DECsystem-10

MANAGEMENT SUMMARY

The DECsystem-10 represents the consolidation of Digital Equipment Corporation's large-scale computer systems efforts over a seven-year period into a full-scale product line that benefits from a high-performance processor, a number of high-speed peripherals, extensive communications capability, 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 on September 1, 1972 for immediate delivery.

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

All six 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. DEC emphasizes that the characteristics of its large-scale systems are visible to the user primarily through its operating system, whose development cost has exceeded 50 percent of the overall DECsystem-10 development cost.

The six-member DECsystem-10 family offers impressive capabilities to the self-reliant, sophisticated user who can forecast his long-range computational requirements for at least five years. The major thrust of these medium-to-large communications-oriented systems is toward the educational, laboratory, industrial, and time-sharing markets where DEC has already achieved a significant penetration.

CHARACTERISTICS

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

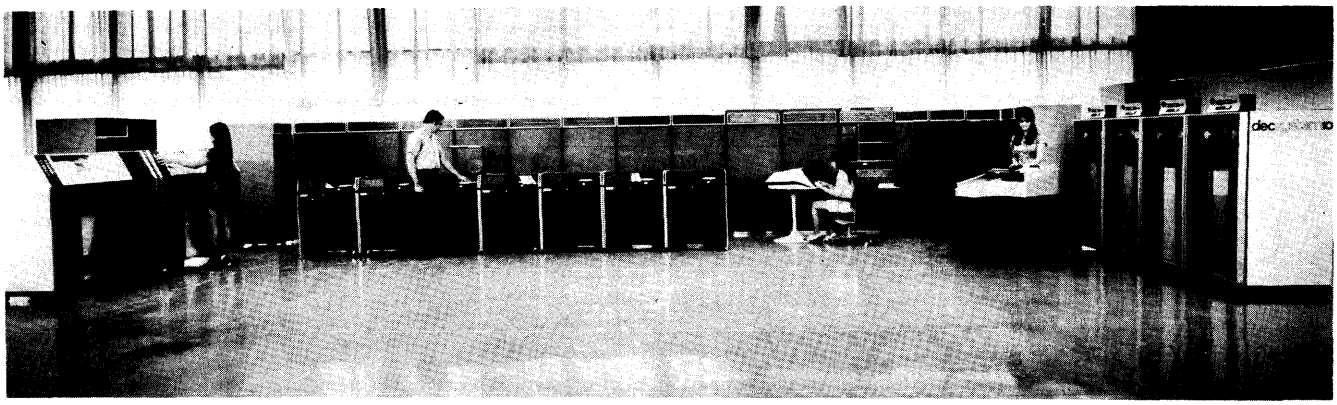
MODELS: DECsystem-10 Models 1040, 1050, 1055, 1060, 1070, and 1077.

DATA FORMATS

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 both the KA10 and KI10 processors. The KI10 has 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



The DECsystem-1070 uses the improved KI10 Processor and is the second largest of the six systems in the DECsystem-10 family. The top-of-the-line DECsystem-1077 is a dual-processor configuration that uses two of the KI10 Processors.

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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 rare in the medium-to-large-scale computer arena. DEC pointed out that the DECsystem-10 price cuts largely reflect savings in production costs made possible by DEC's takeover of the former RCA core memory manufacturing operations. The reduced prices substantially improve the cost/performance of the DECsystem-10 line in comparison to competitive offerings. (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 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 largest 1077 offers up to ten times the processing capability of the smallest 1040.

A substantial part of the 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 strength. That strength is largely derived from the DECsystem-10 Monitor and its excellent applicability to what DEC calls a "multi-mode" environment: combined on-line plus 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 are needed. Even where part of this software is not separately charged for (e.g., the operating system), the required hardware (main and auxiliary storage plus high-performance processor) more than makes up the difference in prices. Clearly, the time-tested DECsystem-10 Monitor is one of the strongest assets of the DECsystem-10; users contacted by Datapro report a high level of satisfaction with the Monitor and rate it as one of the easiest to use in the industry.

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. To date, large-scale systems have contributed approximately 20 percent of DEC's sales revenues, and market penetration for the large PDP systems has been heaviest in the educational and scientific markets, with about 70 PDP-6's and PDP-10's installed in colleges and universities and another 80 in scientific installations. DEC's major commercial market thrust has been in time-sharing, where the DECsystem-10 (or its nearly identical

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 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 performs double precision operations with additional hardware instructions. Double precision fractions with 62 bits are handled on the KI10 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, the next 7 bits address and 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 reentrant (sharable) portion and a non-reentrant, 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 Processor provides 1060, 1070 and 1077 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 con-

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CHARACTERISTICS OF THE DECsystem-10 MODELS

	1040	1050	1055	1060	1070	1077
System Configuration						
Type of CPU	KA10	KA10	KA10	KI10	KI10	KI10
Number of CPU's supported by standard software	1	1	2	1	1	2
Paging	No	No	No	Yes	Yes	Yes
Typical system rental*	$9,541	$13,219	$20,280	$12,920	$21,768	$27,473
Date of announcement	Aug. 1971	Aug. 1971	Aug. 1971	Sept. 1972	Aug. 1971	Aug. 1971
Date of first delivery	Aug. 1971	Aug. 1971	Nov. 1971	Dec. 1972	June 1972	March 1973
Main Storage						
Minimum capacity, 36-bit words	64K	64K	80K	64K	96K	128K
Maximum capacity, 36-bit words	256K	256K	256K	4,096K	4,096K	4,096K
Increment size, 36-bit words	16K/32K/64K	16K/32K/64K	16K/32K/64K	16K/32K/64K	16K/32K/64K	16K/32K/64K
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
Words accessed per cycle	1	1	1	1	1	1
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
Central Processor						
Number of hardware instructions	366	366	366	378	378	378
Instruction look-ahead	No	No	No	Yes	Yes	Yes
Base registers	Yes	Yes	Yes	No	No	No
Index registers	15	15	2 x 15	4 x 15	4 x 15	8 x 15
Register stack switching, microseconds	No	No	No	2.5	2.5	2.5
Interrupt service time, microseconds	6	6	6	3	3	3
Maximum interrupt delay, microseconds	40	40	40	10	10	10
Double precision floating-point hardware	No	No	No	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
I/O Bus cycle time, microseconds	4.50	4.50	4.50	2.70	2.70	2.70
Interrupts	7 levels	7 levels	7 levels	7 levels plus up to 135 trap instructions	7 levels plus up to 135 trap instructions	7 levels plus up to 135 trap instructions

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

predecessors) account for about 20 percent of the independent (non-SBC, non-GE, etc.) marketplace. During the first year of DECsystem-10 sales, DEC's large-scale computer customer base has been expanded by about 45 DECsystem-10's.

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 more than 20,000 installed systems. 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. Most of the early DECsystem-10 installations, however, have been upgrades for PDP-10 users. In order to facilitate this customer migration, DEC provides two programs which make it easier for existing customers to grow upward to the DECsystem-10: a liberal upgrade policy providing substantial trade-in allowances for older

tiguous 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 (see Paging).

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 instructions) 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

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systems and slower peripherals, and full-payout lease plans usually offered on a 5- or 7-year term, with 5 years being the most common period.

The 5-year lease plan offers a purchase-to-monthly-payment ratio of 48:1 and yields 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. (For customers who prefer to do so, direct purchase of the DECsystem-10 is also available.) The less frequently chosen 7-year lease provides a purchase-to-monthly payment ratio of about 60:1.

At the present time the extensive library of DECsystem-10 software is largely provided through DECUS, the DEC Users' Society. This software is offered free to DEC users, but no free centralized software maintenance service is provided for the user-written programs. Included in the more than 500 DECsystem-10 program systems and subroutines (available either at no charge from DECUS or for a fee from DEC or independent sources) is a scant offering of commercial applications packages. DEC maintains a staff of about 1800 sales, service, and software support personnel at 88 offices in 25 countries to assist customers in the installation of DEC computers. Training is provided at centers in Maynard, Palo Alto, England, France, and Germany.

Digital's DECsystem-10 market target is the "discriminating large computer user" who has the sophistication to clearly define his long-range objectives and determine that the range of processing capability offered by the DECsystem-10 family is able to provide a 5-year solution to his data processing requirements. Such users may be scarce in today's computer marketplace, with its rapid rate of technological advance and the uncertain nature of future data processing demands upon commercial applications in particular.

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 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

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.

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. No decimal arithmetic instructions, code conversion instructions, or radix conversion instructions are available on the DECsystem-10.

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
Fixed-point add/subtract (36-bits)	2.6	1.5
Fixed-point multiply	9.8	4.1
Floating-point add/subtract (single precision)	5.6	3.2
Floating-point multiply (single precision)	10.5	4.2
Floating-point add/subtract (double precision)	*	3.7
Floating-point multiply (double precision)	59.4	7.6
Jump	1.5	1.1

*Performed by subroutine; timing not available.

PAGING: The KI10 Processor provides 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 which can reference any of 4 million words (maximum memory size of the 1070 or 1077).

PROCESSOR MODES: The KI10 Processor used in the DECsystem 1060, 1070, and 1077 has two modes. User Mode and Exec Mode.

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

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variety of vendors (e.g., large-scale R&D organizations employing instrumentation or lab monitoring equipment).

Compatibility for the DECsystem-10 is limited primarily to its PDP-6 and PDP-10 forerunners. Absence of a business data processing package with decimal edit and arithmetic instructions, code translation instructions, or radix conversion instructions means that EBCDIC data compatibility with systems such as the IBM System/360 and 370 requires time-consuming I/O code conversions. Although there is no object-level compatibility between the DECsystem-10 and other popular systems, DEC's COBOL, FORTRAN IV, ALGOL-60, and BASIC source-language specifications all conform closely to industry standards, and DEC has simulators for IBM 1401 and 360/20 systems.

Distinctions between models in the DECsystem-10 family are based largely on configuration rules and marketing strategy. The 1040 may have from 64K to 256K 36-bit words of main memory 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 an RM10G drum subsystem. The 1055, in turn, is a dual-processor version of the 1050. Rules for the 1070 system call for replacement of the KA10 processor used in the 1050 with the improved KI10 processor. The 1077 is a dual-processor version of the 1070, while the more recently announced 1060 is a 1070 minus the drum subsystem. Main memory used with the KI10 processor can be as large as 4 million 36-bit words due to the paging registers on the KI10 which permit addresses that large to be referenced. The KI10 uses the same core memories as the KA10, although the instruction execution times on the new processor have been speeded up.

DEC has demonstrated a gradually increasing reliance upon internal peripheral development during recent years, but it continues to market a number of peripherals which are purchased from other suppliers. There are still some significant gaps in DEC's peripheral product line, notably in the areas of high-performance magnetic tape units, large-capacity disk units, and really high-speed printers.

On the other hand, DEC provides a wide variety of "standard" interfaces to "non-standard" products, in the sense that each of these devices has already been interfaced to the DECsystem-10 a number of times. In this regard, DEC considers the device itself a special or non-standard item only because no major OEM source of supply has been established. Thus, what appear to be product-line gaps are not necessarily gaps at all. This is particularly true for magnetic tape, where all levels of high-performance units are already in use with installed DECsystem-10's.

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 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.

The KA10 operates in three modes: Executive Mode, which permits execution of any instruction and suppresses the dual protection and relocation registers; User Mode, where most instructions may be executed except I/O instructions or those which would interfere with system integrity; and User I/O Mode, where all instructions are valid including I/O, except where system integrity or other users would be interfered with. The Monitor operates in Executive Mode, while user programs operate in User or User I/O Modes, depending upon the setting of a mode bit.

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 uses 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 are decoded with one instruction.

INPUT/OUTPUT CONTROL

I/O CHANNELS: The DECsystem-10 uses DF10 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. 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

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In addition to the 1060 model and the overall DECsystem-10 price cuts announced in September 1972, DEC also released three new medium-to-high-speed line printers (LSP10L, LP10F, and LP10H), the DC72 Asynchronous Remote Batch Stations, a faster DEC-produced core memory, and several software products, including a data base management system (DBMS-10) and a COBOL Sort program (QSORT). In combination with these product announcements, DEC streamlined the existing line by dropping a number of terminals and communications subsystems and by repackaging several disk subsystems to achieve greater configuration flexibility.

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 attributes outlined above. (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. □

being serviced. A DECsystem-10 can have up to 24 DF10's; each capable of handling its own I/O simultaneously with 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 has four MC10 Memory Access ports to provide direct access to any combination of four processors and/or high-speed data channels. 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, 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 bandwidth of 4 million words (20 million 7-bit characters) per second.

Controllers for slow-speed devices may be attached to the Multiplexed I/O Bus, which provides a full 36-bit word parallel path between the processor and the devices. Data may 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 6-bit characters per second, respectively. Instruction look-ahead is provided on the KI10, where the next sequential instruction is decoded during execution of any given instruction.

MASS STORAGE

RM10G DRUM SYSTEM: Provides an RC10 Drum Control, an RM10B Fixed Head Drum, and a DF10 Data Channel. The RM10B Drum provides moderately fast random-access storage for 345,600 36-bit words (2.07 million 6-bit characters) with an average rotational delay of 8.3 milliseconds and a transfer rate of 243,951 36-bit words (1,463,707 6-bit characters) per second. Rotational speed is 3600 rpm. The RM10B has 540 fixed heads, 6 of which are assigned to each of the 90 tracks. Each track consists of 60 sectors with 64 words per sector. On the DECsystem-1050, a typical user program of 15K words can be swapped in as little as 79 milliseconds. The RC10 Controller can accommodate four RM10B's to provide up to 1.38 million words (8.28 million characters) for swapping, data storage, and a program libraries. One or two 4-drum RM10G subsystems can be attached 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 (30.72 million 6-bit characters) with an average transfer rate of 66,667 36-bit words (400,000 6-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 presensing 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 (245.76 million 6-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 (983.04 million 6-bit characters) 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% lower cost. The RP03 Double-Density Disk Drives use the industry-standard RP02P Packs described above, pre-

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formatted with 400 cylinders, to store 10.24 million 36-bit words (61.44 million 6-bit characters) with an average transfer rate of 66,667 36-bit words (400,000 6-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 equals twice that of a full-size RP02C system: 81.92 million words (491.52 million 6-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 systems can be connected to a DECsystem-10, providing up to 327.68 million words (1,964,880,000 6-bit characters) of on-line storage.

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 2,775 36-bit words (16,650 6-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 capstans 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.

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.

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 OEM product make the system most effective for remote batch entry applications. One or two CR10F units can be connected to a DECsystem-10.

CP10A CARD PUNCH: Punches cards at rates up to 365 cpm when only the first 16 columns are punched. The CP10A includes its own controller and operates at a rate of 200 cpm with all 80 columns being punched. Input hopper and output stacker capacities are 1000 cards each. Only one CP10A can be connected to a DECsystem-10.

LSP10 LINE PRINTER: Prints at 245 lpm using a 64-character drum with 132 print positions per line. 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 the 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.

LA30C DECWRITER: The DECwriter I/O terminal provides asynchronous electromechanical impact printing at a rate of up to 30 characters per second from a 64-character print set. Each character is formed in a 5-by-7 dot matrix by a vertical row of 7 spring-loaded pins in a movable head.

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A standard 9-7/8-inch continuous forms tractor advances 1- or 2-part paper for printing at 6 lines per inch. Characters are printed at a horizontal pitch of 10 characters per inch, and 80 print positions are provided. As a data entry device, the DECwriter has either a 97- or 128-character keyboard for ASCII code. The DECwriter connects to the DC10 Scanner.

XY10 PLOTTER CONTROL: 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 which 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.

DC71A OR DC71B REMOTE TERMINAL: Consists of a PDP-8/I remote processor with 4K words of memory, 200-cpm card reader, line printer, and operator's teletypewriter. The DC71A has a 64-character-set printer with 132 positions and a speed of up to 350 lpm. The DC71B has a 96-character set printer with 132 positions and a speed of up to 250 lpm. The basic DC71 provides 8 lines, which may be expanded, with the DC71E group, to 16 lines. Although widely installed, the DC71A and B are no longer in new production, having been superseded by the DC72.

DC72 REMOTE STATION: The 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 DC10'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.

DS10 SYNCHRONOUS LINE UNIT: Provides a single synchronous line which can handle data transmission rates up to 9600 bits per second when equipped with a high-speed modem. The DS10 is used with the DC72 or DC75 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 9600 bits per second.

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 1500 characters per second or 6000 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's Computer Special System (CSS) group, and may optionally include a function box, keyboard or Rand Tablet input, color display, and larger screen sizes.

VT05 ALPHANUMERIC DISPLAY TERMINAL: The 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 2240-bit read-only memory. Each character is represented with a 5-by-7 dot matrix. The 9816-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 2400 bps.

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 non-resident portion. The resident operating system 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

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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: Process user program requests for I/O devices, and consist of three non-cyclic routines. The Programmed Operator Handler (UUO) 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, 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-10 Monitor allows four basic concurrent modes of operation: interactive time-sharing, real-time processing, multiprogramming batch, and remote communications. Up to 127 interactive terminals can be handled by the Monitor, with multiple remote batch stations multiplexed through the DC75 Synchronous Communications System.

The DECsystem-10 Monitor, as well as the Command Language for the Monitor, is common to all modes of operation on all six 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 K110 Processor is improved over that of the KA10 Processor through hardware features such as additional high-speed registers and fast interrupt handling, which speeds 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 pro-

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vides seven standard priority levels, with up to 135 additional levels available through the use of programmed traps on the K110.

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 communications 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.

DATA BASE MANAGEMENT SYSTEM: DBMS-10 is a full-scale data base organization and management system that uses COBOL as its host language 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 and provides a good degree of data independence from physical devices as well as user application programs. An on-line mode of operation is also provided. DBMS was announced in July 1972 for delivery in April 1973, at a separate charge of $375/month.

ALGOL-60: Consists of a one-pass, single-phase compiler capable of processing up to 5000 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 memroy 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.

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.

COBOL: A complete implementation of American National Standard COBOL X3.23 (Level 4) with compilation speeds, according to DEC, which vary from 2000 to 6000 statements per minute. DEC also claims sort speeds of 1000 to 5000 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 of 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. The monthly charge for QSORT is $125.

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.

BASIC: Provides 13 commands for full BASIC 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.

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

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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.

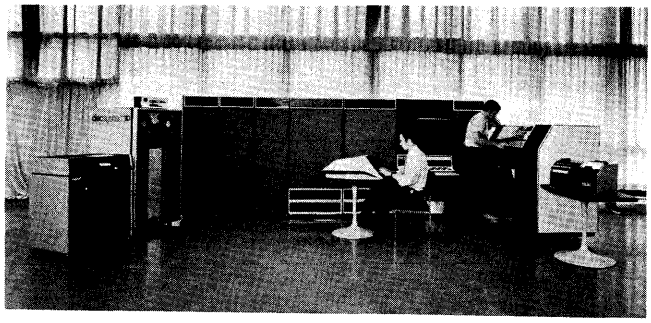
TECO (Text Editor and COrrector) is used to edit individual ASCII characters in an input file. The file is read into a memory buffer from any device except a user terminal, where 30 TECO editing commands of two types may be applied to the data. The first type consists of elementary commands usually found 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.

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 world-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:



The DECsystem-1040, smallest member of the family, offers time-sharing, real-time, and batch processing capabilities in an economical package.

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PRICING

EQUIPMENT: The following 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, and the five-year lease rates include 12-hour equipment maintenance. 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 LSP10L Line Printer (245 lpm), and eight local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $10,099 and $401,400, respectively.

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 Drum, two RP02 Disk Drives, two TU10 Tape Units (36KC), a CR10D Card Reader (1000 cpm), an LP10H Line Printer (925 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $14,591 and $581,100, 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), an RM10B Swapping Drum, 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 $19,231 and $764,100, repsectively.

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DECsystem-1060: Consists of a central processor with 96K words of MF10 core memory (640K 7-bit characters), an operator's console with a KSR-35 Teletypewriter and a Paper Tape Reader/Punch (300/50 cps), three RP03C 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 $16,581 and $640,300, respectively.

DECsystem-1070: Consists of a central processor with 128K words of MF10 core memory (640K 7-bit characters), an operator's console with a KSR-35 Teletypewriter and a Paper Tape Reader/Punch (300/50 cps), two RM10B Swapping Drums, four RP03 Disk Drives, three 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 $22,420 and $867,500, respectively.

DECsystem-1077: Consists of two central processors 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 RM10B Swapping Drums, four RP03 Disk Drives, four 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 $31,800 and $1,255,000, respectively.

SOFTWARE: DEC continues to bundle its systems software at no additional cost to DECsystem-10 users. DECUS-supplied software is subject to a $5 copying charge. Plans have been announced to provide certain applications packages with DEC support for a charge. The first examples of such software are QSORT ($125/month) and DBMS-10 ($375/month).

SUPPORT: DEC has formed a Systems Engineering Group to provide systems integration assistance and field support to customers. Installation support is provided at no charge during the first six months following delivery. Systems engineering support beyond this period or any customized coding is charged for at $33 per hour.

EDUCATION: Each DECsystem-10 user is entitled to 13 man-weeks of training, which can be used for software or hardware courses at the option of the user. On-site training, including course materials, is provided for specialized customer requirements at the rate of $50 per hour.

CONTRACT TERMS: DEC offers a purchase agreement for immediate ownership of the DECsystem-10, and full-payout accrued-equity lease contracts. The most common of these is a 5-year accrued-equity contract which yields DEC a full payout in four years. End-of-contract options include continued lease of the system at an annual rate of 3 percent of the original purchase price, or direct purchase of the system for the then-fair market value, which DEC currently estimates will be 10 to 15 percent of the original purchase price. 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 of about 25 percent 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 equipment or slower DECsystem-10 equipment may be upgraded for the difference in purchase cost to higher-performance DECsystem devices. Traded-in equipment must be in generally good condition (i.e., DEC Field Service maintained) or is subject to a refurbishing charge. Allowances are given, depending upon device type, which vary widely from about 20 to 80 percent of the original purchase prices. ■

DECsystem-10

Equipment prices

		Purchase Price	Monthly Maint.* 12-hour	24-hour	Approx. Monthly Lease Price (5-year lease)**
PROCESSORS AND MAIN MEMORY					
KA10S	Primary Central Processing Unit for 1040, 1050, and 1055 (Includes DK10 Real Time Clock and operator console)	$170,000	$410	$503	$3,570
KA10	Additional Central Processing Unit for 1055 (Includes operator console; DK10 Real Time clock additional)	130,000	410	503	2,730
KI10S	Primary Central Processing Unit for 1060, 1070, and 1077 (Includes DK10 Real Time Clock and operator console)	240,000	555	680	5,040
KI10	Additional Central Processing Unit for 1077 (Includes operator console; DK10 Real Time Clock additional)	200,000	555	680	4,200
DK10	Real Time Clock; 10-microsecond crystal oscillator resolution	3,000	11	14	63
MD10E	Additional 32K-word core memory module for for 64K-word MD10G Mass Memory System; 1.8 microseconds (Note that MD10G is out of new production; for use with KA10 Processor only)	42,000	133	163	882
ME10	Core Memory Module; 16K words, 1.0 microsecond including memory ports (for use on KA10 or KI10 processors with any mix of other memory module types)	30,000	167	204	630
MF10A	Core Memory; 32K words, 0.95 microsecond, including memory ports	50,000	311	380	1,050
MF10G	Core Memory; 64K words, 0.95 microsecond, including memory ports	80,000	444	544	1,680
MX10	Memory Port Multiplexor (direct memory access for eight additional DF10 Data Channels)	4,500	18	22	95
MC10	Memory Port for add-on memory (separately priced only when ordered for already-installed memory)	1,000	7	8	21
DF10	Data Channel (included in RP02C, RP03C, and TU40/41C)	14,000	67	82	294
MASS STORAGE					
RM10G	Drum System; 345,600 words (includes DF10 Data Channel, RC10 Control, RM10B Drum)	87,000	265	338	1,827
RM10B	Additional Drum Unit; 345,600 words	54,000	164	212	1,134
RP02C	Disk System: 5.12M words (includes RP10C Control, 1 RP02 Drive, DF10 Data Channel)	55,000	287	367	1,155
RP02	Additional Disk Drive; 5.12M words	15,000	141	183	315
RP03C	Double-Density Disk System; 10.24M words (includes RP10C Control, 1 RP03 Drive, DF10 Data Channel)	60,000	316	403	1,260
RP03	Additional Disk Drive; 10.24M words	20,000	170	219	420
INPUT/OUTPUT UNITS					
TU40C/ TU41C	Magnetic Tape System (includes DF10 Data Channel, 1 TU40 or TU41 Unit, TM10B Control)	59,000	268	341	1,239
TU40/ TU41	Additional Unit: 30/83.4/120KC, 9-track/7-track	25,000	158	204	525
TU10C	Magnetic Tape System (includes TM10A Control and 1 TU10A-E or TU10A-F Unit)	22,500	116	150	473
TU10A-E/F	Additional Magnetic Tape Unit; 36KC, 9-track/ 7-track	7,500	79	102	157.50
TD10G	DECtape System; 15KC, 3/4-inch (includes TD10 Control and 1 TU56 Dual DECtape)	20,000	54	70	420
TU56	Additional Dual DECtape Unit	4,700	34	44	99
CR10D	Card Reader (incl. control); 1000 cpm	14,000	90	117	294
CR10E	Card Reader (incl. control); 1200 cpm	18,000	102	131	378
CR10F	Card Reader (incl. control); 300 cpm	8,000	68	88	168
CP10	Card Punch (incl. control); 200-365 cpm	35,000	113	146	735
LSP10L	Line Printer (incl. control); 245 lpm	28,000	85	110	588
LP10F	Line Printer (incl. control); 1250 lpm	47,500	153	197	997
LP10FX	Additional Drum for LP10F; 64 characters	1,500	Time & Mat'ls	Time & Mat'ls.	31.50
LP10H	Line Printer (incl. control); 925 lpm	48,500	153	197	1,019
LP10HX	Additional Drum for LP10H; 64 characters	2,500	Time & Mat'ls	Time & Mat'ls.	52.50
XY10	Plotter Control	3,000	12	17	63
XY10A	Incremental Plotter and Control (consists of Calcomp Model 565 and XY10)	9,000	35	50	189
XY10B	Incremental Plotter and Control (consists of Calcomp Model 563 and XY10)	13,400	41	58	281

*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.

**Lease prices are based upon a 5-year lease-purchase contract and do not include maintenance..

DECsystem-10

Equipment prices

		Purchase Price	Monthly Maint.* 12-hour	Monthly Maint.* 24-hour	Approx. Monthly Lease Price (5-year lease)**
COMMUNICATIONS DEVICES					
DC10	Data Line Scanner:				
DC10A	Scanner and Control Unit (includes 4 units of cabinet space)	10,000	19	23	210
DC10B	Eight-Line Group Unit (uses 1 unit of cabinet space)	5,400	18	22	116
DC10C	Eight-Line Telegraph Relay Assembly (uses 2 units of cabinet space)	3,000	19	23	63
DC10D	Telegraph Power Supply for DC10C (no cabinet space required)	500	8	10	11
DC10E	Expander Data Set Control (uses 2 units of cabinet space)	5,500	19	23	116
DC10F	Expander Cabinet (provides 8 units of cabinet space)	2,000	Time & Mat'ls.	Time & Mat'ls.	42
DC71	Remote Stations (Note: DC71 Remote Stations are out of new production):				
DC71D	Teletype Concentration Package (includes 8 lines)	11,500	89	146	242
DC71E	Terminal Expansion Package (includes 8 additonal lines)	5,500	41	70	116
DC72	Asynchronous Remote Stations:				
DC72A	Communications Processor (includes PDP-8/E Processor, 10-cps Teletypewriter, 300-cpm Card Reader, 165-cps Strip Printer)	21,500	***	***	451
DC72B	Communications Processor (includes PDP-8/E Processor, 10-cps Teletypewriter, 300-cpm Card Reader, 245-lpm Line Printer with 64-character set)	34,000	***	***	714
DC72C	Communications Processor (includes PDP-8/E Processor, 10-cps Teletypewriter, 300-cpm Card Reader, 173-lpm Line Printer with 96-character set)	35,500	***	***	745
DC72L	Teletype Concentration Package (includes 8 lines; maximum of 2 DC72L's per DC72 system)	3,000	***	***	63
DC75	Synchronous Programmable Communications System (communications multiplexor):				
DC75A	Communications Processor (includes PDP-11/20 Processor, DS11 Synchronous Modem Interface, DL10 Channel Interface, and 8 lines)	50,000	246	361	1,050
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	225	332	630
DC75E	Additional 8-Line Group for Synchronous Modem Interface (1 per DC75A or D)	10,000	28	40	210
DS10	Single Synchronous Line Interface Unit	12,000	22	27	252
DISPLAYS					
VB10C	Graphic Display System	35,000	***	***	735
VT05B	Alphanumeric CRT Terminal	2,795	31	48	54
TERMINALS					
LT33A (C)	Teleprinter (KSR-33) for local DC10 (DC68) use	1,275	28	37	27
LT33B (H)	Teleprinter (ASR-33) for local DC10 (DC68) use	1,940	34	44	41
LT35A (C)	Teleprinter (KSR-35) for local DC10 (DC68) use	3,240	25	32	68
LA30C	DECwriter (30-cps teleprinter)	3,195	34	44	67

*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.
**Lease prices are based upon a 5-year lease-purchase contract and do not include maintenance.
***Contact DEC Field Service; maintenance charge not established to date.