, two 1400-lpm printers, six 320KB, 1600-bpi, phase-encoded tape units, and 1200 megabytes of disc storage. Purchase price is $1,678,582, monthly rental on a one-year contract is $44,115, and the monthly rate on a five-year lease is $38,535.

UNIVAC 90/80 MEDIUM SYSTEM: Consists of 1048K-byte 90/80 Processor (with virtual storage, four block multiplexer channels, one byte multiplexer channel, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm card reader, 250-cpm card punch, two 1400-lpm printers, six 320KB, 1600-bpi, phase-encoded tape units, and 1200 megabytes of disc

UNIVAC 90/60, 90/70, and 90/80

storage. Purchase price is $2,156,662, monthly rental on a one-year contract is $52,716, and the monthly rate on a five-year lease is $45,973.

UNIVAC 90/80 LARGE SYSTEM: Consists of 2096K-byte 90/80 Processor (with virtual storage, five block multiplexer channels, one byte multiplexer channel, floating-point hardware, storage protection, and VS/9 software), console, 1000-cpm card reader, 250-cpm card punch, two 1400-lpm printers, 1600 megabytes of removable disc storage, and 6 megabytes of fixed-head disc storage. Purchase price is $3,131,122, monthly rental on a one-year contract is $66,101, and the monthly rate on a five-year lease is $57,093.

SOFTWARE AND SUPPORT: UNIVAC has not "unbundled" 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. ■

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
90/60 PROCESSOR AND MAIN STORAGE				
3024-91	90/60 Processor (includes DAT Feature, Multiplexer Channel, 2 Interval Timers, Storage Protection, a Selector Channel, Floating Point Control, and 524,288-byte Memory)	284,184	1,094	7,894
7025-81	Storage Expansion; 262,144 bytes	46,800	200	1,300
F2629-00	Performance Enhancement (increases execution speed of the 90/60 processor by 25 percent)	9,000	25	250
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)	398,304	1,249	11,064
7025-99	Storage; 65,536 bytes (expands main storage from 131,072 to 196,608 bytes)	25,704	143	714
F1775-98	Storage; 65,536 bytes (expands main storage from 196,608 to 262,144 bytes)	25,704	143	714
7025-98	Storage; 131,072 bytes (expands main storage from 262,144 to 393,216 bytes)	30,600	229	850
7025-97	Storage; 131,072 bytes (expands main storage from 393,216 to 524,288 bytes)	27,900	229	775
7025-81	Storage; 262,144 bytes (expands main storage by 262K bytes; requires that 524,288 bytes of main storage be present in the system)	46,800	200	1,300
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	1,800	6	50
F1337-99	Selector Channel; 833 KB (includes channel programming and storage protection; Selector Channels 3, 4, and 5 require 1916-00 Channel Expansion Cabinet)	8,748	243	32
F1337-02	Selector Channel 5 (90/70 only)	1,664	243	32
1916-00	Channel Expansion Cabinet (for third and fourth F1337-00 Selector Channels)	8,568	32	238
F1335-00	Direct Control; interface for another 9000 Series processor plus 2 instructions for transfer of control information	3,564	11	99
F1591-00	Programmable Emulator; provides programmable control for SMOOTH, using special hardware instructions	9,900	65	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	20,268	92	563
0772-00	Console Printer; 30 cps (reduced for OS/4)	9,900	59	275
2519-00	Multiple Channel Switch; 1 switch plus cabinetry for five F1541-00 expansion switches	6,768	26	188
F1541-00	MCS Expansion; one switch	3,348	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
90/80 PROCESSOR AND MAIN STORAGE				
3036-99	90/80 Processor (Includes DAT feature, 1 Byte Multiplexer Channel, 1 Block Multiplexer Channel, Interval Timer, Virtual Storage Timer, Storage Protection, Floating Point Control, and 524,288-byte memory)	1,080,000	3,120	22,500
F2352-00	Storage: 524,288 bytes (expands main storage from 524,288 to 1,048,576 bytes)	218,400	455	4,550

* Rental prices do not include equipment maintenance.

UNIVAC 90/60, 90/70, and 90/80

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
90/80 PROCESSOR AND MAIN STORAGE (Continued)				
F2353-99	Storage: 524,288 bytes (expands main storage from 1,048,576 bytes to 1,572,864 bytes)	96,300	413	2,675
F2352-98	Storage: 524,288 bytes (expands main storage from 1,572,864 bytes to 2,097,152 bytes)	93,600	400	2,600
F2352-97	Storage: 524,288 bytes (expands main storage from 2,097,152 bytes to 2,621,440 bytes)	96,300	413	2,675
F2352-96	Storage: 524,288 bytes (expands main storage from 2,621,440 bytes to 3,145,728 bytes)	93,600	400	2,600
F2352-95	Storage: 524,288 bytes (expands main storage from 3,145,728 bytes to 3,670,016 bytes)	96,300	413	2,675
F2352-94	Storage; 524,288 bytes (expands main storage from 3,670,016 bytes to 4,104,304 bytes)	96,300	400	2,600
90/80 PROCESSOR FEATURES				
F1920-00	Block Multiplexer Channel	15,840	33	330
F1922-01	Byte Multiplexer Channel	16,800	35	350
F2011-00	Expanded interface; expands Byte Multiplexer Channel interface to provide capability for up to 16 subsystems	2,160	5	45
F1921-00	Subchannel expansion; provides an additional 256 Block Multiplexer subchannels	1,440	5	30
F1914-00	Direct control; provides an interface between a 90/80, and another 90/80, 90/70,	4,800	10	100
F1915-00	90/60, 90/70 Mode; provides capability to operate as a 90/60 or 90/70 processor (required for operation with OS/4)	4,800	10	100
4014-97	System Console; includes Uniscope 200 CRT; may be expanded by addition of one 0772-00 printer and up to 6 multi-channel switches	27,024	92	563
0772-00	Console Printer; 30 cps	13,200	59	275
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	436	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	262	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	327	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	44	160
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	142	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	16	85
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	207	760.
F1223-00	Disc Pack (200 MB; maintenance contract not available)	1,150	—	50
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	355	1,189.
F1043-00	Dual Channel	4,416	18	92
F2001-00	Dual Access (per 8425-00 unit)	2,304	5	48
8425-00	Disc Storage (58 million bytes)	17,664	98	368
F1214-01	Disc Pack (for 8425 drives)	382	—	21
INPUT/OUTPUT UNITS				
0861-00	Uniservo 12 Master Tape Unit; 9-track; 1600 bpi, 68.32 KB/second	18,336	131	382
F0934-99	Simultaneous Single-Density Feature (for 0861-00); requires 2 controls	4,080	19	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	19	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	10	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	131	332
F0934-98	Simultaneous Single-Density Feature (for 0861-04); requires 2 control units which each must contain F0823-99	4,080	19	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

* Rental prices do not include equipment maintenance.

UNIVAC 90/60, 90/70, and 90/80

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
INPUT/OUTPUT UNITS (Continued)				
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	90	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	110	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	121	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	73	352
F1029-00	Simultaneous Single-Density Access (for 5017-00); provides second control module	18,960	85	395
F0823-99	7-Track NRZI (for 5017-00 or 5017-99)	5,760	18	120
F0826-00	9-Track NRZI (for 5017-00 or 5017-99)	4,416	18	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	18	92
0862-00	Uniservo 16 Magnetic Tape Unit; 9-track 1600 bpi; 192 KB/second (requires 5034-00 control)	22,032	126	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	126	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	120	441
5045-02	Auxillary 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	18	120
F0825-00	Dual-Channel; permits nonsimultaneous operation on 2 channels of 1 processor or 1 channel on each of 2 processors	4,416	18	92
F0826-00	9-Track NRZI; permits 9-track phase-encoded operation	5,760	18	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	18	120
0870-03	Uniservo 14 9-track PE Magnetic Tape Unit	16,080	87	335
0870-05	Uniservo 14 7-track NRZI Magnetic Tape Unit	14,880	87	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	144	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	104	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	17	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	23	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	17	113
5042-00	Uniservo 30 Series Control; controls up to eight dual-density (GCR/PE) Uniservo 32 and/or Uniservo 34 Tape Units	55,392	288	1,154
F2131-00	9-Track NRZI; enables read or write operation in 9-track NRZI mode at a density of 800 bpi	3,648	19	76
F2132-99	7-Track NRZI; enables read or write operation in 7-track NRZI mode at densities of 800, 556, or 200 bpi	1,824	10	38
F2135-00	Dual Channel; provides an additional I/O interface for the 5042-00 Control	6,000	32	125
F2137-00	16-Drive Addressing; adds 16-drive addressing capability; must be added to all the control units in the subsystem	960	5	20
0872-00	Uniservo 30; 9-track Phase Encoded/NRZI Tape Unit	34,800	181	725
0872-02	Uniservo 30; 7-Track Non-Return to Zero (NRZI) Tape Unit	34,800	181	725
F2123-00	7 to 9-Track Conversion; converts 7-track Type 0872 Tape Unit to 9-track Type 0872 Tape Unit	3,774	0	79
0873-00	Uniservo 32; 9-Track Dual-Density Group Coded Recorded/Phase Encoded Tape Unit	31,584	164	658
0873-02	Uniservo 34; 9-Track Dual-Density Group Coded Recorded/Phase Encoded Tape Unit	36,192	188	754
F2125-00	Tape Speed Conversion; converts a Uniservo 32 Tape Unit (0873-00) at 75 ips to a Uniservo 34 Tape Unit (0873-02) at 125 ips.	4,608	24	96
0874-00	Uniservo 36; 9-Track Dual Density Group Coded Recorded/Phase Encoded Tape Unit	38,880	202	810
0604-99	Card Punch and Control; 250 cpm	22,234	117	463
F0875-00	Read/Punch Feature (for 0604-99)	7,152	61	149
0716-96	Card Reader and Control; 600 cpm	12,192	66	254
0716-99	Card Reader and Control; 1000 cpm	15,504	110	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

* Rental prices do not include equipment maintenance.

UNIVAC 90/60, 90/70, and 90/80

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
INPUT/OUTPUT UNITS (Continued)				
0770-00	Printer, 800 lines per minute	56,304	255	1,173
0770-02	Printer, 1400 lines per minute	64,896	324	1,352
0770-04	Printer, 2000 lines per minute	86,686	425	1,806
F1533-00	160 Print Positions	4,416	18	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	228	993
F1108-00	600-dpm Speed Upgrade (for 2703-00)	12,000	39	250
F1163-00	Modulus 10 Check Digit (for 2703-00)	1,104	5	23
F1106-00	Mark Read–EBCDIC (for 2703-00)	9,024	45	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	18	113
8575-00	Line Terminal Control-4 (for DCS-4); controls 4 duplex lines	12,432	55	259
8575-01	Line Terminal Control-16 (for DCS-16); controls 14 duplex lines	26,208	117	546
F1357-00	Line Terminal Control 1C (for binary synchronous; not supported by UNIVAC software)	6,432	33	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	193	1,092
8579-85	Multi-Channel Communications Controller (MCC 1A) (same as MCC 1 except includes Scanner 1 expansion F2262-99)	61,872	226	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	284	1,642
F2262-99	MCC 1 to MCC 1A Expansion (MCC 1 is prerequisite)	9,456	33	197
F1800-01	Manual Channel Switch (provides capability to switch an MCC between multiplexer channels of two Series 90 host processors)	4,305	14	83
F1793-00	16K-Byte Storage Expansion (maximum of two per MCC)	10,300	32	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
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

*Rental prices do not include equipment maintenance.

UNIVAC 90/60, 90/70, and 90/80

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance	Rental (1-year lease)*
MULTI-CHANNEL COMMUNICATIONS CONTROLLER (Continued)				
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 F1828-01 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 Adatper—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 Adatper—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.