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Digital Equipment DECsystem-10

MANAGEMENT SUMMARY

The DECsystem-10 represents the consolidation of Digital Equipment Corporation's large-scale computer systems efforts into a full-scale product line that features three high-performance processors, a number of high-speed peripherals, extensive data communications capabilities, and a mature and dependable operating system. The DECsystem-10 family was introduced by DEC at the Maynard, Massachusetts "minicomputer capital of the world" in September 1971. The family initially consisted of five models: the 1040, 1050, 1055, 1070, and 1077. A sixth member–the 1060–was announced in September 1972. The two newest processor models–the 1080 and 1090, with internal speeds estimated at twice those of the earlier processors–were announced on October 8, 1974, with first customer delivery scheduled for July 1975.

The DECsystem-10 family is formed around the PDP-10 central processor (called the KA10), which is the heart of the smaller 1040, 1050, and dual-processor 1055 systems. An improved version of that processor (the KI10), which provides for faster execution speeds, better memory utilization, and a higher degree of overlap between processing functions, is used in the 1060, 1070, and dual-processor 1077 versions. Specific processor improvements added to the KI10 include instruction look-ahead, expanded register stack, improved adder, double-precision floating-point hardware, and paging registers.

The newly announced KL10 processor, used in the 1080 and 1090 systems, is an enhancement of the KI10, and achieves its greater speeds through the use of a cache memory, an expanded four-word-wide data path between core memory and the cache memory, and the use of emitter-coupled-logic (ECL) logic circuitry. A significant addition to the KL10 architecture is a set of business-oriented instructions that perform double-precision addition, subtraction, division, and multiplication on fixed-point operands, and a string manipulation instruction that performs decimal/binary conversions and editing functions.

Distinctions between models in the DECsystem-10 family are based largely on configuration rules and marketing ➢

The DECsystem-10 family of medium to large-scale computers has achieved a significant penetration in the educational, laboratory, industrial, and time-sharing markets. The recently announced 1080 and 1090 systems include new business data processing instructions and software enhancements, and a complement of new peripherals for all the DECsystem-10 models should make them more attractive to the selective commercial market segment that DEC is now addressing.

CHARACTERISTICS

MANUFACTURER: Digital Equipment Corporation, 146 Main Street, Maynard, Massachusetts 01754. Telephone (617) 897-5111.

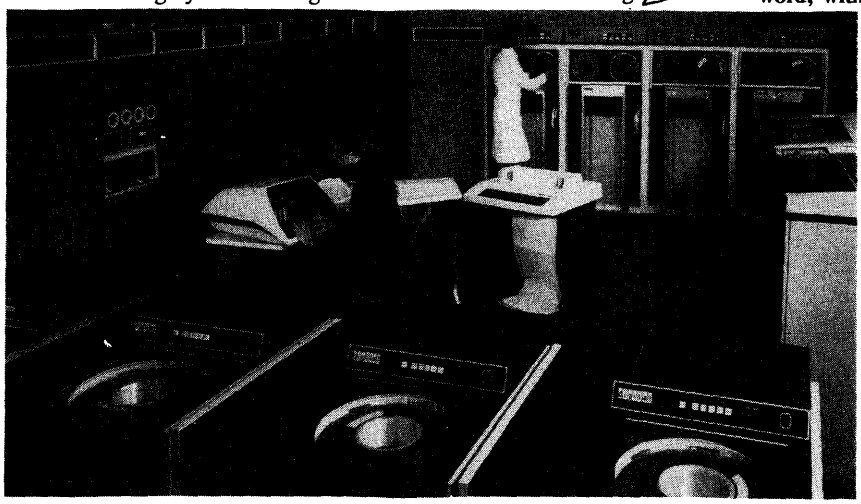
MODELS: DECsystem-10 Models 1040, 1050, 1055, 1060, 1070, 1077, 1080, and 1090.

DATA FORMAT

BASIC UNIT: 36-bit word. In core storage, each word location includes one additional parity bit. The processor handles halfwords, but parity bits are not associated with halfword data representation. Variable-length bytes from 1 to 36 bits in length are also handled.

FIXED-POINT OPERANDS: Either 36-bit words or 18-bit halfwords for add and subtract instructions. The multiply instruction produces a double-word product, and the divide instruction uses a double-word dividend. There are also integer multiply and divide instructions which involve only single words. All arithmetic operations are performed in binary mode.

FLOATING-POINT OPERANDS: Standard floating-point hardware is included on the KA10, KI10, and KL10 processors. The KI10 and KL10 have both single- and double-precision floating-point, while the KA10 has only single-precision and a "long mode," which approximates double-precision through the use of software subroutines. Single-precision floating-point on either processor uses one word, consisting of a 27-bit-plus-sign fraction and 8-bit exponent. The KA10 "long mode" consists of two words with a 54-bit fraction, half of which is in bits 9-35 of each word, with the sign and 8-bit exponent in the high-order ➢



The DECsystem-1080, one of two new models introduced in October 1974, has twice the processing power of previous large-scale DEC computers and includes an extended instruction set for business data processing. It can be equipped with new large-capacity disk drives and high-performance magnetic tape drives.

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strategy. The 1040 may have from 64K to 256K 36-bit words of core storage and uses an I/O Bus and a Memory Bus for attachment of up to 128 peripheral devices. The 1050 differs from the 1040 only in the addition of a swapping subsystem. The 1055, in turn, is a dual-processor version of the 1050. The 1060 replaces the KA10 processor used in the 1050 with the improved KI10 processor, while the 1070 includes the KI10 processor plus a swapping subsystem. The 1077 is a dual-processor version of the 1070.

The recently announced 1080 system incorporates the faster KL10 processor, and, like the KI10 processor, can have from 128K to 4,096K 36-bit words of main memory. Main memory for the new KL10 processor is magnetic core (after all, DEC manufactures core memories), with a new cache memory providing a buffer between the faster CPU and the 1-microsecond main memory. DEC claims that the expanded Memory Bus architecture and the cache provide an effective memory access time of 174 nanoseconds for the KL10 processor. The 1090 system incorporates the KL10 processor and a swapping subsystem. A multiprocessor configuration using KL10 processors is not yet available from DEC.

To enhance its reliability and maintainability, the KL10 processor includes a PDP-11 minicomputer that serves both as a console and diagnostic computer. A separate diagnostic bus permits the PDP-11 to perform diagnostics on the central processor control logic and data paths either in local or remote mode.

All eight members of the DECsystem-10 family operate under control of the DECsystem-10 Monitor, which is the evolutionary result of DEC's large-scale operating system experience since it introduced the DECsystem-10's PDP Series forerunners in 1964. A multi-purpose operating system, the Monitor permits concurrent execution of interactive time-sharing, local and remote batch, real-time, and transaction-oriented processing. Time-sharing on the DECsystem-10 is classified as "general-purpose"; that is, time-sharing users have access to all system facilities, such as the command language, I/O facilities, and data files, under operating system control. The DECsystem-10 Monitor is designed to service up to 512 time-sharing terminals, and time-sharing users have access to the COBOL, FORTRAN, BASIC, APL, ALGOL, and AID (a version of JOSS) languages plus a wide variety of interactive debugging and program preparation aids.

Interactive time-sharing has been the area in which the DECsystem-10 has clearly been most successful; and DEC, with approximately 20 percent of the market for computers in independent time-sharing utilities already under its belt, says that it intends to become "Number One" in marketing to interactive-oriented users. With ambitious plans to produce one DECsystem-10 per day in its new Marlboro facility by the middle of 1977, DEC is looking to expand its marketing efforts into commercial general-purpose processing environments, as well as to enlarge its share of the scientific time-sharing and education markets. Hence the addition of business-oriented instructions to the Model 1080 and 1090 microprogrammed instruction sets, as well as the announcement of enhancements to the DECsystem-10's Data Base Management System (providing access to the data base from both COBOL and FORTRAN programs) and the release of a Message

portion of the word containing the most significant portion of the fraction. Bit positions 0-7 in the other word are not used for floating-point number representation. KA10 floating-point operations are performed in a double-word register, only the most significant word of which is recognized for single-precision.

The KI10 and KL10 processors perform double-precision operations with additional hardware instructions. Double-precision fractions with 62 bits are handled in two words, with the high-order word containing one bit for the sign, 8 bits for the exponent, and 27 bits for the most significant portion of the fraction. The low-order word contains a sign bit and 35 bits for the least significant portion of the fraction.

INSTRUCTIONS: For all but I/O, each instruction consists of one word with a 9-bit operation code, a 4-bit accumulator or flag address, and 23 bits for development of the effective address. The effective address field uses one bit to specify the type of addressing, 4 bits as an index register designator, and 18 bits to reference a memory location. In I/O instructions, the first 3 bits identify the instruction as I/O, and the next 7 bits address an I/O device, with 2 more bits as an operation code. The next 23 bits are used to develop an effective address just as in the non-I/O instructions described above.

INTERNAL CODE: Seven-bit ASCII. Each 36-bit word is used to represent five 7-bit bytes, with one unused bit per word. Bytes from 1 to 36 bits in length can also be recognized and manipulated.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: See table.

CYCLE TIME: See table.

CHECKING: Parity bit with each 36-bit word is generated with writing and checked with reading.

STORAGE PROTECTION: The KT10A Dual Memory Protection and Relocation Registers, required on the KA10 processor, allow 1040, 1050, and 1055 users to define up to two memory areas for each program. Typically, each program is divided into a re-entrant (sharable) portion and a non-re-entrant, user-specified portion. The extents and physical locations of the two program segments are specified, and protection is provided from other users. Memory may be allocated to user programs in multiples of 1024 words. As core memory becomes fragmented during multiprogramming operations, or as swapping occurs in time-sharing, memory segments consisting of less than 1024 words become unusable, requiring realignment of user programs to more appropriate memory boundaries to eliminate the effects of checkerboarding.

The KI10 and KL10 processors provide 1060, 1070, 1077, 1080, and 1090 system users with a more efficient and flexible storage protection scheme than is available for the three smaller DECsystem-10 models. A paging system reserves up to 256K 36-bit words of memory in as many as 512 pages of 512 words each. The individual pages need not be located in contiguous memory locations, thus eliminating the need to shuffle program segments in memory to counteract checkerboarding. The paging registers effectively permit addressing of 4 million words of memory through use of special hardware on the KI10 and KL10. Three bits are used to denote the type of access possible for each page, such as read/write, read-only, proprietary, or denial of access.

CENTRAL PROCESSORS

REGISTERS: Each 1040, 1050, and 1055 processor has sixteen 36-bit general-purpose KM10 registers which can be used as multiple accumulators, index registers, or memory locations. Each of these integrated-circuit registers has a cycle time of 200 nanoseconds, and 15 of them can be used as fast-access memory to increase the execution speed of instructions or program loops (not to exceed 15 instruc-

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CHARACTERISTICS OF THE DECsystem-10 MODELS

	1040	1050	1055	1060	1070	1077	1080	1090
System Configuration								
Type of CPU	KA10	KA10	KA10	KI10	KI10	KI10	KL10	KL10
Number of CPU's supported by standard software	1	1	2	1	1	2	1	1
Paging	No	No	No	Yes	Yes	Yes	Yes	Yes
Typical system rental*	$8,900	$12,300	$18,700	$14,500	$18,500	$27,400	$23,100	$27,500
Date of announcement	Aug. 1971	Aug. 1971	Aug. 1971	Sept. 1972	Aug. 1971	Aug. 1971	Sept. 1974	Sept. 1974
Date of first delivery	Aug. 1971	Aug. 1971	Nov. 1971	Dec. 1972	June 1972	Mar. 1973	July 1975	July 1975
Main Storage								
Minimum capacity, 36-bit words	64K	64K	80K	64K	96K	128K	128K	128K
Maximum capacity, 36-bit words	256K	256K	256K	4,096K	4,096K	4,096K	4,096K	4,096K
Increment size, 36-bit words	16K/32K/ 64K/128K	16K/32K/ 64K/128K	16K/32K/ 64K/128K	32K/64K 128K/256K	32K/64K 128K/256K	32K/64K	64K/128K/ 256K	64K/128K/ 256K
Memory cycle time, microseconds (new/old)	0.95/1.0	0.95/1.0	0.95/1.0	0.95/1.0	0.95/1.0	0.95/1.0	0.95/1.0	0.95/1.0
Words accessed per cycle	1	1	1	1	1	1	4	4
Storage interleaving	2 or 4-way	2 or 4-way	2 or 4-way	2 or 4-way	2 or 4-way	2 or 4-way	2 or 4-way	2 or 4-way
Central Processor								
Number of hardware instructions	366	366	366	378	378	378	386	386
Instruction look-ahead	No	No	No	Yes	Yes	Yes	Yes	Yes
Index registers	15	15	2 x 15	4 x 15	4 x 15	8 x 15	8 x 15	8 x 15
Register stack switching, microseconds	No	No	No	2.5	2.5	2.5	0.5	0.5
Interrupt service time, microseconds	6	6	6	3	3	3	3	3
Maximum interrupt delay, microseconds	40	40	40	10	10	10	10	10
Double-precision floating-point hardware	No	No	No	Yes	Yes	Yes	Yes	Yes
I/O Control								
High speed data channel cycle time, microseconds	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
I/O Bus cycle time, microseconds	4.50	4.50	4.50	2.70	2.70	2.70	2.70	2.70
Interrupts	7 levels	7 levels	7 levels	7 levels plus up to 135 trap instr.	7 levels plus up to 135 trap instr.	7 levels plus up to 135 trap instr.	7 levels plus up to 135 trap instr.	7 levels plus up to 135 trap instr.

*Monthly payment under 5-year accrued-equity lease, including equipment maintenance.

Control System, a general-purpose communications monitor designed to ease the development of communications software for on-line applications.

The DECsystem-10 family offers a range of computational capability that stretches across the current IBM product line from the 370/125 through the 370/158–at equipment prices about one-half those of their IBM counterparts. The newly announced KL10 central processor utilized in the 1080 and 1090 systems is expected to surpass the internal performance of an IBM System/370 Model 158 in scientific processing environments and to approximately equal the performance of a 370/158 in business-oriented processing.

One key reason why the DECsystem-10 models are so much cheaper than functionally comparable IBM systems is that DEC competes only in system environments that favor the DECsystem-10's particular strengths. Those strengths are largely derived from the excellent appli-

tions) stored in them. The KM10 registers occupy the first 16 locations of main memory.

The KI10 processor used in the 1060, 1070, and 1077 systems has 64 general-purpose registers contained in 4 blocks of 16 registers each. Fifteen registers in each block can be used as high-speed memory. Because of the greater degree of overlap between the operation of the KI10 registers and main memory, the effective execution time for the high-speed registers ranges between 70 and 200 nanoseconds.

The KL10 processor used in the 1080 and 1090 systems has 128 integrated-circuit general-purpose registers, contained in 8 blocks of 16 registers each, that can be used as accumulators, index registers, or for other high-speed memory functions. In both the KI10 and KL10 processors, register blocks can be assigned to the operating system and to individual user programs to provide for rapid context switching. Program switching between register blocks is estimated to require 2.5 microseconds for the KI10 and 500 nanoseconds for the KL10. One register block also can be assigned for the exclusive use of a time-critical real-time program.

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cability of the DECsystem-10 Monitor to a "multi-mode" environment, including on-line processing plus local batch plus remote batch plus computer network requirements. In order for IBM, as an example, to satisfy these requirements, a full-scale OS or OS/VS system with the Time-Sharing option (TSO) and a host of other ancillary software support products is needed. Even where part of the DEC software is now separately priced (for example, the operating system), the difference in the cost of the required hardware (main and auxiliary storage plus high-performance processor) usually leads to a sizeable overall cost advantage for DEC.

DEC's initial entry into the large-scale computer business was made in 1964 with the 36-bit PDP-6, which was succeeded in 1967 by the PDP-10. Some 25 PDP-6 systems were delivered, followed by about 175 PDP-10 installations. Since the announcement of the DECsystem-10 family in September 1971, DEC has doubled its annual volume of business in large-scale computer systems, and has installed an estimated 400 DECsystem-10's. Revenues from the DECsystem-10 now contribute approximately 15 percent of DEC's sales revenues.

Ranking second only to IBM in terms of the number of computers of all types installed, DEC has a broad minicomputer customer base, with an overall total of nearly 40,000 installed systems worldwide. Many of these installations are in scientific laboratories and industrial control applications, and it is from these ranks that the bulk of new customers for Digital's large-scale DECsystem-10 will come. Many of the early DECsystem-10 installations have been upgrades for PDP-10 users. In order to facilitate the upward migration of its customer base, DEC provides a liberal upgrade policy that allows substantial trade-in allowances for older systems and slower peripherals.

To support the ambitious marketing plans that DEC announced for its DECsystem-10 family at the recent unveiling of its two newest members, new business will have to come from sources other than the existing DEC customer base. DEC, of course, is counting on cashing in on the expanding market for time-sharing systems, an application where the DECsystem-10 has already proved its worth. In addition, DEC is looking for substantial growth in commercial environments, particularly in applications in which the strengths of the DECsystem-10 can be put to good use in interactive program development and in communications networks. To provide momentum for its marketing thrust, DEC has assembled a field organization of nearly 200 sales and software engineers and close to 300 field engineers dedicated to selling and servicing DECsystem-10 installations.

They won't, however, be calling on the typical batch-oriented computer user whose processing requirements are concentrated on conventional business applications. Instead, Digital's DECsystem-10 market target includes "the top manufacturing and service companies" where a DECsystem-10 can complement the processing capabilities of an already existing large computer installation.

In addition to the above criteria, DEC observes that a typical DECsystem-10 user will:

- Have already gained a respect for DEC's products and service through use of its minicomputers (scientific

INDIRECT ADDRESSING: Possible on all processors. Indirect addressing may occur at multiple levels, with indexing at each level.

INSTRUCTION REPERTOIRE: The DECsystem 1040, 1050, and 1055 processors have 366 standard instructions, all of which are one word in length. The processor has 64 data transfer instructions which operate on half-words; 20 instructions to shift the location of one or more full words; 5 byte manipulation instructions; 26 fixed-point arithmetic instructions, 35 floating-point instructions, and comprehensive logical testing, and branching facilities. The more powerful 1060, 1070, and 1077 processors have 11 additional standard instructions: 8 for double precision floating-point arithmetic and 3 for conversion between fixed-point and floating-point formats.

In addition, the KL10 processor used in 1080 and 1090 systems has a Business Instruction Set that includes four new arithmetic instructions to add, subtract, multiply, and divide double-precision fixed-point operands. A new STRING instruction also performs a variety of functions including editing, decimal/binary translations, and moving and comparing strings composed of ASCII or EBCDIC characters. The 386-instruction repertoire of the KL10 processor is microprogrammed.

INSTRUCTION TIMES: See table below. All times are in microseconds and are for the basic mode using direct addressing without indexing (i.e., with no effective address calculation) and assuming no effects from multiprogramming, such as program segment relocation, etc. Note that the dual-processor 1055 and 1077 systems permit execution of two instructions simultaneously.

	1040, 1050, & 1055	1060,1070, & 1077	1080 & 1090
Fixed-point add/subtract (36-bits)	2.6	1.5	0.7
Fixed-point multiply	9.8	4.1	2.4
Floating-point add/subtract (single precision)	5.6	3.2	1.9
Floating-point multiply (single precision)	10.5	4.2	*
Floating-point add/subtract (double precision)	59.4	7.6	5.0
Floating-point multiply (double precision)	59.4	7.6	*
Jump	1.5	1.1	0.5

***Timing not available.**

CACHE: The KL10 processor used in 1080 and 1090 systems includes a fast-access MOS cache memory with a 125-nanosecond access time. The cache, which is 2,048 words in size, actually consists of four caches, each with a capacity of 512 words (or one page) that operate in parallel. Each cache is a two-dimensional array consisting of 128 horizontal lines and 4 vertical columns containing one word of data each. In addition, the cache accesses a list of physical page addresses calculated by the memory-mapping hardware that correspond to the four columns of program data. For each processor fetch operation, a simultaneous search is performed of all four cache pages to determine if the data is present in the cache. If not, the referenced data must be retrieved from main memory. Data is loaded into the cache from main memory four words at a time, thereby providing an instruction look-ahead feature.

DEC estimates that data being written to or read from main memory is typically found in the cache from 90 to 95 percent of the time, resulting in an effective access time of 174 nanoseconds for the KL10 processor. The cache uses a least-recently-used algorithm to identify the oldest cache entry, and that entry is removed to provide space for new data. Physical memory addresses, in contrast to logical user addresses, are maintained by the cache to facilitate context switching and the use of re-entrant code. A "written" bit is activated each time a user program has written a location in the cache, but the entry is not "written through" to main memory until it becomes necessary to provide cache space

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laboratory and industrial control environments are good examples); and/or

- Have experienced some degree of exposure to on-line environments, particularly through the use of a time-sharing service bureau using DECsystem-10 equipment; and/or
- Have an application requirement that falls into one of DEC's industry specialties, whether or not the user has dealt directly with DEC in this specialized area (e.g., typesetting applications); and/or
- Require the establishment of a network of high-level applications-oriented terminals that may come from a variety of vendors (e.g., large-scale R&D organizations employing instrumentation or lab monitoring equipment).

The new 1080 and 1090 computer systems are expected to spearhead DEC's thrust into new markets. Along with their commercial instruction sets and software enhancements, they can be equipped with a selection of new disk and tape drives, a new fast-access swapping disk, and a PDP-11-based asynchronous communications controller. Although DEC has demonstrated a gradually increasing reliance upon internal peripheral development during recent years, it continues to market a number of peripherals which are purchased from other suppliers. The newly announced RHP04 Disk System, with a capacity of 100 million characters per spindle, is manufactured by ISS, and DEC's TU70 1600-bpi Magnetic Tape Drives are purchased from Storage Technology Corporation. A new high-speed fixed-head disk provides up to two million characters of swapping storage and replaces the more expensive RM10 Drum System as a backing store for program swapping and virtual memory operations. The new peripherals are available for all processor models in the DECsystem-10 product line.

Communications capabilities of the DECsystem-10 have been enhanced by the addition of the DC76 Asynchronous Communications System that can handle up to 512 ASCII or IBM 2741-compatible asynchronous terminals. A new terminal for time-sharing users is the VT50 DECscope Interactive Video Terminal, announced in June 1974 as a low-cost, low-maintenance terminal for large networks. The VT50 DECscope represents DEC's first product to be offered in the highly competitive end-user terminal market. A new LA36 DECwriter Keyboard Terminal provides true 30-character-per-second print speeds for use with a 300-bit-per-second communication line and replaces the earlier LA30 DECwriter.

In addition, DEC provides a wide variety of "standard" interfaces to "nonstandard" products, in the sense that each of these devices has already been interfaced to the DECsystem-10 a number of times. Indeed, many of the products available from the DEC Advanced Systems Group, although not yet offered as part of the DEC standard product line with publicly available prices, provide an inkling of what's coming next in DECsystem-10 development. Here are three examples:

- The DAS85 Synchronous Communications System is a PDP-11-based communications multiplexer that supports individual line speeds of up to 40.8K bits per

for newly accessed data. When an entire user program is swapped out by the Monitor, a "cache sweep" feature writes all altered pages in the cache associated with that program back to main memory before the program is swapped out of main memory.

PAGING: The KI10 and KL10 processors provide a mapping capability from physical memory addresses of up to 4 million words (which require 22 bits for representation) to shorter effective addresses contained in 18 bits. The most significant half of the 18-bit effective address is used as an index to a page table which contains up to 4096 physical page numbers. The referenced physical page number is concatenated with the low-order 9 bits of the effective address (which indicates one of the 512 words on a page) to produce a 22-bit main memory address that can reference any of the 4 million words (maximum memory size of the 1080 or 1090). The KI10 processor uses an associative memory-mapping unit to perform address translation, while the KL10 maintains a 512-word hardware version of the entire page table. In the KL10, the high-order bits of the virtual address are used to perform a table look-up to locate the 13-bit most significant portion of the resulting 22-bit physical address.

PROCESSOR MODES: The KA10 processor used in the DEC-system 1040, 1050, and 1055 has two modes: User Mode and Executive Mode. The Monitor operates in the Executive Mode, in which addresses are not relocated and all memory locations are accessible. User programs execute in the User Mode, and are relocatable and subject to memory protection restrictions.

IN KI10 and KL10 processors, the Exec Mode is further divided into the Supervisor Submode and the Kernel Submode. Kernel Submode is used for the most frequently performed segments of the DECsystem-10 Monitor, which handle system I/O and any functions which affect all users of the system. The rest of the DECsystem-10 Monitor executes in the Supervisor Submode and performs general management of the system and functions which affect only one user at a time. All instructions are permitted for use in the Exec Mode.

User Mode on the KI10 and KL10 permits the execution of all instructions except those which would cause interference with other users or the integrity of the DECsystem-10 Monitor. User Mode is subdivided into the Public Submode and the Concealed Submode. Concealed Submode protects any program in that category from being copied or modified, even by the program itself, and is normally used for proprietary software. Concealed Submode programs can read, write, execute, and transfer to any Public location, while Public programs can access addresses in Concealed programs only by transferring to locations which have ENTRY instructions. In User Mode, a program can access up to 256K words.

INTERRUPT STRUCTURE: The KA10 has seven standard prioritized channels associated with the I/O bus that transfers interrupt signals between system devices and the I/O Bus. Twenty-one additional channels can be added for a maximum of 28. Assignment of the channels to specific devices is under user program control, and may be altered during processing. The processor itself is treated as a device, and internal overflow or priority checks can cause signals to be sent to the user program. Any number of devices can be connected to a single channel, and some devices may use two channels to transfer interrupts identifying different conditions, such as device ready for data transmission or error condition encountered.

In addition to the seven-level interrupts available on the KA10, the KI10 and KL10 use up to 135 Programmed Trap Instructions. The trap instructions can be executed in the same address space as the instructions which caused the trap. This allows user programs to handle their own interrupts by directing the monitor to place a jump to a user routine in the trap location. Up to 40 programmed traps may be specified which execute in the executive area. These trap routines are loaded into the system at monitor generation time. Interrupts on the KI10 and KL10 are decoded with one instruction.

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second and supports the DAS80 series of remote batch stations. Special software for the DAS85 permits multiple DECsystem-10 computers in a communications network to communicate and to pass data files between executing programs. Both the DAS85 and the DAS80 terminals operate with DEC's new DDCMP synchronous communications protocol, a message-oriented protocol that is oriented toward computer-to-computer communications.

- The DAS78 Synchronous Communications System permits a DECsystem-10 (emulating an IBM 2780 remote batch station) to operate in a computer network with IBM System/360 and System/370 computers.

- The DAS79 Synchronous Communications System provides a high-speed communications link between DECsystem-10 processors and large Control Data 6000 Series and Cyber Series computer systems using a modified version of the CDC Import/Export communications protocol. In network configurations including Control Data computer systems, programs developed on the DECsystem-10 can be submitted for execution in batch mode on the Control Data central processor, with conversion from DEC 7-bit ASCII code to CDC display code performed by the DAS79 software.

Aside from these applications utilizing specialized software, compatibility for the DECsystem-10 is limited primarily to its PDP-6 and PDP-10 forerunners. There is no current object-level compatibility between the DECsystem-10 and other popular computer systems, although DEC's COBOL, FORTRAN IV, ALGOL-60, and BASIC source-level language specifications all conform closely to industry standards. The DECsystem-10 is currently being utilized in customer installations for development of COBOL programs for execution on IBM System/370 computers. Incompatibilities between DEC's ASCII internal representation and the IBM EBCDIC are resolved by source program editing, although DEC plans future enhancements to improve compatibility between the two compilers. In addition, DEC has simulators for IBM 1401 and 360/20 systems, but has revealed no plans for utilizing the writable control storage facilities of its newest KL10 central processor for emulating competitive systems.

In mid-1972 DEC startled its competitors by announcing DECsystem-10 price cuts ranging from 15 to 35 percent, depending upon model and configuration. Direct price reductions of this sort, while routine in the fast-moving minicomputer business where DEC reigns supreme, have been less common in the medium-to-large computer arena. DEC pointed out that the DECsystem-10 price cuts largely reflected savings in production costs made possible by DEC's takeover of the former RCA core memory manufacturing operation. It is worth noting that at least part of DEC's willingness to reduce system pricing is based upon its lack of a significant rental base, which enables it to make price cuts without impacting a major established revenue source.

The new KL10 processor is priced approximately on a par with the older KI10 processor. Memory modules and the newly announced complement of peripherals, however,

INPUT/OUTPUT CONTROL

I/O CHANNELS: The DECsystem-10 uses DF10 and DF10C Data Channels to control the transfer of data between high-speed device controllers and memory ports via the memory bus, and a multiplexed I/O Bus to attach controllers for slower peripherals. DF10 Data Channels interface with the MX10 Memory Port Multiplexer and utilize 18-bit address logic with the capability to address 256K words of main memory. DF10C Data Channels utilize 22-bit address logic and interface with the MX10C Memory Port Multiplexer, with the capability to address up to 4 million words of main memory.

Up to 126 I/O devices can be connected to a DECsystem-10. Each DF10 Data Channel can interface up to eight controllers or special devices, but provides only one path through the memory bus directly to an assigned memory port, thus requiring other devices connected to the DF10 to wait until data transfer has been completed before being serviced. A DECsystem-10 can have up to 24 DF10's, each capable of handling its own I/O simultaneously with that of other DF10's. Any device connected to memory through a DF10 is also connected to the processor thru the I/O bus to allow for testing of device status.

Each memory module (with the exception of the MG10 Module) has four MC10 Memory Access ports to provide direct access to any combination of four processors and/or high-speed data channels. The 256K word MG10 Memory Module has up to eight ports and supports four-way interleaving. The capacity of each MC10 port can be increased by seven additional channels with an MX10 Memory Port Multiplexor. Thus, full expansion with the addition of an MX10 Multiplexor on each port gives 32 channels to each memory module for high-speed data access and/or processor connection. The memory bus for KA10, KI10, and KL10 processors, which gives access to memory both for high-speed DF10 Data Channels and the arithmetic processors, allows full 36-bit word parallel transfers at a rate of 1 million words (5 million 7-bit characters) per second. Thus, a memory module can transfer up to 3 million words (15 million 7-bit characters) per second on high-speed I/O channels concurrently with computation, for a total memory handwidth of 4 million words (20 million 7-bit characters) per second.

Controllers for slow-speed devices can be attached to the Multiplexed I/O Bus, which provides a full 36-bit-word parallel path between the processor and the devices. Data can be transferred in words or blocks of up to 256K words by a single instruction at a maximum rate of 200,000 words per second.

SIMULTANEOUS OPERATIONS: Each controller is capable of transferring data to or from only one of the devices attached to it at a time. Swapping disk or drum devices have two paths to memory, allowing direct transfer of data to memory while control information is passed through the I/O bus. The I/O bus, memory bus, and processor can each operate independently with simultaneous computing. Up to four-way memory interleaving is possible, which causes consecutive addresses to be stored in alternate physical memory banks. Overlap of memory accesses is thus provided. Aggregate maximum data transfer rates for the I/O bus and memory bus are 1.2 million and 20 million 7-bit characters per second, respectively. Instruction look-ahead is provided on the KI10 and KL10 processors, where the next sequential instruction is decoded during execution of any given instruction.

MASS STORAGE

RHS04 SWAPPING DISK SYSTEM: Provides up to 2 million words of high-speed swapping storage for DECsystem-10 time-sharing and real-time systems. Each disk has a capacity of 256,000 36-bit words, an average rotational delay of 8.5 milliseconds, and a transfer rate of 250,000 words (1.25 million 7-bit characters) per second. Each track consists of 64 sectors with 128 words per sector. The basic subsystem includes an RHS04 Controller, either a DF10 (18-bit) Data Channel or a DC10C (22-bit) Data Channel, and a single fixed-head disk drive. A maximum of

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are substantially less expensive, resulting in overall reductions in configuration prices ranging from 6 to 30 percent over comparable earlier DECsystem-10 systems. For example, DEC's new RHS04 Swapping System provides 256K words of fixed-head disk storage for a purchase price of $62,000, compared to $87,000 for the RM10G Drum System which it replaced in the DEC product line. An RP04 Disk Subsystem, including a controller, data channel and 100 million words of storage, can be purchased for $173,500 in comparison to $200,000 for an eight-drive RP03 Disk Subsystem with a controller, data channel, and an 80-million-word storage capacity. Purchase prices for the new 1080 and 1090 systems range from approximately $600,000 for an entry-level 1080 to $1,500,000 for a large 1090 configuration.

Many potential customers in DEC's recently targeted market segments are conditioned to acquiring their computers through rental agreements. DEC has offered full-payout lease plans for the DECsystem-10 on both a five- and a seven-year term. The original five-year lease plan offered a purchase-to-monthly-payment ratio of 48:1 and yielded an accrued equity for DECsystem-10 customers, with an end-of-term option to acquire ownership of the system at 10 to 15 percent of its original purchase price. However, DEC hasn't released new five-year lease prices, either for its new 1080 and 1090 systems or for the earlier DECsystem-10's, stating that current high interest rates make it necessary to individually negotiate any such long-term agreements. The estimated five-year lease prices for typical DECsystem 1080 and 1090 configurations and new lease prices for the earlier DECsystem-10 models in the Characteristics section of this report were supplied by DEC and now reflect a purchase-to-monthly-payment ratio of approximately 42:1, although detailed five-year lease prices are not available from DEC.

DEC's fundamental approach to the marketplace for the DECsystem-10 is to avoid head-on encounters with IBM except upon DEC's terms. These terms specify a sophisticated user (generally in the top 20 to 30 percent of current computer installations) and one who generally meets the criteria outlined earlier. (For example, general-purpose commercial batch-oriented installations are definitely not sought after, if not actually discouraged.) Furthermore, DEC has historically been conservative in accepting business that is predicated upon heavy systems responsibility. This approach has resulted in a very high level of customer loyalty and has contributed to steady if not rapid growth for DEC's large-scale systems business. In this regard, DEC's current business plan remains essentially unchanged from previous years, and the company's realistic approach seems likely to yield continued market acceptance of the DECsystem-10 at a pace satisfactory to DEC.

USER REACTION

Datapro received 10 responses from DECsystem-10 users in its 1974 survey of general-purpose computer users. Fourteen DECsystem-10 computer systems were represented in the replies. Five of the systems were configured in a general-purpose time-sharing service. The other nine replies reported on one computer system each. Eight of these systems were new computer installations; two replaced NCR Century 200 systems; and the remaining

eight drives can be attached to a single controller to provide the maximum of 2 million words of swapping storage per subsystem. One or two RHS04 subsystems can be connected to a DECsystem-10.

RP02C DISK SYSTEM: Provides up to eight on-line RP02 Disk Pack Drives, an RP10C Disk Control, and a DF10 Data Channel. Each RP02 Disk Drive uses an RP02P Disk Pack and can store 5.12 million 36-bit words (25.6 million 7-bit characters) with an average transfer rate of 66,667 36-bit words (333,333 7-bit characters) per second. The average access time of 47.5 milliseconds includes a 12.5-millisecond average rotational delay at 2400 rpm and a 35-millisecond head-positioning time. The industry-standard 11-high RP02P Pack is physically interchangeable with the IBM 2316 Pack, although not logically compatible with it. Timing notches cut into the base plate of the RP02P Pack facilitate presenting of addresses on the pack. Data is organized on 20 recording surfaces with 128 words/sector, 10 sectors/track, 20 tracks/cylinder, and 203 cylinders/pack. The disk packs are preformatted at initialization time so that all physical reads and writes are for 128-word data blocks.

The minimum RP02C Disk System consists of one RP02 Disk Drive and can be expanded in increments of one drive to the eight-drive maximum capacity of 40.96 million 36-bit words (240.8 million 7-bit characters). A maximum of 4 eight-drive RP02C single-channel systems can be connected to a DECsystem-10 to provide up to 163.84 million words of on-line storage.

RP03C DOUBLE-DENSITY DISK SYSTEM: Provides up to eight on-line RP03 Disk Pack Drives, an RP10C Control, and a DF10 Data Channel to give twice the storage capacity of the RP02C System described above at up to 32 percent lower cost. The RP03 Double-Density Disk Drives use the industry-standard RP02P Packs described above, preformatted with 400 cylinders, to store 10.24 million 36-bit words (51.2 million 7-bit characters) with an average transfer rate of 66,667 36-bit words (333,333 7-bit characters) per second. RP02P packs initialized for the RP03C system can be read only on the RP03C. Average access time is 41.5 milliseconds, which includes a 12.5-millisecond average rotational delay and a 35-millisecond head-positioning time.

The minimum RP03C Disk System consists of one RP03 Disk Pack Drive and can be expanded in one-drive increments to the maximum of eight drives on-line. The total storage capacity of the full RP03C is twice that of a full-size RP02C system: 81.92 million words (409.6 million 7-bit characters). RP02 Disk Drives can be substituted for RP03 Disk Drives or used in combination with them on the single-channel RP10C Controller to form an entry-level disk system for new users or a compatibility approach for current PDP-10 users with installed (purchased) RP02 drives. A maximum of four RP03C system can be connected to a DECsystem-10, providing up to 327.68 million words of on-line storage.

RHP04 DISK SYSTEM: Provides large-capacity random-access storage. Includes a controller and from one to eight RP04 Disk Drives, each with a storage capacity of 20 million 36-bit words. A maximum of four controllers, each with a maximum of eight disk drives, can be connected to a DECsystem-10 for a total of 640 million 36-bit words (or 3.2 billion 7-bit characters). Average seek time is 28 milliseconds, average rotational delay is 8.8 milliseconds, and data transfer rate is 178,571 million 36-bit words (or 892,855 7-bit characters) per second. Rotational speed is 3600 rpm.

The RHP04 Disk System uses an industry-standard IBM 3336-type disk pack that contains 12 disks and uses 19 recording surfaces. Data is organized into 128 words per sector, 20 sectors per track, 19 tracks per cylinder, and 411 cylinders per pack. Error detection and correction circuitry permits detection and correction of bursts up to 11 bits in length under control of the operating system. Instruction retry is also supported. In addition to a rotational position-sensing capability, the RHP04 Controller also permits overlapped head positioning on two or more disk drives under control of the operating system software. Additional

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DECsystem-10's replaced an IBM System/370 Model 135, a Standard Computer Corporation IC-4000 system, an IBM 1130 plus outside time-sharing service, and an IBM 1401/1620 combination.

Twelve of the 14 systems were purchased; only one was leased from DEC, and the remaining system was acquired through a third-party leasing arrangement. Eight of these systems were described as performing both business data processing and scientific and engineering computing, five were operating in a commercial time-sharing environment, and one was performing only scientific and engineering computing for a university. All the systems included networks of interactive terminals, with the number of terminals per system ranging from 6 to 50.

The ratings assigned by these DECsystem-10 users illustrate that DEC's selective marketing policies have paid off in creating a customer base of highly satisfied users:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	8	2	0	0	3.8
Reliability of mainframe	8	1	0	1	3.6
Reliability of peripherals	3	7	0	0	3.3
Maintenance:					
Responsiveness	5	4	1	0	3.4
Effectiveness	5	5	0	0	3.5
Technical support	2	7	1	0	3.1
Operating system	5	5	0	0	3.5
Compilers and assemblers	4	6	0	0	3.4
Applications programs	1	4	1	1	2.7
Ease of conversion	4	3	2	0	3.2
Overall satisfaction	7	3	0	0	3.7

*Weighted Average on a scale of 4.0 for Excellent.

In subsequent telephone interviews, these users expressed their satisfaction with both the throughput and the reliability of the DECsystem-10 computers. Estimates of the number of concurrent operations per system, including batch, inquiry, and time-sharing activities, ranged from 20 to 30 at a time. Several of the systems were used extensively for program development and debugging. Reports of increases in programmer productivity after the switch from a batch environment to the DECsystem-10 for program development ranged from 40 percent to 400 percent.

Despite the lack of object-level compatibility with competitive computer systems, users experienced almost no problems in preparing COBOL programs for subsequent execution on other manufacturers' equipment, using the DEC Text Editor program for making the necessary adjustments in the COBOL source code. One user who converted a library of COBOL programs from NCR ANS COBOL to DEC ANS COBOL reported that the process required an average of two hours per program for conversion and testing using the Text Editor, and that the task was performed with a minimum of trouble. DEC's re-entrant COBOL compiler was cited as an additional plus, for permitting multiple compilations to be performed without extremely high main memory overhead.

Most of these users gave the DECsystem-10 high marks for reliability of both the mainframe and the operating system. They appreciated the sophistication of the operating system, with its dynamic memory management capabilities, its ease of use in time-sharing environments, and the whole system's price/performance.

reliability features include an offset head capability to facilitate read recovery and the ability to dynamically eliminate track sectors with unrecoverable errors from use by the system.

INPUT/OUTPUT UNITS

TD10G DECTAPE SYSTEM: This inexpensive but slow magnetic tape system reads forward or reverse on up to four TU56 Dual DECtape Units. The single-channel TD10 Controller transfers data to the central processor over the I/O bus at a peak rate of 2,777 36-bit words (13,885 7-bit characters) per second at 97 ips. The TU56 reads and writes fixed-length blocks of 128 words each on pocket-sized, 3/4-inch wide, 260-foot-long reels of magnetic tape which are 3-3/4 inches in diameter, at a recording density of 172 six-bit characters per inch. The DECtape unit has a directory on tape which is indexed to a special track on the tape marked with physical tape position information. This special track is read to provide the user with the ability to position the DECtape directly at the beginning of a given 128-word block. DEC describes the tape as a "linear file" which can read or write single words within any block and is used either as a very slow direct-access device or as a substitute for punched-card equipment. Redundant recording of each bit on two separate tracks increases reliability of the TD10G DECtape System. The simplicity of the transport mechanism, which uses drive motors to control tape movement instead of capstant or pinch rollers, helps reduce maintenance requirements. One or two TD10G systems can be connected to a DECsystem-10.

TU10C MAGNETIC TAPE SYSTEM: Available in 9- and 7-track NRZI versions, which record on standard 1/2-inch tape in ANS standard formats. Up to eight TU10 Tape Units can be interfaced to the I/O bus via the single-channel TM10A. Control in any combination of 9- and 7-track units. The 7-track TU10A-F Unit records data at densities of 200, 556, or 800 bpi with peak transfer rates of 9,000, 25,020, or 36,000 characters per second at 45 ips. The 9-track TU10A-E reads and writes tape at 45 ips with a density of 800 bpi to transfer data at a peak rate of 36,000 characters per second. The TU10A-E/F drives, manufactured by DEC, replace the earlier plug-compatible TU20 Magnetic Tape Unit which was purchased OEM by DEC. The TU20 will continue to be supported on the DECsystem-10 for upward migration by PDP/10 customers with purchased TU20's. One TU10C system can be connected to a DECsystem-10. The TU10C is not available for KL10 processors.

TU40C/TU41C MAGNETIC TAPE SYSTEM: Includes a DF10 Data Channel, a TM10B Control, and one 9-track TU40 or 7-track TU41 Tape Unit. The TM10B Controller handles up to eight units consisting of any combination of 9- or 7-track TU40's, TU41's, TU10's or TU20 Magnetic Tape Units. Data is transferred between the single-channel control and a main memory port via the DF10 Data Channel. Control information and device status are transferred between the controller and main memory through the I/O bus. Both the TU40 and TU41 record on industry-standard 1/2-inch tape at 200, 556, or 800 bpi with a tape speed of 150 inches per second to produce peak transfer rates of 30,000, 83,400, or 120,000 characters per second. One or two 8-drive TU40C systems can be connected to a DECsystem-10.

TU70 MAGNETIC TAPE SYSTEM: These high-speed tape units are available in 7- and 9-track versions with program-selectable recording densities of 800 ot 1600 bits per inch for 9-track tape drives and 200, 556, or 800 bits per inch for 7-track transports. The recording method for the 1600-bpi tapes is Phase Encoding, while NRZI is utilized for the 800-bpi 9-track transports and for all 7-track tape transports. Tape speed is 200 inches per second, resulting in a maximum data transfer rate of 320,000 characters per second. A TU70 Magnetic Tape System consists of a channel controller and one 9-track tape drive. Up to seven 9-track or 7-track add-on tape drives can be added to a controller for a maximum subsystem of eight tape drives per controller. The TU70 Magnetic Tape Drives feature an automatic reel hub to facilitate tape loading, analog capstan control, vacuum tape buffers, power windows, and radial attachment to the controller.

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Some users expressed mild dissatisfaction with the limited amount of applications software available for business and management applications. On the whole, however, the respondents in this survey appear to be representative of the market segment where the DECsystem-10 has firmly ensconced itself, with 7 of the 10 responses representing universities or technical computing facilities for businesses. These users gave the DECsystem-10 the highest rating for overall satisfaction achieved by any computer manufacturer in Datapro's 1974 user survey, underscoring the success of DEC's selective marketing policies.□

PC10 PAPER TAPE READER/PUNCH: Reads paper tape at 300 characters per second using a photo-electric paper tape reader, and punches tape at 50 characters/second. The PC10 is included as a standard I/O device on all DECsystem-10 models.

CR10D AND CR10E HIGH-SPEED CARD READERS: The CR10E reads 80-column cards from a 2,250-card input hopper at 1200 cpm, while the CR10D reads from a 1000-card input hopper at a rate of 1000 cpm. In each machine a vacuum picker and riffle air-stream help feed worn or damaged cards to a jam-resistant mechanism. Each reader uses light-emitting diodes (LED) and photoelectric cells for high reliability. Both card readers have built-in controllers. Up to two CR10D's and two CR10E's can be connected to a DECsystem-10.

CR10F CARD READER AND CONTROL: Reads 80-column cards at a rate of 300 cpm from an input hopper with a 600-card capacity. Although the CR10F uses the same card input techniques and jam-resistant read mechanism employed in the high-speed CR10D and CR10E Card Readers, the slow speed and table-top size of this Documation-built unit make it most effective for remote batch entry applications. One or two CR10F units can be connected to a DECsystem-10.

CP10D CARD PUNCH: Punches cards at the rate of 100 80-column cards per minute. The CP10D includes its own controller. Input hopper and output stacker capacities are 1000 cards each. Only one CP10D can be connected to a DECsystem-10.

LSP10 LINE PRINTER: Prints at 300 lpm using a 64-character drum with 132 print positions per line and at 200 lpm using a full 96-character set. A single-channel controller that connects the LSP10 to the I/O bus is included. A paper-tape carriage control mechanism permits selectable forms control at optional densities of 6 or 8 lines per inch.

LP10F AND LP10H LINE PRINTERS: Print at 1250 lpm with a 64-character drum or at 925 lpm with a 96-character drum, respectively. These drum printers have 132 print positions per line and connect through the I/O bus to a processor via a built-in controller. The print feed mechanism is advanced by a paper tape control carriage, and can be set to print 6 or 8 lines per inch. Both models can be equipped with either a scientific or commercial character set.

XY10 PLOTTER CONTROL: Provides an interface for the CalComp 500 and 600 Series Digital Incremental Plotters. The single-channel XY10 can connect one plotter device directly to a DECsystem-10 memory port. Only one plotter system can be attached to a DECsystem-10.

XY10A INCREMENTAL PLOTTER AND CONTROL: Consists of a single-channel XY10 Controller and CalComp Model 565 drum-type plotter. Plots up to 300 0.01-inch steps per second on a chart up to 12 inches wide and 120 feet long.

XY10B INCREMENTAL PLOTTER AND CONTROL: Consists of a single-channel XY10 Controller and a CalComp Model 563 drum-type plotter. Plots up to 200 0.01-inch steps per second on a chart up to 31 inches wide and 120 feet long.

COMMUNICATIONS EQUIPMENT

DC10 DATA LINE SCANNER: Provides on-line servicing of up to 64 communications lines with accommodation of any device that uses 8- or 5-level serial Teletype code at speeds to 2400 bits/second. Full-duplex with local copy or half-duplex mode is available on each line serviced. The DC10 System includes a DC10A Control Unit which houses the scanner and contains I/O interface and control logic, as well as providing 4 units of cabinet space and power supplies for various combinations of line equipment. Half-duplex or full-duplex interfacing to data sets is accomplished in 2 units of cabinet space by the DC10C 8-line Telegraph Relay Assembly and DC10D Power Supply. The minimum 8-line capability of the DC10 system can be expanded with the 1-unit DC10B 8-line group up to the 64-line maximum. Eight additional units of cabinet space are available with the DC10F Expander Cabinet if required.

DC72 REMOTE STATION: Uses full-duplex lines to provide both remote job entry capability and interactive terminal facilities for general time-sharing use. The basic DC72A, B, and C synchronous stations provide a PDP-8/E communications processor, 10-cps teletypewriter, 300-cpm card reader, and one of the following printers, respectively: 165-cps strip printer, 245-lpm (132-position) line printer with 64-character set, or 173-lpm (132-position) line printer with 96-character set. Eight additional 110-to-2400-bps synchronous ASCII transmit or 110-to-300-bps receive terminals can be attached to a DC72 station through a DC72L Teletype Concentration or terminal expansion package. Up to eight DC72 remote stations can be connected through full-duplex modems to DS10's or a DC75.

DC75 SYNCHRONOUS COMMUNICATIONS SYSTEM: Consists of up to four PDP-11 programmable controllers, a multiplexer, and eight communications lines. The full-duplex DC75 can interface 64 2400-bps lines or 16 9600-bps lines directly to the DECsystem-10 memory bus. The main function of the DC75 is to serve as a synchronous data communications multiplexer. Other functions include character formatting, line control, and error checking.

DC76 ASYNCHRONOUS COMMUNICATIONS SYSTEM: Consists of up to 4 PDP-11/40 processors for multiplexer control and up to 128 full-duplex asynchronous communications lines per multiplexer. A DC76 equipped with 4 multiplexers can thus handle a maximum of 512 full-duplex communications lines. The PDP-11/40 processor/multiplexers are interfaced directly to the DECsystem-10 memory through the DL10 PDP-10/PDP-11 interface. The total aggregate line speed for each multiplexer is 1500 characters per second. The maximum individual line speed is 9,600 bits per second, but the standard software support restricts incoming line speeds to 2,400 bits per second. The DC76 supports automatic recognition for lines with speeds of 110, 134.5, 150, and 300 bits per second. Other line speeds from 50 to 9,600 bits per second and a split-speed operation are program-selectable. The DC76 supports asynchronous terminals that operate in eight-level ASCII code or IBM 2741-compatible terminals that utilize seven-level EBCDIC, APL, or Correspondence character sets. The DC76 software supports the full-duplex and full-duplex with local copy transmission modes, but not two-way alternate simplex or polled operations.

DS10 SYNCHRONOUS LINE UNIT: Provides a single synchronous line that can handle data transmission rates up to 9,600 bits per second when equipped with a high-speed modem. The DS10 is used with the DC72 Remote Station to interface a remote batch terminal, a high-speed display, a remote job entry station, or another computer. Up to two DS10 units can be attached to a DECsystem-10 to handle an aggregate data rate of 9,600 bits per second.

LA36 DECWRITER II KEYBOARD TERMINAL: Provides electromechanical impact printing at a rate of 30 characters per second in a "60-character-per-second mode." Printable characters are stored in a buffer during carriage return and line feed, allowing subsequent bursts at 60 characters per second while multiple characters are stored in the buffer. ►

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Prints in rows of 132 print position on forms ranging from 3 to 14-7/8 inches in width. Up to six-part forms can be handled. The LA36 keyboard generates a set of 128 ASCII characters, including 96 upper and lower case letters and numbers and 32 control characters. Characters are formed in a 7-by-7 dot matrix and are printed at a horizontal pitch of 10 characters per inch and a vertical spacing of 6 lines per inch. The keyboard layout conforms to the most recent ANS standard. The LA36 features quietized operations to enhance its suitability for office environments.

GT40 GRAPHIC DISPLAY SYSTEM: This multipurpose graphic display system incorporates a PDP-11 processor with 8K words of memory that allows it to operate as an interactive terminal or a stand-alone system. An additional 256-word read-only memory contains routines required for loading a program or initiating dialogue with a central computer in a communications network. The GT40 features a 12-inch (diagonal) display of 31 72-character lines, for a total of 2,432 characters per display. The 96-character ASCII character set includes both upper and lower case characters and 31 special symbols. Control characters include those for carriage return, line feedback, backspace, and bell. Each character is represented by a 6-by-8 dot matrix. Vector generation capabilities include both relative and arbitrary vectors in solid, long dash, short dash, and dot/dash vector types. The nominal point plotting speed is 20 microseconds per point; approximately 200 microseconds are required for a full-screen vector. A light pen, free-standing ASCII keyboard, and separate eight-key function pad are included in the system. Data transmission is asynchronous at rates of from 300 to 9600 bits per second. Standard PDP-11 peripherals also can be attached to the system.

VB10C GRAPHIC DISPLAY SYSTEM: Provides both alphanumeric and graphic display capabilities to represent information as straight lines, vectors, curved lines, characters, or single random-position points. The basic VB10C system features a Parameter Mode, allowing use of a standard light pen with display intensity and coordinate zoom (scaling) controls. Both I/O bus and memory bus interfacing is available to handle control information and data transmission on a full 36-bit-plus-parity data path. The ASCII 128-character set and graphic capabilities are supported by the I/O Handler available through DECUS, and by diagnostics provided by DEC. Each character is represented by a 5-by-7 dot matrix. A maximum character plotting rate of 1,500 characters per second or 6,000 inches of short or long vectors is made possible by the refresh buffer, which regenerates the display 30 times per second. Nominal point plotting speed is 20 microseconds per point, with less than 0.6 microsecond per point required in vector mode for incremental plotting of contiguous points. The 21-inch-diagonal-screen VB10C system is built by DEC and can optionally include a function box, keyboard or Rand Tablet input, color display, and larger screen sizes.

VT05 ALPHANUMERIC DISPLAY TERMINAL: This solid-state CRT terminal, built by DEC, provides a buffered 10-1/8" by 7-5/8" display of twenty 72-character lines, for a total of 1,440 characters per display. Displayable upper-case ASCII characters are generated in a 2,240-bit-read-only memory. Each character is represented with a 5-by-7 dot matrix. The 9,816-bit refresh buffer regenerates the display 60 times per second. The 64-character-set keyboard is supported by a nondestructive, blinking cursor and erase controls. The alphanumeric character set can be superimposed on a background video image derived from a closed-circuit TV or video player. The VT05 is Teletype-compatible and communicates in half- or full-duplex mode over standard telephone lines, using data sets, at rates up to 2,400 bps.

VT50 DECSCOPE INTERACTIVE VIDEO TERMINAL: A solid-state CRT terminal, built by DEC, that provides an 8.7" by 4.3" display of up to 12 lines of 80 characters each, for a total of 980 characters. The displayable characters, consisting of upper-case ASCII characters and punctuation symbols, are represented with a 5-by-7 dot matrix. The 64-character set keyboard uses a typewriter keyboard format and is supported by a nondestructive blinking cursor that serves as a position indicator. The cursor can be moved to the top left-hand corner, to the right or left by one character position, and up or down one line. The VT50 operates in either an off-line or on-line mode. The transmission code is teletypwriter-compatible ASCII in full-duplex or full-duplex with local copy mode. Transmission rates are switch-selectable and range from 75 to 9,600 bits per second in the full-duplex mode and from 110 to 9,600 bits per second in the full-duplex with local copy mode.

SOFTWARE

OPERATING SYSTEM: A single operating system and Command Control Language is provided for all DECsystem-10 models. The DECsystem-10 Monitor consists of a resident portion and a nonresident portion. The resident operating system, in turn, consists of the following components:

- Service Request Handler: Accepts requests for allocation of system resources such as main memory, processor time, and I/O device availability. Includes the cyclic Command Decoder, which is responsible for validity checking and interpreting user requests and passing them to the appropriate system program.
- Sharable Resource Allocator: Distributes system resources to individual users in accordance with messages from the service request handler. Includes two cyclic programs: the Scheduler and the Swapper. The Scheduler determines which user program is to be run during a given time-slice, using a round-robin queue monitor as well as the Core Allocator (to provide access to sharable system resources) and the Context Switcher (for saving and restoring program conditions when swapping). The Scheduler is activated by the system clock 60 times per second, and user jobs are given time-slices of ½ second for execution. Jobs which do not issue I/O requests during their ½-second time-slice are considered to be compute-bound, and are placed in a different queue where they get 2-second time-slices at less frequent intervals. The Swapper transfers jobs between drum/disk and main memory after determining which user programs must be present in core for a job to run and which programs must be removed from core in order to make room for the run.
- I/O Service Routines: These routines process user program requests for I/O devices, and consist of three non-cyclic routines. The Programmed Operator Handler traps user service requests to the operating system and is the only means by which the user can switch to Exec Mode for operating system service. Input/output routines are initiated by the Programmed Operator Handler to manage data transfers between peripheral devices and user programs in core memory. The disk I/O service routine includes optimization techniques for disk accesses, which according to DEC result in 25-50% faster disk throughput than would otherwise be possible under the same loading conditions where the controller is saturated with transfer requests. The I/O System permits the use of symbolic device names and allows the user to have device independence. The File Handler permits users to define protected output files for permanent storage.

The resident Monitor requires from about 20K to 40K words of main memory, depending upon processor model.

Non-resident DECsystem-10 Monitor software is usually stored on drum or disk and includes the language processors, debugging programs, and operating system support programs. Languages available for the DECsystem-10 include COBOL, FORTRAN IV, ALGOL-60, BASIC, APL, and the Macro Assembler. Each language processor consists of a "pure" or re-entrant portion and a user portion which contains parameters defining a specific user job. The language processors produce sharable, re-entrant user programs.

The DECsystem-20 Monitor allows four basic concurrent modes of operation: interactive time-sharing, real-time processing, batch, multiprogramming and remote communications. Up to 512 interactive terminals can be handled by

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the Monitor, with multiple remote batch stations multiplexed through the DEC75 Synchronous Communication System.

The DECsystem-10 Monitor, as well as the Command Language for the Monitor, is common to all modes of operation on all single- and dual-processor DECsystem-10 models. This hierarchy of capabilities within one operating system, as well as the flexible hardware boundaries between the models, permits relatively simple upward growth for DECsystem-10 users, without extensive retraining or reprogramming.

Time-sharing users have the same command languages available to them as do multiprogramming batch users, allowing time-sharing terminals to initiate batch jobs. Commands are available to let terminal users manipulate files and control their own programs from creation through execution. Individual peripherals can be dedicated to a user for his exclusive use on a given job, or he can create and access files on peripheral devices shared with others. File protection schemes allow sharing of files among multiple designated users, with differing degrees of access authorized to each. Mass storage devices such as the drum cannot be exclusively dedicated to an individual user.

In multiprogramming mode, users are scheduled on a modified round-robin basis by the queue manager program, using disk or drum to hold swapped-out segments. The swapping device is usually connected directly to main memory via a high-speed data channel. Control information is passed through the I/O bus to initiate swapping or memory transfers. This device attachment scheme permits independent overlapped operation between the swapping of one program and the execution of another program in memory. The re-entrant or sharable nature of many monitor segments, as well as the sharable code segments produced by the sharable DECsystem-10 compilers, results in additional core utilization by minimizing swapping.

Multiprogramming performance of the KI10 and KL10 processors is improved over that of the KA10 processor through hardware features such as additional high-speed registers and fast interrupt handling, which speed up switching between programs.

Multiprogramming batch mode allows operation of up to 14 jobs concurrently with time-sharing. The batch user places his program in an input stream which is loaded into the system through an input device: cards, tape, or disk. EBCDIC card input will automatically be handled by the stacker program and passed through a code conversion. Tapes, however, are currently required to be ASCII and must be converted through a DEC "Filter" program prior to input. The Stacker program collects batched input data in the job stream and accumulates it onto different individual files depending upon data type. Individual alternating inputs resulting from multiple data acquisition processes cannot be gathered by the system on a common input spool for subsequent processing by applications programs.

The batch controller system accepts parameters specified by the user, such as start and deadline times, which then are used by the queue manager to modify the basic round-robin scheduling algorithm inherent in the system. At monitor generation time, default conditions can be established providing standard parameters to be inserted unless otherwise specified by individual users. During concurrent operation with time-sharing, batch jobs may occupy any available area in main memory. No partitions are set up to separate main memory into areas exclusively reserved for time-sharing or batch processing.

Real-time applications are handled by the DECsystem-10 Monitor using the system facilities available for time-sharing and multiprogramming, as well as the additional features of guaranteed residence, where user programs are locked into core, and the programmable interrupt system, which can link a real-time sensor or activator device to one or more assigned priority interrupt levels. The DECsystem-10 provides seven standard priority levels, with up to 135 additional levels available through the use of programmed traps on the KI10 and KL10.

Real-time devices may be serviced in single mode or block mode. Single mode service runs the user's interrupt program each time the device interrupts. Block mode allows an entire block of data to be read from the real-time device before the interrupt program is executed. In either mode, execution of the interrupt program causes the status of all DECsystem-10 operations to be preserved and restored upon completion of the interrupt processing.

Remote communciations hardware and software capability on the DECsystem-10 permits simultaneous use of multiple remote stations with other DECsystem-10 modes of operation. Synchronous full-duplex communication between small remote computer stations allows remote users to send or receive data at speeds up to 9600 bits/second. The remote batch terminals may have printers, card readers, etc., locally attached, and may also support additional remote terminals. Operating system commands allow the user to drive peripherals at the central station as well as at other remote locations. Remote stations may change their logical addresses to back up or copy the functions of a different remote station.

VIRTUAL MEMORY: The Release 6.04 Virtual Memory Feature (VMSER) provides an optional virtual-memory mode of operation for DECsystem-10 installations with a KI10 or KL10 processor and at least Release 5.07 of the Monitor. The VMSER option supplies a system Page Fault Handler that works in conjunction with the central processor hardware Swapper to effect a demand paging mode of operation for designated user programs. When a page fault is detected by the Swapper, control is transferred to the Page Fault Handler, which specifies the pages to be swapped out to make room for currently referenced data. As an alternative, a user-written Page Fault Handler can be embedded in a user program to provide optimized demand paging based upon its specific characteristics.

Any user program can be made to run in the virtual-memory mode without modification by specifying "virtual core" in the SET job control command that allocates memory to the program. The REACT administrative control program permits each installation to restrict the use of the virtual memory option to specified users, to set limits on the amount of physical and virtual storage allocated to user programs, and to establish installation standard paging rates for all virtual-memory programs. The VMSER option provides a limited fail-soft facility in the event of a partial memory failure by permitting jobs to be reloaded to execute in the virtual memory mode of operation.

The VMSER Virtual Memory Feature requires a minimum configuration consisting of a KI10 or KL10 Processor with 128K words of main memory, two RP02, RP03, or RHP04 Disk Drives, one Swapping Disk System, a DC10 or DC76 Communication System, and two magnetic tape drives, VMSER occupies 5K words of main memory, and the sharable system Page Fault Handler occupies 1K words.

MESSAGE CONTROL SYSTEM (MCS-10): Announced in October 1974, the Message Control System provides the facilities for developing tailored communications-oriented programs using the DC75 Synchronous Communication System and the DC76 Asynchronous Communications System. MCS-10 consists of four major software components. The MCS Generation Program accepts user-supplied parameters that define the communications network and the terminals operating in the network, define the message types, establish queue structures, and define the message processing programs in the communications network. The output of the MCS Generation Program is an installation-tailored MCS Kernel module that operates with MCS Message Control Program as a user-specified communications control program. The Message Control Program contains the generalized logic that performs message handling and acts as a message queue mechanism for queuing and routing messages to user message processing programs. The COBOL Communications Facility is an extension to the COBOL compiler that provides the COBOL communications verbs SEND, RECEIVE, ENABLE, DISABLE, and ACCEPT COUNT, and a communications description section that can be accessed by message processing programs written in COBOL. In

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addition, each COBOL user message processing program includes a LIBOL Communications Module, which provides extensions to DECsystem-10 COBOL programs that enable them to execute the extended verb complement and provides an interface to the MCS communications control program.

Message processing functions performed by the MCS-10 software include initiation and termination of message processing programs, activation of identical copies of message processing programs in cases where additional messages require immediate processing, and logging of activities that occur between message processing programs and the MCS control program. The message handling functions include message routing; queuing (in first-in/first-out order or in four-level tree structures to permit priority access between message types); a roll-down/roll-up feature that automatically transfers messages to direct access storage queues when main memory queues are filled and restores them to main memory when space is available; and a fail-soft capability that permits optional copying of messages in main memory queues to direct-access storage as a basis for recovery in event of a system malfunction. Other activities performed by the MCS software include keeping audit trails, time-stamping of input messages, message buffering, and the enable-disable function which controls access by terminals in the network to input message queues. The MCP Control program and multiple message processing programs operate concurrently with DECsystem-10 time-sharing and batch processing operations.

DATA BASE MANAGEMENT SYSTEM: DBMS-10 is a full-scale data base organization and management system that uses both COBOL and FORTRAN as its host languages and provides a data management language (DML) based largely upon the April 1971 CODASYL Data Base Task Group (DBTG) specifications. DBMS-10 supports hierarchical data structures in simple tree format or in more complex network structures and provides a high degree of data independence from physical devices as well as user application programs. Owner and member relationships are defined by chained pointers. DBMS-10 permits access to data through the DIRECT, CALCULATION, or VIA set location modes, permitting clustering of records normally accessed in groups. In addition to the Schema, DBMS-10 allows multiple subschemas to be associated with the Schema to minimize the program modifications required due to the addition of data and new relationships to the files. A temporary subschema area is used to permit program testing on data without jeopardizing the integrity of the data base.

The Data Base Control System module is composed of re-entrant routines that permit concurrent retrievals to the same data areas. Data areas can be subjected to an exclusive update provision that grants exclusive update rights of a data area to a given processing program. The protected update option permits concurrent retrievals from a data area but proscribes concurrent updating activities. Concurrent updates to the same data area can be performed by a multiple-update queuing mechanism. Privacy of data within the data base is provided by privacy locks of up to 30 characters in length which are associated with the schema, subschemas, and data areas. Data base support utilities include initialization, print, schema update, and statistics logging routines. Recovery files are maintained for each file each time it is opened for protected update. The COBOL extension module, LIBOL, provides an interface to an on-line communications network. DBMS-10 Version II was announced in October 1974 and is separately priced program product.

COBOL: A complete implementation of American National Standard COBOL X3.23 (Level 4) with compilation speeds, according to DEC, which vary from 2,000 to 6,000 statements per minute. DEC also claims sort speeds of 1,600 to 5,000 records per minute for the COBOL Sort statement, which uses the disk as intermediate storage by default but may assign intermediate files to tape or drum. An ISAM package is also included in the compiler to allow access to data files which may employ a variety file organizations. The COBOL Compiler may be used for line-by-line compilation or for batch compilation. The standard recording mode for DECsystem-10 COBOL is ASCII, in either 6-bit or 7-bit bytes; however, IBM-compatible EBCDIC code may also be read or written on magnetic tape after a code conversion to or from the internal ASCII code representation. The COBOL Compiler has 7K words of "pure" (re-entrant) code and a minimum of 10K words for each user's portion.

A separately priced QSORT package for use with COBOL can reduce sort times for disk data sets with more than 1000 records by about half.

FORTRAN IV: Provides full ANS FORTRAN IV capabilities, plus additional features such as mixed-mode expressions, unlimited subscript dimensions, zero or negative DO loop parameters, and literal text and constants. The re-entrant compiler requires 10K words of main storage plus 2K words for a non-sharable user segment, and runs under either time-sharing or batch processing. The DECsystem-10 FORTRAN IV library contains 110 functions, any number of which can be loaded into the system at monitor generation time.

FORTRAN-10: FORTRAN-10 is a new FORTRAN compiler that contains both extensions to the ANS FORTRAN-IV standard and global and local optimization capabilities for improving execution times. DEC estimates that even without the global optimization capability, FORTRAN-10 object code executes 5 to 10 percent faster than that compiled with DEC's earlier FORTRAN IV compiler, and that compilations require only half of the CPU time required by DEC FORTRAN IV. When global optimization is invoked, DEC estimates that compilation speed will decrease slightly but that the resulting object code will execute up to 40 percent faster than unoptimized code.

Language extensions in FORTRAN-10 include OPEN and CLOSE file statements, list-directed READ and WRITE statements, INPUT and OUTPUT statements, multiple ENTRY subprograms, a multiple form of RETURN statements, implied DO loops in DATA statements, floating-point variables for DO loop control, ENCODE and DECODE statements, SKIP RECORD and SKIP FILE statements, and APPEND mode I/O. Error detection facilities available at the user terminal include compile-time error messages (including the erroneous line of code), detection of unintialized variables, and optional invocation of array-bounds checking for each subscript in a multiple-subscripted array. FORTRAN-10 executes under Release 5.06 (or a subsequent version) of the Monitor, occupies 19K words of re-entrant code plus 4K words for a non-sharable user segment, and runs in either batch or time-sharing mode.

FORTRAN-10 supports FORDDT, an interactive debugging aid allows breakpoints to be set on any line, allows array elements to be referenced by name, and permits interactive run-time recovery of file and device selection errors.

ALGOL-60: Consists of a one-pass, single-phase compiler capable of processing up to 5,000 ALGOL lines per minute, according to DEC; this speed assumes disk I/O with 24 unpacked significant symbols per line. Advanced features of DECsystem-10 ALGOL include a full range of diagnostics, extended-precision floating-point representation, byte-string manipulation capability, "while" and "for" statements for iterative procedures, and independent program and procedure compilation. DECsystem-10 ALGOL is limited by the following restrictions: labels are not allowed, all formal parameters must be specified, and ALGOL-60 identifiers are restricted to 63 symbols. Use of the compiler requires a 13K-word re-entrant segment in memory and a non-sharable user segment consisting of 2K words plus an amount of core dependent upon the size of the user's ALGOL program. The ALGOL-60 object-time system provides a basic I/O system including teletype I/O default with 16 logical channels, storage management, on-line debug tools, and a library of attachable routines including FORTRAN interface, byte-string manipulation, bit-field manipulation, single- and double-precision mathematical functions, etc.

APL: A conversational programming language that is particularly well suited for operating on numeric and

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character array-structured data, the DEC APL system runs under the DECsystem-10 time-sharing Monitor. DEC's APL closely resembles the IBM APL/360 implementation, but provides additional features. DEC offers both basic and extended versions of APL, each of which can have double-precision arithmetic facilities. Extended APL includes the Divide-Quad, Execute, Quote, and Dyadic Format for performing matrix inversions, solving linear equations, and evaluating character strings, plus user-level file access to standard ASCII sequential files, internal format random-access and sequential files, and immediate I/O to any peripheral through an OUTPUT command.

Extended APL, with or without double-precision arithmetic, occupies 24K words of re-entrant code plus 7,500 characters of user code area and a 5K or 6K user workspace. Basic APL, with or without double-precision arithmetic, requires 20K words of re-entrant code plus 7500 characters of user code area and a 5K to 6K user workspace. APL is a separately priced program product.

BASIC: Provides 13 commands for full BASIC language capabilities plus enhancements in four areas:

- Editing facilities for adding or deleting lines, renaming files, resequencing line numbers, combining two files, and listing any portion of a file on the line printer or a user terminal.
- User-controlled peripheral assignments for input or output files, including disk.
- Output format controls allowing terminal output to include tabs, spaces, and columnar headings.
- Expanded command set including matrix manipulation operators and a macro capability.

The pure, re-entrant code for BASIC occupies 12K words of main storage, and each user's portion requires a minimum of 2K words.

MACRO ASSEMBLER: This two-pass symbolic assembler is device-independent, allowing the user to select I/O devices for source program entry, program listing output, and object code storage. Powerful macro capabilities permit creation of user-defined language extensions for frequently used coding sequences. The pure, re-entrant code for the macro assembler occupies 7K words of main storage, and each user's portion of the assembler requires a minimum of 1K words.

AID (Algebraic Interpretive Dialog) is DEC's version of JOSS. AID output is device-independent, allowing the user to create files for storage of routines and data on any available medium specified by the user. AID performs line-by-line compilation without producing an object version of the program. This language is generally used for one-shot computational problems as an alternative to BASIC, and requires a minimum of 9K words of core for sharable code plus a minimum of 2K words of user code area.

LINED (LINe EDitor) is used to create files of numbered command statements at a terminal. LINED may then be used for editing the files prior to their submission for compilation to a DECsystem-10 language processor. Lines may be inserted, replaced, or deleted. LINED uses 1K words for re-entrant code and a minimum of 2K words for non-sharable user code.

TECO (Text Editor and COrrector) is used to edit individual ASCII characters in an input file. The file is read into a memory buffer from any device except a user terminal, where 30 TECO editing commands of two types may be applied to the data. The first type consists of elementary commands usually found in text editing systems. The second type consists of more sophisticated commands including those which perform character string searching, text block movement, testing and conditional branching, command sequence iterations, and programmed editing where text in the buffer is modified with data received from a user terminal or a command file. The pure re-entrant code for TECO occupies 3K words of main storage, and each user's portion of TECO requires a minimum of 2K words.

EDITS is a page- and line-oriented file editor that permits blocks of data to be transferred within files and allows lines or complete pages of data to be copied from one file to another. Other facilities provided by EDITS include string searches and substitutions, the capability to modify text within a line and to complete a line, and the ability to save edited material by issuing one command. EDITS requires 8K words of main storage, and each user's portion requires a minimum of 5K words.

SOUP (SOftware Updating Package) is a system programming utility provided by DEC to facilitate the revision of other DEC software. A string of changes to source code is processed against a master copy of the program to be updated by SOUP to produce a current master copy of the source version.

PIP (Peripheral Interchange Program) transfers data files from one I/O device to another. Files from more than one source device may be stored on a single destination device, either as one combined file or as a series of individual files. The user may (1) name the resulting output file(s), (2) edit the input data files, (3) define the mode of transfer, (4) manipulate the file directory if one is present, (5) control magnetic tape and card punch functions, and (6) recover from errors during processing. The pure, re-entrant code for PIP occupies 4K words of main storage, and each user's portion requires a minimum of 1K words.

Other systems utilities supplied by DEC include RUNOFF, which formats TECO or LINED files for printed manuscripts; CREF, a cross-reference listing program which aids debugging efforts by producing assembly listings with sequence-numbered statements and cross-reference tables for user programs; DDT (Dynamic Debugging Technique), with 50 different commands for on-line checkout and testing of individual Macro Assembler program segments in a minimum of 2K words of sharable code; FILEX to convert files to various formats; and COBDDT (COBOL Dynamic Debugging Technique) for on-line checkout and testing of individual program segments. A file backup system which copies disk files on tape for subsequent restoration to disk is also available.

USER GROUP: The word-wide DEC Users' Society (DECUS) was founded in 1961 and currently has more than 10,000 members in over 40 countries. This group is directly supported by DEC and schedules two meetings annually in addition to publishing a bi-monthly newsletter, DECUSCOPE. The DECUS Program Library Catalog lists more than 500 programs written by DEC users, most of which are available at no charge, or in some cases for a $5.00 handling fee. DECUS Membership is limited to DEC users, although some meetings are opened to general attendance. Inquiries should be directed to:

DECUS Executive Director
Digital Equipment Corp.
146 Main Street
Maynard, Mass. 91754

DECUS European Secretary
DECUS International Office
81 Route de L'Aire
1227 Carouge
Geneva, Switzerland

PRICING

EQUIPMENT: The folliwing systems are representative of the types of DECsystem-10 configurations which are normally used and supported by the DECsystem-10 Monitor. All necessary controllers, processor features, and interfaces are included in the indicated prices. Note that the five-year lease is a full-payout plan providing accrued equity.

DECsystem-1040: Consists of a central processor with 64K words of MF10 core memory (320K 7-bit characters), an operator's console including a KSR-35 Teletypewriter, a Paper Tape Reader/Punch (300/50 cps), two RP02 Disk Drives, two TU10 Tape Units (36KC), a CR10F Card Reader (300 cpm), an LSP10V Line Printer (300 lpm), and eight local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $8,900 and $369,700, respectively.

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DECsystem-1050: Consists of a central processor with 96K words of MF10 core memory (480K 7-bit characters), an operator's console including a KSR-35 Teletypewriter, a Paper Tape Reader/Punch (300/50 cps), an RM10B Swapping System, two RP02 Disk Drives, two TU10 Tape Units (36KC), a CR10D Card Reader (1000 cpm), an LP10F Line Printer (1250 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $12,300 and $520,700, respectively.

DECsystem-1055: Consists of two central processors with 128K words of MF10 core memory (640K 7-bit characters), two operator's consoles with two KSR-35 Teletypewriters and two Paper Reader/Punches (300/50 cps), and RHS04 Swapping System, four RP03 Disk Drives, two TU40 Tape Units (120KC), a CR10E Card Reader (1200 cpm), an LP10F Line Printer (1250 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $18,700 and $791,500, respectively.

DECsystem-1060: Consists of a central processor with 96K words of MF10 core memory (640K 7-bit characters), an operator's console with KSR-35 Teletypewriter and a Paper Tape Reader/Punch (300/50 cps), three RP03 Disk Drives, two TU40 Tape Units (120KC), a CR10E Card Reader (1200 cpm), an LP10F Line Printer (1250 lpm), and 16 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $14,500 and $610,500, respectively.

DECsystem 1080: Consists of a central processor with 256K words of core memory (1.28 million 7-bit characters), two operator's consoles with two KSR-35 Teletypewriters and ~~two Paper Tape Reader/Punches (300/50 cps)~~, two RHS04 Swapping Systems, four RHP04 Disk Systems, three TU70 Tape Units (320KC), a CR10E CArd Reader (1200 cpm), an LP10F Line Printer (1250 lpm), a DC76 Asynchronous Communications System, and 64 local ~~DC10 data lines and 64 dial-up~~ lines. Monthly rental (5-year lease) and purchase prices are $23,000 and $974,000, respectively.

DECsystem 1090: Consists of a central processor with 256K words of core memory (1.28 million 7-bit characters), two operator's consoles with two KSR-35 Teletypewriters and two Paper Tape Reader/Punches (300/50 cps), four RHS04 Swapping Systems, five RHP04 Disk Systems, four TU70 Tape Units (320KC), a CR10E Card Reader (1200 cpm), an LP10F Line Printer (1250 lpm), a DC76 Asynchronous Communications System, and 64 local ~~DC10 data lines~~ and 64 dial-up lines, Monthly rental (5-year lease) and purchase prices are $27,500 and $1,168,000, respectively.

SOFTWARE: Software support for the DECsystem-10, including the operating system and language processors, is separately priced and is available for a one-time charge ranging from $40,000 to $60,000, depending upon the processor model. The charges for system software, language processors, and DEC-supplied program products are listed in the price list that follows. In addition, DECUS-supplied software is subject to a $5 copying charge.

SUPPORT: Six man-weeks of installation support are provided at no charge following delivery of a system. Thereafter, systems integration assistance and field support by DEC's Systems Engineering Group are available at several prices, depending upon the level of support provided. The most basic support package, the Software Distribution Service, supplies monthly copies of software modifications and updates plus regular distribution of general software "fixes," and is priced at $1,080 per year. The Customer Software Maintenance Service, in addition, provides remedial action for software bugs occurring at participating installations plus limited on-site support for critical malfunctions, and is priced at $3,500 per year. The On-Site Customer Maintenance Service offers, in addition to the above services, scheduled monthly visits of up to one full day by a DEC software support representative for consultation on software plus seminars on new Monitor releases, and is priced at $7,000 per year.

Customized software support beyond that supplied in the three support packages is charged for at $36 per hour, with a $75 minimum per call. The charge for a "resident" DEC Systems Engineer spending 40 hours per week at a customer site is $4,000 per month on a six-month term and $3,600 per month on a twelve-month term. A monthly consulting arrangement that provides the services of a DEC Systems Engineer for 160 hours during a four-week period is available for $5,000 per month.

EDUCATION: Each DECsystem-10 user is entitled to 13 man-weeks of training. On-site training, including course materials, is provided for specialized customer requirements at individually arranged rates.

CONTRACT TERMS: DEC offers a purchase agreement for immediate ownership of the DECsystem-10, and full-payout accrued-equity lease contracts. The most common on these is a five-year accrued-equity contract that yields DEC a full payout in four years. An end-of-contract option permits the direct purchase of the system for the then-fair market value, which DEC estimates will be 10 percent of the original purchase price. The monthly charges for accrued-equity contracts for new DECsystem-10 systems are negotiated on an individual basis in order to reflect prevailing interest rates. There are no extra-use charges for the equipment, although maintenance contracts may be negotiated for any amount of daily maintenance from 8 to 24 hours. Liberal educational discounts are given to qualified institutions.

UPGRADE POLICY: With the release of the DECsystem-10, DEC announced a trade-in policy giving credits toward the purchase of more advanced DECsystem-10 devices. Older PDP-10 equipment or slower DECsystem-10 equipment may be upgraded to higher-performance DECsystem devices. Traded-in equipment must be in generally good condition(i.e., DEC maintained by Field Service) or is subject to a refurnishing charge. Allowances depend upon device type and vary widely from about 20 to 50 percent of the original purchase prices. ■

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.* 12-hour	24-hour
PROCESSORS AND MAIN MEMORY				
KA10S	Primary Central Processing Unit for 1040, 1050, and 1055 (includes DK10 Real-Time Clock and operator console)**	130,000	410	503
KA10	Additional Central Processing Unit for 1055 (includes operator console; DK10 Real-Time clock additional)**	130,000	410	503
KI10S	Primary Central Processing Unit for 1060, 1070, and 1077 (includes DK10 Real-Time Clock and operator console)	200,000	555	680
KI10	Additional Central Processing Unit for 1077 (includes operator console; DK10 Real-Time Clock additional)	200,000	555	680
KI10A	Central Processing Unit for 1080 and 1090 (includes operator console)	250,000	***	***
DK10	Real-Time Clock; 10-microsecond crystal oscillator resolution	3,000	12	16

* Minimum 12-hour maintenance coverage is recommended for all systems, but 8-hour coverage is available on the 1040 at $1300 per month for the basic system. Rates are available from DEC for 16- or 20-hour coverage also.

** Offered on an as-available basis.

*** Contact DEC Field Service; maintenance charge not established to date.

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.* 12-hour	Monthly Maint.* 24-hour
PROCESSORS AND MAIN MEMORY (Continued)				
MD10E	Additional 32K-word core memory module for 64K-word MD10G Mass Memory System; 1.8 microseconds (Note that MD10G is out of new production; for use with KA10 and KI10 processors.)	42,000	147	180
MF10A	Core Memory; 32K words, 1.0 microsecond, including memory ports	40,000	311	381
MF10E	Core Memory; 32K-word expansion module, 1.0 microsecond	35,000	133	163
MF10G	Core Memory; 64K words, 1.0 microsecond, including memory ports	60,000	444	544
MF10L	Core Memory; 128K words, 1.0 microsecond, including memory ports	110,000	888	1,088
MG10L	Core Memory; 256K words, 1.0 microsecond, including memory ports	180,000	*** 1166	*** 1428
MX10	Memory Port Multiplexer (direct memory access for eight additional DF 10 Data Channels)	4,500	18	22
MX10C	Memory Port Multiplexer (direct memory access for eight additional DF 10C Data Channels; 22-bit addressing)	6,500	21	26
MC10	Memory Port for add-on memory (separately priced only when ordered for already-installed memory)	1,000	8	10
DF10	Data Channel (included in RP02C, RP03C, and TU40/41C)	14,000	73	90
DF10C	Data Channel; 22-bit addressing	20,000	85	105
MASS STORAGE				
RHS04H	Swapping System; 256K words, includes DF10 Data Channel, controller, and one fixed-head disk	62,000	301	388
RHS07J	Swapping System; 256K words, includes DF10C Data Channel, controller, and one fixed-head disk	68,000	313	404
RHS04D	Fixed-Head Disk Drive; 256K words	18,000	73	95
RHS04C	Add-On Fixed-Head Disk Drive; 256K words	18,000	73	95
RP02C	Disk System: 5.12M words (includes RP10C Control, 1 RP02 Drive, DF10 Data Channel)	55,000	287	367
RP02	Additional Disk Drive; 5.12M words	15,000	141	183
RP03C	Double-Density Disk System; 10.24M words (includes RP10C Control, one RP03 Drive, and DF10 Data Channel)	60,000	341	441
RP03	Additional Disk Drive; 10.24M words	20,000	180	232
RP02-P	Disk Pack for RP02/RP03 Disk Drives	295	NC	NC
RHP04A	Disk System; 20 million words; includes controller and RP04A single-access disk drive	55,900	390	504
RHP04B	Disk System; 20 million words; includes controller and RP04B dual-access disk drive	60,800	412	533
RHP04D	Disk System; includes DF10 Data Channel, controller, and RP04A single-access disk drive	69,900	464	600
RHP04E	Disk System; includes DF10 Data Channel, controller, and RP04B dual-access disk drive	74,800	487	629
RHP04F	Disk System; includes DF10C Data Channel, controller, and RP04A single-access disk drive	75,900	477	616
RHP04H	Disk System; includes DF10C Data Channel, controller, and RHP04B dual-access disk drive	80,800	499	645
RP04A	Add-On Disk Drive; 20 million words, single-access, includes one RP04P Disk Pack	25,900	215	277
RP04B	Add-On Disk Drive; 20 million words, dual-access, includes one RP04P Disk Pack	30,800	237	307
RP04P	Disk Pack for RP04A and RP04B Disk Drives	795	NC	NC
INPUT/OUTPUT UNITS				
TU40C/TU41C	Magnetic Tape System (includes DF10 Data Channel, one TU40 or TU41 Unit, and TM10B Control)	59,000	294	380
TU40/TU41	Additional Unit: 30/83.4/120KC, 9-track/7-track	25,000	158	204
TU10C	Magnetic Tape System (includes TM10A Control and one TU10A-E or TU10A-F Unit); not available for KL10	23,100	128	165
TU10A-E/F	Additional Magnetic Tape Unit; 36KC, 9-track/7-track; not available for KL10	8,100	87	112
TD10G	DECtape System; 15KC, 3/4-inch (includes TD10 Control and one TU56 Dual DECtape)	20,000	58	74
TU56	Additional Dual DECtape Unit	4,700	36	47
TU70C	Magnetic Tape System (includes DF10 Data Channel, controller, and one TU70 unit)	100,000	525	679
TU70	Add-On Tape Drive; 9-track, 800/1600 bpi	27,000	***	***
TU71	Add-On Tape Drive; 7-track, 200/556/800 bpi	27,000	***	***
CR10D	Card Reader (incl. control); 1000 cpm	14,000	99	128
CR10E	Card Reader (incl. control); 1200 cpm	18,000	112	145
CR10F	Card Reader (incl. control); 300 cpm	8,000	75	96
CP10	Card Punch (incl. control); 200-365 cpm	35,000	113	146
LSP10V	Line Printer (incl. control); 300 lpm	21,000	***	***
LP10F	Line Printer (incl. control); 1250 lpm	47,500	192	248
LP10FF	Scientific Drum for LP10F	1,500	NC	NC
LP10FE	Additional Drum for LP10F; 64 characters	1,500	NC	NC
LP10H	Line Printer (incl. control); 925 lpm	48,500	198	256
LP10HE	Additional Drum for LP10H; 64 characters	2,500	NC	NC
LP10HF	Scientific Drum for LP10H	2,500	NC	NC
XY10	Plotter Control	3,000	12	15

* Minimum 12-hour maintenance coverage is recommended for all systems, but 8-hour coverage is available on the 1040 at $1300 per month for the basic system. Rates are available from DEC for 16- or 20-hour coverage also.
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Digital Equipment DECsystem-10
EQUIPMENT PRICES

		Purchase Price	Monthly Maint.* 12-hour	24-hour
INPUT/OUTPUT UNITS (Continued)				
XY10A	Incremental Plotter and Control (consists of Calcomp Model 565 and XY10)	9,000	37	48
XY10B	Incremental Plotter and Control (consists of Calcomp Model 563 and XY10)	13,400	44	57
COMMUNICATIONS DEVICES				
DC10 Data Line Scanner:				
DC10A	Scanner and Control Unit (includes 4 units of cabinet space)	10,000	22	27
DC10B	Eight-Line Group Unit (uses 1 unit of cabinet space)	5,400	21	26
DC10C	Eight-Line Telegraph Relay Assembly (uses 2 units of cabinet space)	3,000	22	27
DC10D	Telegraph Power Supply for DC10C (no cabinet space required)	500	9	11
DC10E	Expander Data Set Control (uses 2 units of cabinet space)	5,500	22	27
DC10F	Expander Cabinet (provides 8 units of cabinet space)	2,000	NC	NC
DC72 Asynchronous Remote Stations:				
DC72A	Communications Processor (includes PDP-8/E processor, 10-cps Teletypewriter, 300-cpm card reader, 165-cps stripe printer)	24,775	302	390
DC72B	Communications Processor (includes PDP-8/E processor, 10-cps Teletypewriter, 300-cpm card reader, 245-lpm line printer with 64-character set)	36,600	338	437
DC72C	Communications Processor (includes PDP-8/E processor, 10-cps Teletypewriter, 300-cpm card reader, 173-lpm line printer with 96-character set)	38,160	344	444
DC72L	Teletype Concentration Package (includes 8 lines; maximum of 2 DC72L's per DC72 system)	3,000	47	57
DC75 Synchronous Programmable Communications System (communications multiplexer):				
DC75A	Communications Processor (includes PDP-11/20 processor, DS11 Synchronous Modem Interface, DL10 Channel Interface, and 8 lines)	50,000	301	388
DC75D	Expander Option for Multiple Synchronous Modem Interfaces (includes DS11 Synchronous Modem Interface, PDP-11 processor, and 8 lines; maximum of 3 DC75D's per DC75A system)	30,000	224	275
DC75E	Additional 8-Line Group for Synchronous Modem Interface (1 per DC75A or D)	10,000	47	57
DS10	Single Synchronous Line Interface Unit	12,000	27	33
DC76 Asynchronous Programmable Communications System (communications multiplexer):				
DC76A	Communications Multiplexer (includes PDP-11/40 processor, DC76E 16-line group, and DL10A high-speed memory interface	53,390	302	370
DC76D	16-Line Expansion for DC76A (includes PDP 11/40 processor, DC76E 16-line group, and DL10C Unibus port for DL10A memory interface	29,890	232	284
DC76E	Additional 16-Line Group for DC76A or DC76D (up to 7 per DC76A or DC76D)	6,195	57	69
DC76EC	16-Line Group and Expansion Cabinet (required for over 64 lines)	8,785	62	76
DC76FA	Eight-Line Current Loop Local Interface	860	19	23
DC76FB	Eight-Line EIA Local Interface	1,490	19	23
DC76FC	Eight-Line Full Modem Control Interface	1,720	28	34
DC76FD	Eight-Line Integral Auto-Answer Modem Interface	4,240	94	116
DISPLAYS				
VB10C	Graphic Display System	35,000	***	***
VT05B	Alphanumeric CRT Terminal	2,795	31	48
VT50C	Interactive Video Terminal	1,250	24	30
GT40A	Graphic Display System	14,500	210	272
TERMINALS				
LT33A (C)	Teleprinter (KSR-33) for local DC10 (DC68) use	1,400	36	47
LT33B (H)	Teleprinter (ASR-33) for local DC10 (DC68) use	1,940	42	54
LT35A (C)	Teleprinter (KSR-35) for local DC10 (DC68) use	3,240	33	42
LA36C	DECwriter (30-cps teleprinter)	1,850	28	37

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SOFTWARE PRICES

	1-Year Charge	Annual Maintenance Charge
Total System Software for KA10 and KI10 Processors (includes Monitor and all compilers)	$40,000	—
Total System Software for KL10 Processor (includes Monitor and all compilers)	60,000	—
Virtual Memory Feature (for KI10 or KL10 Processors)	7,000	—
Message Control System	50,000	$5,000
Data Base Management System II	25,000	2,500
APL—Basic	15,000	1,500
APL—Basic with double-precision arithmetic	16,500	1,650
APL—Extended	28,500	2,850
APL—Extended with double-precision arithmetic	30,000	3,000

The prices for Software License Agreements apply to one system only. A license agreement for use of the software on two systems in an installation costs an additional 15% of the software price; for three, four, or five systems in an installation an additional 10% of the software price; and for the sixth system an additional 5% of the software price.