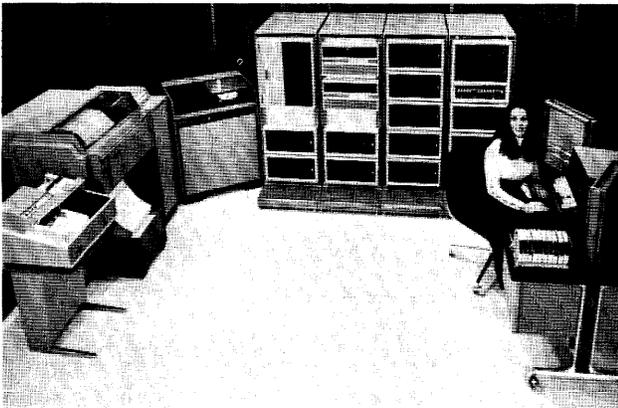


u 9/75
Hewlett-Packard 3000



The HP-3000 multiprogramming system shown here includes a 96K-byte, 980-nanosecond core main memory, an operator console, two 4.9MB disc cartridge drives, a 47MB disc drive, an industry-compatible 800-bpi magnetic tape drive, a 600-lpm line printer, and a 600-cpm card reader. Purchase price for this configuration is about \$210,000. The MPE/3000 operating system provides program development support for COBOL, FORTRAN, BASIC, and SPL for up to eight typical terminal users, while concurrently supporting batch processing.

MANAGEMENT SUMMARY

Hewlett-Packard's much heralded HP-3000 is a broad-based minicomputer system that offers a variety of powerful features and high performance capability usually found only in much larger and more expensive traditional computer systems. Originally announced on November 3, 1971, for initial delivery in November 1972, about two dozen HP-3000 systems were delivered through mid-1973. At that time, promised delivery schedules of key software were not met, and active marketing of the HP-3000 was suspended.

In November, 1973 the HP-3000 was reannounced with a modified "Version B" of the original operating system (MPE-3000), and marketing resumed with a flourish. Prophecies of recidivism for the HP-3000 by competitors notwithstanding, the strong HP hardware is now matched with a powerful operating system well within Hewlett-Packard's software support and development capabilities.

Basically, the HP-3000 is a virtual memory multiprogramming machine that uses either a moving head disc or an optional high-speed fixed-head disc unit to provide a swapping area for up to two million bytes of virtual storage. The basic system includes a 64K-byte, 980-nanosecond core main memory, a 30 character-per-second console terminal, an industry-compatible magnetic tape drive, and a direct access disc storage device for a purchase price of \$121,150.

HP-3000 configurations range from about \$2,800 per month for a minimum system to as much as \$8,000 per ➤

The recently re-released HP 3000 is a small-scale disc-based system with a powerful multiprogramming, multi-lingual capability designed to handle simultaneous interactive and batch operation, each in more than one programming language. FORTRAN, COBOL, BASIC, and an ALGOL-like SPL are all supported.

CHARACTERISTICS

MANUFACTURER: Hewlett-Packard Company, Data Systems Division, 11000 Wolfe Road, Cupertino, California 95014. Telephone (408) 257-7000.

MODEL: HP-3000.

DATA FORMATS

BASIC UNIT: 16-bit word or eight-bit byte.

FIXED-POINT OPERANDS: 16-bit operands that can be used by logical or fixed-point arithmetic instructions to represent an unsigned 16-bit integer from zero to 65,535 or a signed 15-bit integer from -32,768 to +32,767, respectively. Double-integer fixed-point formats (for FORTRAN) provide 32 bits for representation of values from -4 billion to +4 billion (via subroutine call; addition/subtraction implemented in hardware, other operations implemented through software).

FLOATING-POINT OPERANDS: Single-precision 32-bit operand with signed nine-bit exponent and 22-bit positive fraction. Extended-precision 48-bit operands with a signed nine-bit exponent and 38-bit positive fraction. In both single- and extended-precision formats, the exponent can range between -256 and +256, while an assumed "one" is placed to the left of the binary point in the fraction.

INSTRUCTIONS: The HP-3000 has an unusually rich and varied complement of instructions, all of which except the stack operation instructions are one-word types with 23 distinct formats for 13 different instruction groups. (Note that the 62 stack instructions can be packed two per word). In general, each instruction has a number of basic fields. Invariably, the first field is always four bits long and is used to define a specific operation code (for memory reference or loop control instructions) or one of four "sub-opcode" groups. All "sub-opcode"-type instructions have an operation code extension field whose length and position in the instruction vary depending upon which of the four sub-opcode groups is specified. In some cases, a third operation code field ("mini-opcode" or "special opcode") is used to extend the basic operation code.

The rest of the 16-bit instruction is used for a variety of functions (count fields, bit positions, index specification, immediate operand, etc.) and is called the "argument". ➤

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▷ month for a larger system, with typical systems at about \$4,000 per month lease (five-year term) or \$140,000 purchase. A wide variety of peripherals is available, including 600-lpm printers, 1600-bpi (72 KBS) magnetic tapes, 1,200/250-cpm card reader/punches, and interfaces for most popular communications terminals.

The HP-3000 processor employs a stack architecture to support push-down pop-up processing, and uses a special variable-length segmentation technique that separates user program code from data. These two types of segments permit reentrant user programs and allows a program to be used by more than one user without requiring multiple images of the same program to be stored in memory. A large number of stack-pointing registers are provided to keep track of the user's current program location and data segment(s).

From a functional point-of-view, the most nearly cost-effective systems available that can match the concurrent multi-lingual, multi-terminal capabilities of the HP-3000 are the DECSYSTEM-10 from Digital Equipment, the Sigma 6 from Xerox, and IBM's System/370 Model 135. Against each of these systems, the HP-3000 is considerably more cost-effective, however.

What often happens in actual competition is that a multi-lingual system – but not necessarily one that offers concurrent multi-lingual capability – is encountered from among the ranks of the minicomputers. This competition comes from the high end of most popular 16-bit mini-computer families, including the arch-rival PDP-11/45 from DEC, Data General's Nova 840, the Interdata 80, and the Xerox 530. Each of these hefty minicomputer systems provides strong general-purpose operating systems. However, Hewlett-Packard has narrowed the HP-3000 marketplace somewhat through a market strategy that stresses flexible, concurrent, multi-lingual environments where terminal-oriented scientific/engineering problem solving is likely to be combined with background batch processing. Typically, users in this environment will work in several languages, using FORTRAN, ALGOL, or BASIC for on-line applications, with COBOL for administrative background batch processing. While many of the top-of-the-line minicomputer competitors can beat the performance of the HP-3000 when running any one of its four languages, the HP-3000 extends the functional ability of the user to support multiple languages concurrently in a manner transparent to the user (except for a nominal degree of performance overhead).

Ideal HP-3000 prospects include current high-volume IBM 1130 users as well as users of FORTRAN or ALGOL either at service bureaus or under commercial time sharing. (ALGOL users can work in the very similar SPL.) These users are generally rather sophisticated, and tend to be in a program development environment, well able to develop their own applications programs with individual ▷

▶ The following are examples of ten instruction group formats.

| | | | | |
|--------------------------|-----------|-------------|-------------------------|----------------|
| General I/O Interrupt | OP CODE | SUB OP CODE | MINI OP CODE | K |
| | 0 3 4 | 7 8 | 11 12 | 15 |
| Stack | OP CODE | STACK OP A | STACK OP B | |
| | 0 3 4 | 9 10 | 15 | |
| Shift or Bit Test | OP CODE | SUB OP CODE | SHIFT COUNT OR BIT POS. | |
| | 0 3 4 5 | 9 10 | 15 | |
| Branch | OP CODE | SUB OP CODE | ± | DISP |
| | 0 3 4 5 | 9 10 11 | 15 | |
| Move or Special | OP CODE | SUB OP CODE | SUB OP CODE | DISP |
| | 0 3 4 | 7 8 | 11 12 | 15 |
| Immediate: | OP CODE | SUB OP CODE | IMMEDIATE | |
| | 0 3 4 | 7 8 | 15 | |
| Field: | OP CODE | SUB OP CODE | J | K |
| | 0 3 4 | 7 8 | 11 12 | 15 |
| Register Control: | OP CODE | SUB OP CODE | O | REGISTER |
| | 0 3 4 | 7 8 9 | 15 | |
| Program or Loop Control: | OP CODE | SUB OP CODE | N OR DISP. | |
| | 0 3 4 | 7 8 | 15 | |
| Memory Address | OP CODE | X | I | MODE AND DISP. |
| | 0 3 4 5 6 | | | 15 |

For memory address instructions, six memory addressing modes are provided. Except for privileged instructions (including I/O), all addressing is relative to the P-register (plus or minus), the Q-register (plus or minus), the DB-register (plus only), or the S-register (minus only). Indirect addressing and indexing are both provided, singly or in combination. Up to 65K words (addresses) can be referenced by a memory reference instruction. For byte addressing, the left half of each word can be addressed, permitting a memory byte reference instruction to address up to 32K bytes. For byte addressing, four addressing modes are provided: direct, direct-indexed, indirect and indirect indexed.

Double word indexing is provided for two memory address instructions that automatically causes the index register contents to be multiplied by two during development of the effective address.

INTERNAL CODE: ASCII.

MAIN STORAGE

STORAGE TYPE: Core, MOS, and bipolar memories can be intermixed: standard HP-3000 basic memory is magnetic core. ▶

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PERIPHERALS/TERMINALS

| DEVICE | DESCRIPTION | SPEED |
|-------------------------|---|-----------------|
| MAGNETIC TAPE EQUIPMENT | | |
| 30115A | Industry-compatible, 45 ips, 7/9 track, 200/556/800 or 800/1600 bpi | 36 or 72 KBS |
| LINE PRINTERS | | |
| 30108A | 132-position, 64/96 character | 200/136 lpm |
| 30109A | 132-position, 64/96 character | 600/400 lpm |
| CARD EQUIPMENT | | |
| 30106A | Reader; 80-column | 600 cpm |
| 30107A | Reader, 80-column | 1200 cpm |
| 30112A | Punch 80-column | 250 cpm |
| PAPER TAPE EQUIPMENT | | |
| 30104A | Reader, 8-level | 500 cps |
| 30105A | Punch, 5- or 8-level | 75 cps |
| TERMINALS | | |
| 30102A | Printer Terminal, 75 or 118 column format, 96-character | 30 cps |
| 30123A | CRT, 25 lines with 72 positions/line; 64-character | 110, 2400 bps |
| 30124A | System Console, ASR 33, 63-character, 72 positions | 10 cps, 110 bps |
| PLOTTER INTERFACE | | |
| 30126A | Interface for Calcomp Series 500 plotters | — |

▷ programmers using FORTRAN, BASIC, COBOL or the ALGOL-like Systems Programming Language (SPL), in accordance with their skills and preferences.

Each of these languages is supported on the HP-3000, with particular strength present in the reentrant FORTRAN compiler, providing highly efficient operation for users of this popular scientific language. Furthermore, the close parallels between FORTRAN and BASIC on the smaller HP-2100's to these languages on the HP-3000 makes it possible for users with these smaller systems to upgrade easily to the new computer. (Even though conversion will be required, the standard portions of the languages will be unchanged, and only the discrepancies in language extensions and data format expressions will need to be resolved.)

A choice of operating modes is provided for the HP-3000: multiprogramming for up to eight typical users operating concurrently with batch processing; and conversational remote access from a variety of different communications ▷

▶ **CYCLE TIME:** 980 nanoseconds.

CAPACITY: 64K bytes to 128K bytes in two 32K-byte increments.

CHECKING: Standard parity bit per 16-bit word is set with each write operation and checked with each read.

STORAGE PROTECTION: Standard protection using upper and lower address boundaries to define limits of authorized program access in main memory. The micro-program routinely checks for bounds violation during execution (overlapped with operand fetch), and generates an interrupt if an unauthorized memory access attempt is made.

RESERVED STORAGE: The first twelve words are always reserved for system pointers (to facilitate implementation of the virtual memory variable length segment swapping scheme), an interrupt counter, and cold-load (bootstrap) register values. In addition to these locations, a Device Reference Table (DRT) must be reserved to contain a cross-reference table of symbolic and physical I/O device addresses with a minimum of 16 words to as many as 506 words depending upon peripheral configuration. ▶

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▷ terminals. For terminal access, the system responds identically as it would to batch processing except that unusual or error conditions are reported directly to the terminal user, while in a batch mode MPE 3000 automatically invokes the "standard" default action. (The terminal user is free, of course, to request invocation of the same defaults.)

Users with combined engineering/scientific problem solving and concurrent background batch processing requirements particularly when more than one language is used are well advised to give serious consideration to the HP-3000. The HP-3000's technical features are tailored to multiprogramming in a multi-lingual environment, and include an unusually powerful instruction repertoire, stack processing architecture, and virtual memory operation. □

▶ CENTRAL PROCESSOR

GENERAL: The HP-3000 is a complex system, complete with features and processor capabilities usually found only in larger mainframes. The basic microprogram architecture is asynchronous and designed to facilitate a multiprogrammed, variable-length code segmentation virtual memory mode of operation with extensive stack processing using paging registers. The system design emphasizes a modular structure, with the CPU, I/O processor (IOP), and Module Control Unit (MCU) connected via a high-speed central data bus to other system modules. The MCU is shared by the CPU and IOP. The I/O processor executes I/O programs in parallel with CPU operations.

Program code and data are maintained in strictly separate domains and cannot be intermixed except for "immediate" type data present in program instructions. This design was chosen so that all program code would be protected from alteration, thus permitting the development of reentrant programs for multi-thread operation.

REGISTERS: Twenty-two hardware registers are provided in the HP-3000. Three of these are code segment pointer registers: program base (PB), program counter (P), and program limit (PL). Six of the registers are data segment pointers: data limit (DL), data base (DB), stack marker (Q), top-of-stack-in-memory (SM), logical-top-of-stack pointer (S), and stack limit (Z). Other registers include an index register, status register, and mask register. All of these registers except the SM register have 16 bits: the SM register has three bits. Other registers are available for internal use only, such as the four scratch pad registers available to the microprograms.

INDIRECT ADDRESSING: Yes, to one level.

INSTRUCTION REPERTOIRE: There are 170 machine instructions in the HP-3000: 63 stack instructions, six single-word shifts, six double-word shifts, three triple-word shifts, thirteen branches, six bit test instructions, two field instructions, five register controls, seven program controls, five privileged I/O instructions, six Interrupt instructions, four loop control instructions, and sixteen memory address instructions.

INSTRUCTION TIMINGS: All times are for full-word, fixed-point operands in microseconds:

| | 980-nanosecond Core memory |
|---------------------------|-------------------------------|
| Load/Store | 2.10/1.75 |
| Add/Subtract | .70 |
| Multiply/Divide | 5.95/8.75 |
| Compare and Branch (CPRB) | 5.08 |

INTERRUPTS: The interrupt system provides for up to 253 external interrupt levels. There are sixteen levels of interrupt masking, and each device is assigned to one of the sixteen levels when the system is configured to fix a priority and permit masking under software control. Under microprogram control, context switching for an interrupt is performed in an average time of 21 microseconds (minimum eighteen; maximum 24.5). The interrupt routines operate on a common Interrupt Control Stack to permit nesting of interrupt routines for multiple interrupts and further reduces context switching time by about two microseconds should nested interrupts occur. Seventeen internal interrupts for user errors, system violations, hardware faults, and power fail/restart are also provided, plus seven traps are provided for arithmetic errors and illegal use of instructions or privileged mode.

CONTROL STORAGE: The HP-3000 is under control of a 2K-word 32-bit bipolar programmable read-only-memory (PROM) that implements the instruction repertoire, the interrupt handler, and the cold start or bootstrap loader. The control storage is not directly accessible to the end user, and has a cycle time of 175 nanoseconds and an average instruction execution time of 175 nanoseconds.

VIRTUAL MEMORY: The HP-3000 uses a variable-length segment swapping scheme to implement a virtual memory structure. For segmentation purposes, either program code or data (but not both), can be included in a single segment that is stored in a swapping area of fixed-head disc memory until called for in main memory. This design allows code to be reentrant, meaning that a given sequence of instructions can be in simultaneous use by several users and can be reentered several times by the same user whether or not preceding entries are concluded. Each compiled program or subprogram is stored in a file storage area on disc as a relocatable binary module and held ready for segmentation and transfer into the swapping area on disc. The first eight locations of the segment hold a linkage header, and the last location in the segment effectively points back to the header. Code segments may be up to 16K words long and data segments may be up to 32K words in length.

STACK OPERATION: A push-down, pop-up, or LIFO (last in, first out), stack capability is provided. Several stacks may be set up in memory at once (one for each process) but only one is active at a given time. The stack area is bounded at the low end by the DL register and at the high end by the Z register. A major division in the stack is made by the DB register, which points to the "base" location. Locations between DL and DB form a dynamic area for symbol tables, and arrays. The SM register points to the current top-of-stack location, with locations between SM and Z available for current stack expansion.

The Q register points at a location in the "current" stack between DB and SM, and establishes a start point for new procedures. Stacks can be used to hold data values for basic arithmetic operations, code segment(s) for procedure calls ▶

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- to allow simplified parameter passing, and recursive or reentrant procedures that call themselves one or more times during execution.

INPUT/OUTPUT CONTROL

I/O PROCESSOR: The IOP operates in parallel with the CPU, and communicates with the CPU as well as other system modules over a high-speed central data bus. Data is transferred directly to or from memory over the central data bus, via a high-speed selector channel, or multiplexed via the IOP. Up to seven system modules (CPU, IOP, Selector channel, and four memory modules) can be attached to the central data bus, and up to 253 I/O devices can be connected to the system via the IOP bus, the multiplexer channel, and the selector channel. Each of the modules in the system can operate independently at its own speed when not operating over the central bus. The selector channel can transfer at a maximum rate of 2.28 (input) or 3.80 (output) million bytes per second.

Up to eight device controllers can be handled by one selector channel, and two devices can transfer data over the selector simultaneously via a limited multiplex capability. Up to four selector channels can be attached to the module control unit (MCU) bus. The aggregate selector channel data rate cannot exceed the central data bus maximum data rate of 5.7 million bytes/second. Each multiplexer channel can handle up to sixteen device controllers, with an aggregate data rate of 880K (input) or 1,300K (output) bytes per second. Data from the multiplexer channel is passed through the IOP for transfer to memory via the central data bus.

In addition to the multiplexer and selector modes of I/O data transfer, a direct I/O mode is also available that permits the CPU to transfer information directly to/from low-speed asynchronous peripheral devices without involving memory, the multiplexer, or the selector channels at rates of 2.9 (input) or 3.3 (output) million bytes per second. Four privileged I/O instructions are included in the HP-3000 to handle these direct data transfers to/from the top of a stack in memory.

SIMULTANEOUS OPERATIONS: In addition to overlapped operations between the CPU and IOP, and the basically asynchronous nature of the HP-3000's architecture, two-way interleaving is permitted between symmetrically-sized memory modules. When interleaving is specified (under switch or jumper cable control), memory address alternation between modules proceeds automatically. Synchronous operation is required only when communicating with other modules over the central data bus.

CONFIGURATION RULES: The basic HP-3000 system includes 64K bytes of core memory (up to two modules), a system control desk with a 30120A printer terminal/console (30 cps, 75 or 118 column format), and a multiplexer channel (for sixteen peripheral controllers). One magnetic tape drive and a disc are also required in the minimum configuration. As a performance improvement feature, the HP-30103A fixed-head disc can be used as the swapping device. The configuration limits are a matter of channel bandwidth capacity and are subject to the overall system limitation of 253 I/O devices; up to seven basic system modules can be configured in the system.

The CPU and IOP are in one ten-slot chassis; a second ten-slot chassis can hold the two memory modules (three slots each), the port controller (one slot), and a selector

channel (three slots). A third basic ten-slot chassis is used for two high-speed device controllers (two slots each), a multiplexer channel (one slot), and individual device controllers (five slots). Additional ten-slot chassis are available as required. (Please refer to the I/O Control section of the report for other configuration limits.)

MASS STORAGE

30102A CARTRIDGE DISC SUBSYSTEM: Consists of a controller and one moving head disc drive. Up to seven additional drives can be added, each with a capacity of 47,104,000 bytes. The 11-high, 20-surface disc pack stores 116,019 bytes per cylinder, and has 406 cylinders (six spares). Data transfer rate is 312K bytes per second, and average access time is 41.5 milliseconds (including 12.5 milliseconds average latency) at 2400 rpm.

30103A FIXED HEAD DISC: Provides two or four million bytes of disc storage normally used for system residence and swapping area. Data is stored with 8KB per track (32 sectors), and either 256 or 512 tracks (depending upon model). Four discs are provided with two surfaces per disc, and 64 tracks per surface. Data transfer rate is 485K bytes/second, and average access time is 8.5 milliseconds at 3520 rpm.

30110A CARTRIDGE DISC: Consists of a controller and one 4,915,200-byte disc drive. The IBM 2315-type disc cartridge stores 256 bytes per sector, 24 sectors per track, four tracks per cylinder, and 200 cylinders per drive. Up to three additional drives can be ordered for the 30110A (maximum 19.6 MB per subsystem). Data transfer rate is 245.7K bytes/second, and average access time is 47.5 milliseconds (including 12.5 milliseconds average latency) at 2400 rpm.

INPUT/OUTPUT UNITS

See Peripherals/Terminals table.

COMMUNICATIONS CONTROL

30032A ASYNCHRONOUS TERMINAL CONTROLLER: Controls up to sixteen hardwired, Bell 103 or 202 type data sets at 300 or 2400 bps, respectively. The 30032A connects to the IOP.

30055A SYNCHRONOUS SERIAL COMMUNICATIONS INTERFACE: Controls a single 301B data set at 40.8K bps, or an EIA compatible device at 96K bps. The 30055A connects to the IOP.

SOFTWARE

MULTIPROGRAMMING EXECUTIVE (VERSION B): MPE/3000 is a disk-based operating system that provides concurrent batch and interactive multiprogramming either from traditional batch input devices or interactive terminals. Concurrent program development support is provided for FORTRAN, BASIC, COBOL, and SPL, as well as a program file edit subsystem (EDIT/3000), debug programs, TRACE/3000, system diagnostics (SDM/3000) and general utility support including a sort capability using sort keys with up to 15 digits. MPE/3000 supports reentrant program operation by keeping program code segments separate from data areas, and permits a virtual storage method of operation for a combined program size of up to 2 million bytes. Other facilities provided by MPE/3000 include a job accounting facility and a system log. ►

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► For each given main memory size, disc requirement in bytes (system residence and "swapping" area) are summarized below:

| Main Memory Size (KB) | MPE/3000 Disc Requirements (MB) |
|-----------------------|---------------------------------|
| 64 | 1.65 |
| 96 | 2.00 |
| 128 | 2.57 |

Main memory resident (nucleus) requirements for MPE/3000 range from 32KB (typical for a 64KB system) to about 40KB (typical for a 128KB system).

MPE/3000 is a relatively easy-to-use operating system, and the user interfaces with MPE/3000 through commands (for general functions external to his programs) and intrinsic calls (for specific functions invoked during program execution).

PROGRAMMING: Program development support is provided for extended ANS FORTRAN, BASIC, ANS COBOL (minus the Report Writer Feature), and SPL (Systems Programming Language). SPL is an ALGOL-like language. The language most frequently used by typical HP-3000 users is FORTRAN. Also, a Text Editor and a Sort subsystem are available.

APPLICATIONS: HP makes available a scientific library subsystem with 28 programs and routines, the STAR — a system of Statistical Analysis Routines capable of handling up to 32,767 observations (single precision floating-point numbers) of each of 63 variables. STAR requires about 40K bytes, with a maximum resident segment size of about 8K bytes.

PRICING

POLICY: The HP-3000 is provided on a lease or purchase basis, with MPE-3000 and program development support for COBOL, FORTRAN, BASIC, and SPL separately priced. (See Software pricing).

Lease rates can be calculated as percentages of the list (purchase) price payable per month for terms from 3 years to 5 years in accordance with the following table:

| Term (months) | Percent of List Price per Month |
|---------------|---------------------------------|
| 36 | 3.42 |
| 42 | 3.24 |
| 48 | 2.80 |
| 60 | 2.30 |

Since the leases are non-cancellable, a special provision is available that permits a nine-month cancellation notice for an additional premium of 1.25% of the list price per month.

A purchase option provision is available to apply 70% of the lease payments toward purchase to a maximum of 85% of the list price.

SUPPORT: Maintenance is separately priced for eight consecutive prime time hours per day, Monday through Friday, with extended period maintenance available for a premium of the basic rates, as follows.

| Consecutive Hours per day | Monday thru Friday | Saturday | Sunday |
|---------------------------|--------------------|----------|--------|
| 8 | * | 20% | 20% |
| 16 | 35% | 25% | 30% |
| 24 | 50% | 30% | 30% |

*Basic maintenance rates as shown in Equipment Price list.

Non-scheduled on-site maintenance is charged for at \$37 per hour during regular weekday hours, and \$46.25 per hour after hours on weekdays, or during weekends and holidays. Service is provided via more than 170 offices, service centers, supply depots and data centers worldwide.

EQUIPMENT: The following typical purchase prices include controllers and adapters.

SMALL INTERACTIVE SYSTEM: Consists of a basic HP-3000 with 65KB of memory, a 4.9MB disc, one 800-bpi magnetic-tape unit, and a 30-cps console to support up to seven terminals. Purchase price is \$121,150.

SMALL BATCH SYSTEM: Consists of a basic HP-3000 with 65KB of memory, two 4.9MB discs, one 800-bpi magnetic-tape unit, a 30-cps console, a 600-cpm card reader, and a 200-lpm line printer. Purchase price is \$153,400.

COMBINED BATCH AND INTERACTIVE SYSTEM: Consists of an HP-3000 CPU with 96KB of memory, a 47MB disc, one magnetic tape unit, a 30-cps console, a 600-lpm line printer, and a 600-cpm card reader to support batch operation concurrently with up to six interactive terminals. Purchase price is \$175,950.

LARGE-SCALE SYSTEM: Consists of an HP-3000 CPU with 128KB of memory, a 30-cps console, one additional selector channel, a 4MB fixed-head disc, two 47MB moving head discs, two 1600-bpi magnetic tape units, two 600-lpm printers, and two 600-cpm card readers to support multi-programmed batch operations concurrently with up to eight interactive terminals. Purchase price is \$328,400. ■

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EQUIPMENT PRICES

| | | <u>Purchase Price</u> | <u>Monthly Maint.</u> |
|---------------------------------|---|---------------------------|---------------------------|
| 3000A | Processor with 64K bytes of 980-microsecond core main memory, 30120A 30-cps system console, desk, clock, and asynchronous terminal controller for 16 devices. (Requires tape drive and disc). | \$95,000 | \$339 |
| MEMORY/PROCESSOR OPTIONS | | | |
| 140 | 32K bytes additional core main memory | 10,000 | 46 |
| 181 | 64K bytes additional core main memory | 20,000 | 104 |
| 30030A | High speed selector channel (1.9M bytes/sec) | 5,900 | 13 |
| MASS STORAGE | | | |
| 30102A | Moving head disc drive and controller for 7 additional drives, 47MB, 312 KBS, 41.5 ms | 32,000 | 215 |
| 30102A-010 | Add-on Drive for 30102A | 20,000 | 175 |
| 30103A-001 | Fixed Head (swapping) disc and controller 2 MB, 485 KBS, 8.5 ms | 42,000 | 184 |
| 30103A-002 | Fixed Head (swapping) disc and controller, 4MB, 485 KBS, 8.5 ms | 53,000 | 202 |
| 30110A | Cartridge disc drive and controller for 3 additional drives, 4.9 MB, 31.2 KBS | 14,750 | 111 |
| 30110A-010 | Add-on Cartridge disc drive for 30110A | 8,800 | 92 |
| MAGNETIC TAPE EQUIPMENT | | | |
| 30115A | Drive and control for one additional drive, 36KBS, 9-track, 800 bpi (NRZI) | 11,400 | 83 |
| 30115A-100 | Drive and control for one additional drive, 72 KBS, 9-track, 800 bpi (NRZI) | 14,600 | 118 |
| 30115A-200 | Cartridge disc drive and controller for 3 additional drives, 4.9 MB, 31.2 KBS | 6,475 | 61 |
| 30115A-300 | First Add-on drive, 36 KBS, 9-track, 1600 bpi (PE) | 10,000 | 96 |
| 30115A-400 | Second Add-on drive, 72 KBS, 9-track, 1600 bpi (PE) | 7,975 | 88 |
| PUNCHED CARD EQUIPMENT | | | |
| 30106A | Reader, 600 cpm | 6,950 | 76 |
| 30107A | Reader, 1200 cpm | 18,000 | 126 |
| 30107A-001 | Dual read station for 30107A | 2,500 | 2 |
| 30112A | Punch, 250 cpm | 32,000 | 120 |
| LINE PRINTERS | | | |
| 30108A | Drum Printer, 200 lpm, 64-character | 16,500 | 89 |
| 30108A-001 | Drum Printer, 150 lpm, 96-character | 19,000 | 89 |
| 30109A | Drum Printer, 600 lpm, 64-character | 32,000 | 103 |
| 30109A-001 | Drum Printer, 500 lpm, 96-character | 35,000 | 103 |
| PAPER TAPE EQUIPMENT | | | |
| 30104A | Reader (500 cps) | 3,250 | 35 |
| 30105A | Punch (75 cps) | 4,100 | 54 |
| PLOTTER | | | |
| 30126A | Interface for Calcomp Series 500 | 1,000 | - |
| COMMUNICATIONS | | | |
| 30000A-001 | Modem support for Bell 103 and 202 | 1,200 | 16 |
| 30120A | Printer Terminal (30 cps) | 4,775 | 42 |
| 30123A | CRT (110-2400 bps) | 3,850 | 64 |
| 30124 | ASR 33 Teleprinter (10 cps) | 1,925 | 88 |

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SOFTWARE PRICES

| | | <u>Monthly Charge</u> |
|--------|---|---------------------------|
| 32001A | Fundamental Operating Software (includes MPE/3000, diagnostics, compiler library, utilities, TRACE/3000, and SPL/3000). | \$25 |
| 32101 | BASIC | 40 |
| 32102A | FORTRAN | 50 |
| 32201A | EDIT | 10 |
| 32204A | STAR | 20 |
| 32205A | Scientific Library | 10 |
| 32213A | COBOL | 50 |
| 32214A | SORT | 10 |