

# Hewlett-Packard 3000CX

## MANAGEMENT SUMMARY

Hewlett-Packard has enhanced the already much-heralded 3000 system with the marketing of the HP-3000CX. The multilingual, multiterminal capabilities are still there, but now it can be validly said that the HP-3000CX handles business and scientific processing simultaneously and with fairly equal facility. Along with continued support of COBOL, a new language capability (RPG-II), a decimal arithmetic package, and I/O spooling have been added to better equip the system to do business processing. New peripherals are now in the 3000 line along with a data base management software system, IMAGE. A new version of the operating system is also there, designed to handle the business, scientific, real-time, and time-sharing processing simultaneously.

The HP-3000 was first introduced on November 3, 1971, for initial delivery in November 1972. By mid-1973, promised delivery schedules of key software elements had not been met and active marketing was suspended. In November 1973, the HP-3000 was reannounced with a modified version of the operating system. The HP-3000CX system was first announced in November 1974, with first deliveries in the first quarter of 1975. Its chief competitors include the DEC PDP-11/70, the Burroughs B 1700, the UNIVAC 90/30, the Data General ECLIPSE, and the once ubiquitous IBM 1130. A recent seminar indicated that HP has about 120 installed 3000's, with at least half the new accounts utilizing IMAGE. First announced in the summer of 1974, IMAGE was delivered in the early fall of 1974.

Basically, the HP-3000CX is a multiprogramming machine that uses either a moving-head disc or a high-speed fixed-head disc unit to provide a maximum swapping area

The HP-3000, at the top end of minicomputer power and capability, has been enhanced and repackaged into four models characterized by a common processor and designated the 3000CX series. An expanded line of peripherals and software support for multiple languages and data base management make the purchase prices, which start at \$99,500, reasonable, even though high by minicomputer standards.

## CHARACTERISTICS

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

**MODELS:** 50CX, 100CX, 200CX, 300CX.

## DATA FORMATS

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

**FIXED-POINT OPERANDS:** 16-bit operands can be used by logical or fixed-point arithmetic instructions to represent an unsigned 16-bit integer from 0 to 65,535 or a signed 15-bit integer from -32,768 to +32,767. Double-integer fixed-point formats (for FORTRAN) provide 32 bits for representation of values from -4 billion to +4 billion; addition/subtraction are implemented in hardware, other operations implemented through software.

**FLOATING-POINT OPERANDS:** Single-precision 32-bit operand with signed 9-bit exponent and 22-bit positive fraction. Extended-precision 48-bit operands with a signed 9-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.



*Pictured here is the largest model of the 3000CX family, the 300CX. Features include virtual memory, stack architecture, and dynamic resource allocation. This model also supports a data base management package, along with FORTRAN, BASIC, ANSI COBOL, RPG II, and SPL (Systems Programming Language).*

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▷ of 4.4 to 14.75 million bytes of virtual storage. The lowest model in the line, the Model 50CX, provides a central processor with a 96K byte, 980 nanosecond core main memory; a 32-bit LSI bipolar ROM-based micro-processor; an instruction set expandable up to 186 instructions; a 16-level external interrupt priority system; facilities for handling up to 253 peripherals; an operating system (MPE/C) with virtual memory capabilities, I/O spooling, hardware stacks, and separation of data and program code (for user program sharing); a 16-port asynchronous terminal controller; a multiplexer channel with 16-device capacity; a 4.9 megabyte cartridge disc unit, and a magnetic tape unit (800 or 1600 bpi). The Model 100CX incorporates the same CPU and features as the Model 50CX but increases disc storage to 14.75 megabytes and adds a 200-lpm printer and a 600-cpm card reader. The Model 200CX adds a 32K increment of core storage and a 47-megabyte moving-head disc. The Model 300CX substitutes a 1,250-lpm printer and 200-cpm reader/75-cpm punch. All models come with basic software including MPE/C, but language processors are extra except for the BASIC compiler and interpreter on the 100CX, 200CX, and 300CX. The Model 50CX has a base price of \$99,500, the Model 100CX \$129,500, the Model 200CX \$171,000, and the Model 300CX \$203,500.

Maintenance is handled through 53 HP offices in the U.S., 9 in Canada, 18 in Central and South America, and 103 in Europe, Africa, Asia, and Australia. Both on-call and scheduled services are available.

Hewlett-Packard stresses flexible concurrent, multilingual environments where terminal-oriented scientific/engineering problem solving is likely to be combined with background batch business processing. HP's support of FORTRAN, SPL (an ALGOL-like systems programming language), and BASIC indicate its scientific bent, while the introduction of Report Program Generator (RPG) and continued support of COBOL show renewed interest and strength in business applications.

The close parallels between FORTRAN and BASIC on the smaller HP-2100's to the languages on the HP-3000CX make it possible for users with these smaller systems to upgrade easily. (Even through 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 possible future trend is indicated by the development of a data base management system for the HP-3000CX. IMAGE/3000, as HP calls its DBMS, is both a terminal and batch-oriented system with direct interface to COBOL, RPG II, FORTRAN, and SPL and programmable interface to BASIC. IMAGE compares favorably to larger, more powerful DBMS's currently available on medium and large-scale systems, except for more limited data capacities. A companion package, QUERY/3000, provides a language to facilitate quick locating, reporting, and updating of data values within an IMAGE/3000 data base. ▷

▶ **INSTRUCTIONS:** The HP-3000CX has an unusually rich and varied complement of instructions; all, except the stack operation instructions, are one-word types with 23 distinct formats for 13 different instruction groups. The 69 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.

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 individually, 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 cause 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-3000CX basic memory is magnetic core.

**CYCLE TIME:** 980 nanoseconds.

**CAPACITY:** 96K bytes or 128K bytes.

**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 12 words are always reserved for system pointers (to facilitate implementation of the virtual memory variable-length segment swapping technique), 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 and as many as 506 words depending upon peripheral configuration.

### CENTRAL PROCESSOR

▶ **GENERAL:** The HP-3000CX is a complex system, complete with features and processor capabilities usually found

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## PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
<b>MAGNETIC TAPE EQUIPMENT</b>		
30115A	Industry compatible, 45 inches/sec., 9-track, 800 bpi (36K bytes/sec.) or 1600 bpi (72K bytes/sec.)	HP
<b>LINE PRINTERS</b>		
30118A	132 positions, 64/128 character set, 200/165 lpm	HP
30127A	132 positions, 64/96 character set, 300/240 lpm	Dataproducts
30128A	132 positions, 64/96 character set, 1800/925 lpm	Dataproducts
30133A	132 positions, 64/96 character set, 600/436 lpm	Dataproducts
<b>CARD EQUIPMENT</b>		
30106A	Reader, 80-column, 600 cpm	Documation
30107A	Reader, 80-column, 1200 cpm	Documation
30119A	Reader/Punch, 80-column, 200 cpm read, 75-cpm punch	Decision Data
<b>PAPER TAPE EQUIPMENT</b>		
30104A	Reader, 8-level, 500 cps	HP
30105A	Punch, 5- or 8-level, 75 cps	HP and Facit
<b>TERMINALS</b>		
2762B	Printer terminal, 120 positions, 10/30/120 cps	GE
2762A	Printer terminal, 75 or 118 positions, 96 character set, 30 cps	GE
30124A	System console, ASR 33, 72 positions, 63 character set, 10 cps (110 bps)	Teletype
2640A	CRT, 24 lines of 80 characters, 64 and 128 character sets, 110, 150, 300, 1200, 2400 bps	HP
<b>PLOTTER INTERFACE</b>		
30126A	Interface for CalComp Series 500 plotters	HP

▷ Up to 12 users can access the system through batch peripherals and/or through a variety of different interactive communication terminals. Program development, debugging and application features are the same for either batch or terminal access. The only processing difference is logistic; the interactive terminal user is given a recovery option to continue processing, while the batch user invokes the standard default action of job cancellation and an optional dump.

**USER REACTION**

Summarized below are the results of Datapro's interviews with six users of the HP-3000 contacted during the summer of 1975. Four of the six systems were purchased. All had been installed since March of 1974. Five of the machines represented included the maximum core of 128K and had from 2 to 16 interactive terminals attached. Applications for these systems included operations research, market research-data collection (for an IBM 360/65), RJE terminal to an IBM 360/195, and real-time scientific endeavors. Among the systems replaced by the HP-3000 were an IBM 1130, an HP 2100, and a time-sharing service. The most common language encountered was FORTRAN, followed by BASIC, SPL, RPG, and COBOL. By their configurations, at least four of the systems are HP-3000CX's. The following ratings were given:

▶ only in larger mainframes. The basic microprogram architecture is asynchronous and designed to facilitate a multi-programmed, 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 re-entrant programs for multi-thread operation.

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

**REGISTERS:** Twenty-two hardware registers are provided in the HP-3000CX. 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

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

\*Weighted Average on a scale of 4.0 for Excellent.

As indicated by the weighted averages, the HP-3000 and HP-3000CX received commendably high marks. Problems were noted in the early version of RPG by a user with business and engineering applications, but have since been corrected. The I/O spooler offered some concern to one user because of its present inability to differentiate, by console message, between jobs to be run on one-part and multi-part forms. Likewise, one user, who primarily handled insurance applications, expressed concern over the FORTRAN manual (however, a new one is in the works). The survey found that the highest mark given was to the ease with which the HP-3000 and the HP-3000CX could be programmed, although most complaints voiced were in the software area. This does attest to HP's fast reaction and its ability to lend support when necessary. Overall performance ratings make it clear that the 3000 series will remain a top competitor in the upper bracket of minicomputers. □

▶ 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.

INDEXING: Yes, through the use of one index register.

INSTRUCTION REPERTOIRE: In total, there are 186 machine instructions in the HP-3000CX: 69 stack instructions, 16 memory address instructions, 13 branch instructions, 4 loop control instructions, 6 single word shift instructions, 6 double word shift instructions, 3 triple word shift instructions, 6 bit test instructions, 2 field instructions, 11 I/O and interrupt instructions (10 privileged), 15 immediate instructions, 7 program control instructions (2 privileged), 5 register control instructions (2 privileged), 5 special instructions (3 privileged), 10 packaged decimal instructions, and 8 move instructions (2 privileged).

INSTRUCTION TIMINGS: All times are for full-word (16 bits), fixed-point operands microseconds:

	Fixed Point	Floating Point (Extended)	Packed Decimal
Load/Store	2.10/1.75	-	-
Add/Subtract	.70	35.4/35.9 avg.	119.5 avg.
Multiply/Divide	5.95/8.75	61.75/78.5 avg.	-
Compare and Branch	5.08	11.35 avg.	98.5 avg.

INTERRUPTS: The interrupt system provides for up to 253 external interrupts. There are 16 levels of interrupt masking, and each device is initially assigned to one of the 16 levels to fix priorities and permit masking under software control. Under microprogram control, context switching for an interrupt is performed in an average time of 21 microseconds (minimum 18; maximum 24.5). The interrupt routines operate on a common Interrupt Control Stack to permit nesting of interrupt routines for multiple interrupts; context switching time is reduced 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 for arithmetic errors and illegal use of instructions or privileged mode.

The priority assigned to external devices is determined by the device's logical proximity to the I/O processor (IOP) on the interrupt poll line. Masking is permissible through the 16-bit bit mask word which will enable or disable an interrupt request according to the bit pattern of the word.

PHYSICAL SPECIFICATIONS: The power requirements are 115 to 230 VAC, 50 or 60 cycle. The operating temperature range for an average system with mass storage should be within 59 to 82 degrees F. Relative humidity can be up to 80 per cent. Air conditioning requirements will exceed the average office installation by about 2 tons. The system will output approximately 24,000 BTU's per hour. Four hundred square feet will amply fulfill the space requirements for the average system for servicing and operator convenience. A raised floor is not required, but is recommended.

### 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 channel 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. The multiplexer channel can handle up to 16 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-3000CX to handle these direct data transfers to/from the top of a stack in memory. ▶

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► **SIMULTANEOUS OPERATIONS:** In addition to overlapped operations between the CPU and IOP, and the basically asynchronous nature of the HP-3000CX'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:** See Pricing Information at the end of this report, and the *previous* paragraphs on the I/O Processor.

**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.

**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, 4 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.

**30129A CARTRIDGE DISC:** Consists of a controller and one 14,745,600 byte disc drive. The IBM 2315-type disc cartridge stores 256 bytes per sector, 28 sectors per track, three tracks per cylinder (the fourth track is a servo track), and 411 cylinders per drive. Up to seven additional drives (30329A) can be ordered for the 30129A (maximum 118 MB per subsystem). Data transfer rate is 937.5K bytes per second, and average access time is 33.3 milliseconds (including 8.3 milliseconds average latency) at 3600 rpm. The unit's capacity can be selected through software: 4.42 MB (120 cylinders) for use as a high speed system disc or 14.75 MB (400 cylinders) for general use. The unit includes a front loading cartridge with two recording surfaces and a fixed head disc with one recording surface.

**INPUT/OUTPUT UNITS**

See Peripherals/Terminals Table.

**COMMUNICATIONS CONTROL**

**30032A ASYNCHRONOUS TERMINAL CONTROLLER:** Controls up to 16 additional Bell 103 type data sets. With the Option 002, Bell 202 type data sets will be handled (for the HP 2640A only). Speeds of 110, 150, 300, 600, 1200, and 2400 bps are implemented. The 30032A is connected via a 16-bit parallel interface.

**30300A PROGRAMMABLE CONTROLLER SUBSYSTEM:** An HP-2100 minicomputer and interconnecting hardware for the attachment of foreign devices and on-line instrumentation applications; the controller makes available up to 42 (with extender) I/O channels. The 30300A utilizes a 16-bit parallel hardwired interface between the HP-2100 and the HP-3000CX with a transfer rate up to 200K words per second.

**30301A REAL-TIME PROGRAMMABLE CONTROLLER SUBSYSTEM:** The system provides dedicated real-time access to measurement and control devices simultaneously

with general data processing. The controller makes 42 (with extended) I/O channels available. The 30301A offers hardwired 16-bit parallel transfer up to 200K words/sec.

**30055A SYNCHRONOUS SINGLE LINE CONTROLLER:** Hardware portion of the 2780, 3780 emulator subsystem; provides all 2780 and 3780 capabilities plus 22 optional capabilities available from batch and interactive terminals under MPE/C. Uses public telephone or leased lines at speeds up to 4800 bps.

**SOFTWARE**

**OPERATING SYSTEM:** The Multiprogramming Executive/Communications Operating System (MPE/C) provides concurrent processing for multiprogrammed batch, time-sharing, real-time, and transaction processing. Support is provided for FORTRAN, ANSI COBOL, BASIC, RPG II, SPL, a program file edit subsystem (EDIT/3000), a systems diagnostic monitor (SDM/3000), a generalized sort and merge (SORT/3000), and general utilities. Other features include virtual memory allocation (code segmentation), stack architecture, recursive/re-entrant code, spooling from both terminal and batch devices, and dynamic resource allocation. MPE/C is disc-resident, and requires 40K bytes of core memory. Recommended disc space allocation for operating system, subsystems, and virtual memory is 2MB.

SPL/3000 is the Systems Programming Language for the HP-3000CX. It is ALGOL-like, but is machine-dependent (direct register references, bit extraction, etc.). It supports one-dimensional arrays and CALLs from any other language available to the system. SPL is free-form in structure and includes other features such as recursive procedures, high-level statements with unlimited nesting, and arithmetic and logical expressions. A debugging aid, TRACE/3000, is provided.

FORTRAN/3000 is based on ANSI Standard FORTRAN (X3.9-1966). Models 100CX and above offer FORTRAN as a standard option. HP offers language extensions and good flexibility in the use of subroutines written in other supported languages. As a further programming aid, TRACE/3000 may be used for debugging.

COBOL/3000 is based on the ANSI standard of 1968. HP has implemented extensions to the standard, but does not support Report Writer at this time. COBOL is available as an option on the two largest Models, 200CX and 300CX.

RPG/3000 is compatible to a high degree with RPG and RPG II as developed by IBM. It is available on all models except the 50CX as a standard option.

BASIC/3000 is implemented as an interpreter and a compiler. The interpreter offers a good way to debug interactively, while the compiler gives more efficient code with average program execution speed 10 to 30 times faster. BASIC is a standard option on all models except the 50CX.

All implemented languages have the ability to call a subroutine written in another language. Of equal importance is the facility provided by the MPE/C file system for all languages to utilize a common file structure, therefore providing uniform access to disc and tape.

Software support for communications is available through the 30130A Emulation Subsystem, the 30300A Programmable Controller Subsystem, the the 3031A Real-Time Programmable Controller Subsystem.

In the Emulation Subsystem, the supplied software supports all significant 2780/3780 capabilities on point-to-point lines plus most optional capabilities such as EBCDIC ►

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► and ASCII transparency, short record truncation, and multi-record transmission.

In the 30300A Programmable Controller Subsystem, a Cross Assembler is supplied to develop programs on the HP-3000CX for use on the programmable controller. The assembler's support includes extended arithmetic and floating point instructions.

In the 30301A Real-Time Programmable Controller Subsystem, HP has developed a program set including the RTE-C operating system, which allows running multiple instrumentation programs concurrently; the RTE-C scheduler, which orders program execution according to 99 user-supplied priority levels; and the ability to write applications, such as data acquisition and process monitoring, in FORTRAN.

**IMAGE/3000:** The new Data Base Management System (DBMS) for the HP-3000CX is oriented towards general purpose data base management and operates in both terminal and batch environments.

IMAGE consists of three parts: a data base definition subsystem (DBDS), a data base management subsystem (DBMS); and a data base utility subsystem (DBUS). Typically, a data base manager would use DBDS to define the data base and DBUS to create and maintain the data base. The applications programmer, in writing his programs in RPG II, COBOL, FORTRAN, or SPL, would use the data base management language (DBML) which operates on the data base using DBMS.

IMAGE uses a network data structure as its data base organization. Data entry selection is made utilizing one of four access methods: serial, chained, directed, and calculated.

In *serial access*, IMAGE starts at the most recently accessed storage location for the data set and looks at all adjacent records sequentially until the desired entry (if it exists) is found. In *chained access*, entries have a common search item (key) value and are linked together through pointers to form a chain. Access is then merely retrieval of the next item in the current chain. In *directed access*, the calling program specifies the record address of the data entry where the requested data items should be located. In *calculated access*, master entries are retrieved by calculating an address based on a key.

In the chained access technique, pointers link one data set item to another. They are normally paired where one pointer refers to the previous entry in a chain and the other pointer refers to the next entry in a chain. The last member of a chain contains a zero forward pointer. To add a new member in a chain, therefore, means only to change the forward pointer value. Up to 16 different pointer pairs can be maintained for each data item; this permits each data item to be a member of 16 different chains or access paths.

Security is provided at the data base, data set, and data item levels. Multiple users may access a data base concurrently. Restructuring of the data base is accomplished by using DBUS. The restructuring can be through a changed data item or data set name, changed security provisions, changed data set relationships, and increased data set capacities. Inverted data sets are not supported.

Limiting parameters for IMAGE/3000 include the following. In each data base there can be a maximum of 255 data item names and 99 data sets; a single set cannot exceed the capacity of a disc drive. There may be up to 16 characters per item or data set name. In each data entry there may be up to 127 data items. The maximum size of a data entry is 4094 bytes. A maximum of 16 keys per detail

data set and 16 detail data sets per master data set is permitted. Each chain may have up to 65,000 entries.

**QUERY/3000:** Uses such commands as FIND, REPORT, and UPDATE to locate, report, and update data values in an IMAGE/3000 data base. Reporting of retrieved data can be formatted to include page titles, column headings, group subtotals, etc., if desired. All security provisions invoked through IMAGE are adhered to in QUERY. A command file can be utilized to store complex or often-used command sets on disc. For display purposes, nine data types may be converted and error-checked.

► **IMAGE and QUERY** are available as options to Models 100CX, 200CX, and 300CX.

**APPLICATIONS AIDS:** The Scientific Library is a collection of routines that perform the most often-used scientific functions. The routines may be utilized by all implemented languages except RPG.

**STAR/3000** is a set of Statistical Analysis Routines combined in a package available to the user by commands in batch mode or questions and answers in on-line terminal mode. STAR can analyze and edit up to 32,767 observations of each of 63 variables. STAR is available on all models.

**TOADS** represents Terminal-Oriented Administration Data Systems and consists of two separately-priced software packages: SIS/3000—the Student Information System which consists of an integrated data school district data base and maintenance modules, a Family Information Facility (FIF), a Mark Reporting Subsystem (MRS), and an Attendance Accounting Subsystem (AAS); and SAS/3000—the Student Assignment System which compares a manually developed master schedule with student course requests to produce class schedules which are based upon school-defined priorities. SAS and SIS require MPE/C, SORT/3000, SPL/3000, EDIT/3000, IMAGE/3000, and COBOL/3000.

### PRICING

**POLICY:** The HP-3000CX is available on a purchase or lease basis. Individual models are offered at a packaged price (processor, required peripherals, and selected software) with extensive separately priced options. The list of bundled software includes MPE/C, The Compiler Library, Utilities, Trace/3000, SPL/3000, SORT/3000, and EDIT/3000. In addition, if one of the programmable controllers is part of the configuration, all software necessary is supplied. MPE/C and EDIT/3000 may also be purchased separately. The language processors may be purchased separately or as part of the scientific and commercial options.

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

Term, months	Percent of List Price per Month
36	3.23
42	2.83
48	2.54
60	2.13

The leases are noncancellable, but a special provision is available that permits cancellation on nine months notice for an additional premium of 1.25 percent of the list price per month.

A purchase option provision is available throughout the duration of a lease; a substantial portion of the lease payments can be applied to the purchase price. ►

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► **SUPPORT:** Maintenance is separately priced for nine consecutive prime-time hours per day, Monday through Friday, with extended period maintenance available for a premium over the basic rates, as follows:

Consecutive hours per day	Monday thru Friday	Monday thru Saturday	Seven days	Guaranteed response time, hrs.
9	*	25%	50%	24
17	35%	60%	85%	8
24	50%	75%	100%	4
On demand	**	**	**	2

\* Basic maintenance rates as shown in Equipment Price list.

\*\*Negotiated.

**EQUIPMENT:** Purchase prices for typical system configurations are reflected in the equipment price list which follows.

Data Base Management and other user training courses are offered at a nominal fee on a regular basis. Both hands-on and classroom experience are included. ■

## EQUIPMENT PRICES

PACKAGED SYSTEMS		Purchase Price	Monthly Maint.
3000C	Model 50CX; includes central processor with 96K bytes of core memory; multiplex channel (16 device capacity); asynchronous terminal controller (16 ports); system console and cabinets; mag. tape unit (30115A, 800 bpi); 4.9M-byte cartridge disc unit (30110A); 3 phase/60Hz power	\$99,500	\$586.00
015	Optional power, 230V (208V-245V) single-phase, 50Hz,	N.C.	N.C.
100	1600-bpi, replaces 800 bpi tape unit	1,500	9.00
181	Increases memory size to 128K bytes	10,000	32.00
202	202 type data set control for asynchronous terminal	1,240	6.00
403	Delete 4.9M byte cartridge subsystem (must order 30102A or 30129A) . . . subtract	-8,000	-117.00
32400C	Model 100CX: Includes central processor with 96K bytes of core memory; multiplex channel (16 device capacity); asynchronous terminal controller (16 ports); system console and cabinets; mag. tape unit (30115A, 800 bpi); 14.75M byte cartridge disk unit (30129A) and a selector channel (30030A); 600 cpm card reader subsystem (30106A); 200 lpm dot matrix printer (30118A); Standard power with 120/208V and 3 phase/60 Hz	129,500	725.00
015	Optional power, 230V (208V-245V), single-phase, 50Hz	N.C.	N.C.
100	1600-bpi, replaces 800 bpi tape unit	1,500	9.00
102	128-character option for line printer	500	N.C.
181	Increases memory size to 128K bytes	10,000	32.00
202	202 type data set control for asynchronous terminal	1,240	6.00
401	Delete 600 cpm card reader (30106A)	-6,000	-64.00
402	Delete dot matrix printer (30118A)	-9,000	-83.00
600	Time-share package: includes BASIC interpreter (32101A) and BASIC compiler (32103A)	N.C.	40.00
601	Scientific package: includes extended floating point instruction set (30011A), Scientific Library (32205A), and FORTRAN/3000 (32102A)	5,000	41.00
602	Commercial package. Includes RPG (32104A) and decimal firmware (30011A-001)	5,000	31.00
603	Commercial and scientific package. Includes options 601 and 602.*	9,000	61.00
30011A	Extended precision floating point instruction set	3,250	11.00
001	Decimal arithmetic firmware instruction set instead	1,000	N.C.
002	Both decimal and floating point arithmetic instruction set	2,000	N.C.
30030	High speed selector channel, 1.9M bytes/second	3,060	13.00
32401C	Model 200CX; includes central processor with 128K bytes of core memory; multiplex channel (16 device capacity); asynchronous terminal controller (16 ports); system console and cabinets; mag. tape unit (30115A 800 bpi); 14.75M-byte cartridge disc (30129A) and a selector channel (30030A); 4.7M-byte moving-head disc (30102A); 600-cpm card reader subsystem (30106A); 200 lpm dot matrix line printer (30118A); 120/208V, 3-phase/60Hz power	171,000	929.00
015	Optional power, 230V (208V-245V), single-phase, 50Hz	N.C.	N.C.
100	1600 bpi, replaces 800 bpi tape unit	1,500	9.00
102	128-character option for line printer	500	N.C.
202	202 type data set control for asynchronous terminal	1,240	6.00
401	Delete 600-cpm card reader (30106A)	-6,000	-64.00
402	Delete dot matrix printer (30118A)	-9,000	-83.00
600	Time-share package: includes BASIC interpreter (32101A) and BASIC compiler (32103A)	N.C.	40.00
601	Scientific package: includes extended floating point instruction set (30011A), Scientific Library (32205A), and FORTRAN/3000 (32102A)	5,000	41.00
602	Commercial package: includes decimal firmware (30011A-001), RPG (32104A), COBOL (32213A)	6,000	51.00
603	Commercial and scientific package. Includes options 601 and 602.*	10,000	81.00

## Hewlett-Packard 3000CX

### EQUIPMENT PRICES

PACKAGED SYSTEMS (Continued)		Purchase Price	Monthly Maint.
30011A	Extended precision floating point instruction set	\$ 3,250	\$ 11.00
001	Decimal arithmetic firmware instruction set instead	1,000	N.C.
002	Both decimal and floating point arithmetic instruction set	2,000	N.C.
30030	High speed selector channel, 1.9M bytes/second	3,060	13.00
32402C	<b>Model 300CX:</b> Includes central processor with 128K bytes of core memory; multiplex channel (16 device capacity); asynchronous terminal controller (16 ports); system console and cabinets; mag. tape unit (30115A 800 bpi); 14.75M-byte cartridge disc (30129A) and a selector channel (30030A); 1,250 lpm printer (30128A); reader/punch subsystem (30119A); 120/208V, 3 phase/60Hz power	203,500	1,070.00
015	Optional power, 230V (208V-245V), single-phase, 50Hz	N.C.	N.C.
100	1600 bpi, replaces 800 bpi tape unit	1,500	9.00
102	96-character option for line printer	2,000	N.C.
106	Keyboard and verify added to reader/punch (30119A-002 is added to 30119A)	2,000	N.C.
202	202 type data set control for asynchronous terminal	1,240	6.00
404	Delete card reader/punch subsystem (30119A)	-12,000	-129.00
405	Delete high speed printer (30128A)	-28,000	-159.00
600	Time-share package: includes BASIC interpreter (32101A) and BASIC compiler (32103A)	N.C.	40.00
601	Scientific package: includes extended floating point instruction set (30011A), Scientific Library (32205A), and FORTRAN/3000 (32102A)	5,000	41.00
602	Commercial package. Includes option 604, Image (32215A), and Query (32216A)	12,000	91.00
603	Commercial and scientific package. Includes options 601 and 602.*	16,000	121.00
604	Commercial package without data base management capability. Includes decimal firmware (30011A-001), RPG (32104A), and COBOL (32213A)	6,000	51.00
605	Scientific and commercial package without data base management capability (Options 601 and 604, essentially)*	10,000	81.00
30011A	Extended precision floating point instruction set	3,250	11.00
001	Decimal arithmetic firmware instruction set instead	1,000	N.C.
002	Both decimal and floating point arithmetic instruction set	2,000	N.C.
30030	High speed selector channel, 1.9M bytes/second	3,060	13.00
<b>MASS STORAGE</b>			
30102A	Moving-head disc drive and controller for 7 additional drives, 47M bytes, 312 KBS, 29ms	32,000	172.00
010	Additional drive for 30102A	20,000	131.00
30110A	Cartridge disc drive (7900A) and controller for 3 more drives, 4.9M bytes, 245 KBS, 35ms	12,000	117.00
010	Additional drive (7900A)	6,975	98.00
30129A	Cartridge disc drive and controller interface 14.75M bytes (Selector Channel required)	15,000	96.00
30329A	Cartridge disc drive 14.75M bytes (7905)	9,975	70.00
<b>MAGNETIC TAPE EQUIPMENT</b>			
30115A	Drive and controller for 3 additional drives, 36 KBS, 9 track, 800 bpi (NRZI)	12,000	85.00
100	Drive and controller for 3 additional 72 KBS, 9 track 1600 bpi (PE)	13,500	94.00
200	Drive for 30115A or 30115A-100 36 KBS, 9 track, 800 bpi (NRZI)	9,550	64.00
300	Master drive for 30115A or 30115A-100 72 KBS, 9 track, 1600 bpi (PE)	11,025	73.00
400	Slave drive pair with 30115A-100 or 30115A-300 72 KBS, 9 track, 1600 bpi (PE)	9,500	65.00
<b>LINE PRINTERS</b>			
30118A	200 lpm subsystem (132 columns/64 characters)	9,750	83.00
001	128-character set	500	N.C.
30127A	300-lpm subsystem (132 columns/64 characters)	13,500	138.00
001	96-character set	2,000	N.C.
30128A	1250-lpm subsystem (132 columns/64 characters)	36,000	159.00
001	96-character set	2,000	N.C.
30133A	600-lpm subsystem (132 columns/64 characters)	2,000	154.00
001	96-character set	19,000	N.C.
<b>PUNCHED CARD EQUIPMENT</b>			
30106A	Card reader subsystem: 600 cpm	7,160	64.00
30107A	Card reader subsystem: 1200 cpm	18,540	121.00
001	Double read station	2,575	2.00
30119A	Card reader/punch subsystem: reads 200 cpm, punches 75 cpm	13,500	129.00
002	Off-line punch and verify capability	2,000	N.C.



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## EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
<b>PAPER TAPE EQUIPMENT</b>			
30104A	Reader, 500 cps	\$ 3,350	\$ 23.00
30105A	Punch, 75 cps	4,225	48.00
<b>COMMUNICATIONS</b>			
30032B 001	Asynchronous terminal controller for Type 103	4,240	21.00
30032B 002	Asynchronous terminal controller for Type 103 and 202 modems	5,480	27.00
30130B	2780/3780 Emulation subsystem	4,500	18.00
30441A	Converts 30032B-001 to the 30032B-002	1,500	6.00
2762A	Printer terminal, 75-column friction feed	4,835	29.00
015	220V AC/50Hz	230	N.C.
016	240V AC/50Hz	230	N.C.
017	Pin-feed instead of friction feed	195	N.C.
018	Adds pedestal	195	N.C.
2762B	Printer terminal, 120-column tractor feed, 10, 30, 120 cps switch-selectable	5,865	58.00
001	Auto-answerback	120	N.C.
002	Vertical forms control	255	N.C.
003	Horizontal tabs	240	N.C.
005	Pedestal	210	N.C.
015	220V AC/50Hz	230	N.C.
016	240V AC/50Hz	230	N.C.
30124A	ASR-33 teletype terminal 10 cps	2,650	60.00
015	230V AC/50 Hz	200	N.C.
2640A	Character mode CRT (1-5 2640A's \$3,000) 6-74	2,640	25.00
001	<del>128-character set</del> —Roman	100	N.C.
005	Male RS232 connector (Required)	50	N.C.
010	Character mode CRT with simplified keyboard	2,900	25.00
13231A	Display enhancements for the 2640A (blinking, half-bright, underline, 3 more 128 char. sets)	250	4.00
201	64-character mathematic symbol set	350	0.00
202	64-character line drawing set	350	0.00
13233A	2K bytes additional storage for 2640A	250	2.00
13234A	4K bytes additional storage for 2640A	375	4.00
13238A	Terminal duplex register	100	1.00
001	Connection to 9866 line printer	50	1.00
13240A	2640A option slot extender	150	0.00
<b>PLOTTER</b>			
30126A	Interface for Calcomp Series 500	1,030	14.00
<b>PROGRAMMABLE CONTROLLERS</b>			
30300A	Controller with 8K memory and BCS software	18,000	147.00
001	Separate cabinet (replacement)	N.C.	6.00
30361A	Interface kit for 30300A to HP-3000 and HP-2100 with BCS/3000 software	5,000	28.00
30301A	Real-time programmable controller (includes 8K HP-2100S computer with extended arithmetic and floating point instructions, HP 12925A Paper Tape Reader, HP 2752A Teleprinter)	23,000	181.00
001	Stand-alone cabinet	N.C.	N.C.
Options for 30300A and 30301A—			
016	Memory upgrade to 16K words	4,000	18.00
024	Memory upgrade to 24K words	7,000	36.00
032	Memory upgrade to 32K words	9,000	54.00
<b>MISCELLANEOUS EQUIPMENT</b>			
30333A	11-high disc pack for 30102A	620	N.C.
30334A	Disc cartridge for 30110A	130	N.C.

## Hewlett-Packard 3000CX

### SOFTWARE PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
32000C	MPE/C Operating System	\$10,000	\$70.00
32101A	BASIC/3000 interpreter	3,500	15.00
32102A	FORTRAN/3000 compiler	4,500	20.00
32103A	BASIC/3000 compiler	4,500	25.00
32104A	RPG/3000 compiler	4,500	20.00
32213B	COBOL/3000 compiler	4,500	20.00
32201A	Edit/3000	1,000	10.00
32204A	Star/3000	1,500	5.00
32205A	Scientific Library/3000	1,000	5.00
32215A	Image/3000 package	10,000	30.00
32216A	Query/3000	1,000	10.00
32900A	SIS/3000 Student Information System	9,500	35.00
32901A	SAS/3000 Student Assignment System	9,500	35.00

N.C. = No charge.

\* The following options are mutually exclusive if ordered separately: 601 and 602; 601 and 604.

\*\*Option 015 (230 VAC 50Hz) is available with 30127A, 30128A, 30106A, 30107A, 30119A, 30102A, 30110A, 30133A, 30129A, 30300A, 30301A, 2640A, and 30329A.