DECsystem-10

MANAGEMENT SUMMARY

The DECsystem-10 represents the consolidation of Digital Equipment Corporation's existing large-scale computer systems effort into a new product line that benefits from an improved processor, a number of faster peripherals, additional communications capability, and an upgraded version of DEC's existing operating system. The communications-oriented DECsystem-10 family was introduced by DEC at the Maynard, Massachusetts, "minicomputer capital of the world" on September 8, 1971.

The DECsystem-10 family is formed around the PDP-10 processor plus a new version of that processor which has been modestly improved 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 1070 and dual-processor 1077 versions.

All five members of the DECsystem-10 family operate under control of the DECsystem-10 Monitor, which is basically the same TOPS-10 Operating System available with the earlier PDP-10. DEC emphasizes that the characteristics of its large-scale systems are visible primarily to the user through its operating system, whose development cost for the new family has exceeded 50 percent of the overall DECsystem-10 development cost.

The DECsystem-10 family offers a range of computational capability that stretches across the current IBM product line from the 370/135 through the 370/155 at equipment prices from 10 to 25 percent lower than their IBM ▷

With the DECsystem-10 announcement, Digital has focused a major marketing emphasis upon an enhanced line of medium-to-large-scale computer systems based upon the existing PDP-10 hardware and software. The new 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 systems will be in 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.

MODELS: DECsystem-10 Models 1040, 1050, 1055, 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 ▶

The DECsystem-1070, which uses the improved KI10 Processor, costs about $1.2 million in typical configurations and is the second largest of the five systems in the DECsystem-10 family.

The dual-processor DECsystem-1077 uses two of the KI10 Processors.

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▷ counterparts—plus whatever cost an IBM user would pay for the lease of the necessary Program Products.

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 more than 160 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.

Influenced heavily by the contributed experience of developmental work which has been done on TOPS-10 over the past seven years at many of these educational and research institutions, DEC currently offers a sophisticated operating system for the DECsystem-10 that provides multiprogramming batch running concurrently with real-time operation of sensor-based systems and time-sharing. According to DEC, these time-sharing capabilities have enabled the company to lay claim to 17 percent of the time-sharing services computer market with existing large-scale systems.

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 15,000 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 DEC-system-10 will come. Most of the early DECsystem-10 installations, however, will be upgrades for current PDP-10 users. In order to facilitate this customer migration, DEC has announced two programs which make it easier for existing customers to grow upward to DEC-system-10: a liberal upgrade policy providing trade-in allowances for older systems and slower peripherals, and a full-payout lease plan usually offered on a 5-year term. 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.

At the present time, DEC has only a scant offering of commercial applications packages. Much of what is available is provided through DECUS, the DEC Users' Society. This software is offered free to DEC users, but no free centralized software maintenance service for user-written programs is provided. DEC maintains a staff of about 1400 sales, service, and software support personnel at 60 offices in 11 countries to assist customers in the installation of DEC computers. Training is provided at centers in Maynard, Palo Alto, England, France, and Germany. ▷

▶ 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 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 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 bytes. 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. 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 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 ▶

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CHARACTERISTICS OF THE DECsystem-10 MODELS

	1040	1050	1055	1070	1077
System Configuration					
Type of CPU	KA10	KA10	2 KA10	KI10	2 KI10
Paging	No	No	No	Yes	Yes
Typical system rental (incl. maint.)	$10,500	$17,000	$26,000	$29,000	$41,000
Maximum interactive terminals	63	63	63	127	127
Main Storage					
Minimum capacity, 36-bit words	32K	64K	80K	96K	128K
Maximum capacity, 36-bit words	256K	256K	256K	4,096K	4,096K
Increment size, 36-bit words	16K	16K	16K	16K	16K
Cycle time, microseconds	1.0	1.0	1.0	1.0	1.0
Words accessed per cycle	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
Central Processor					
Number of hardware instructions	366	366	366	377	377
Instruction look-ahead	No	No	No	Yes	Yes
Base registers	Yes	Yes	Yes	No	No
Index registers	15	15	2 x 15	4 x 15	8 x 15
Register stack switching microseconds	No	No	No	2.5	2.5
Interrupt service time, microseconds	6	6	6	3	3
Maximum interrupt delay, microseconds	40	40	40	10	10
Double precision floating-point hardware	No	No	No	Yes	Yes
I/O Control					
High speed data channel cycle time, microseconds	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
Interrupts	7 levels	7 levels	7 levels	7 levels plus up to 135 trap instructions	7 levels plus up to 135 trap instructions

▷ 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.

Compatibility for the DECsystem-10 is limited primarily to its earlier 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 ▷

▶ 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 (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 1070 and 1077 systems has 64 general-purpose registers contained in 4 blocks of 16 ▶

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and 370 requires time-consuming I/O code conversions. There is no program compatibility at either the machine level or source-program level between the DECsystem-10 and other popular systems.

Distinctions between models in the DECsystem-10 family are based largely on configuration rules and marketing strategy. The 1040 may have from 32K 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 minimum memory size of 64K 36-bit words and 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. 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 has the same 1.0-microsecond cycle time as the KA10, although the instruction execution times on the new processor have been modestly speeded up.

DEC has demonstrated a gradually increasing self-reliance upon internal peripheral development over the past years, but continues to market a number of peripherals which are purchased from other suppliers. With the arrival of the DECsystem-10, significant peripheral product-line gaps still exist, including high-performance magnetic tape units, large-capacity disk units, and really high-speed printers.

Helping to round out the DEC peripheral offerings are the following new products announced with the DECsystem-10:

- The RP03G Dual-Density Disk System with an on-line maximum capacity of 81.92 million 36-bit words (491.52 million 6-bit characters). This "dual-density" system offers interchangeable disk-pack storage at per-character costs 20 to 30 percent lower than DEC's older RP02G Disk Systems.

- Two magnetic tape units: the 7- or 9-track TU40/TU41 with recording densities of 200, 556, and 800 bpi and a maximum data transfer rate of 120KC at 800 bpi; and the low-cost, low-performance 7- or 9-track TU10 with recording densities of 200, 556, and 800 bpi and a maximum transfer rate of 36KC at 800 bpi.

- Three new card readers: the 300-cpm CR10F, the 1000-cpm CR10D, and the 1200-cpm CR10E.

The already extensive communications capabilities of the DEC product line have been further beefed up with the DC75 Synchronous Communications System announcement. Based on up to four PDP-11 processors as controllers, the DC75 facilitates remote batch processing and

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.

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 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	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.

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 being serviced.

Each memory module has four ports to provide direct access to any combination of four processors and/or high-speed data channels. The capacity of each 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

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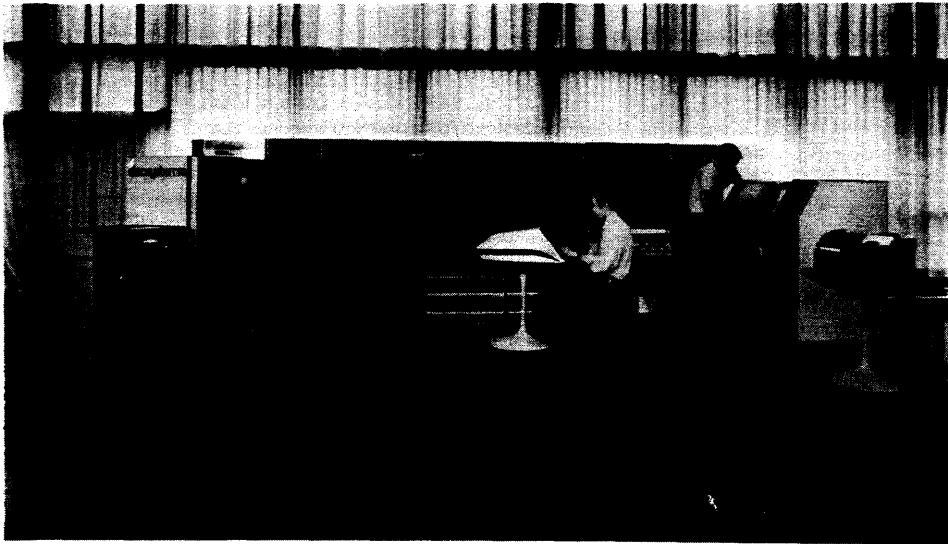
The DECsystem-1040, small-est member of the family, offers time-sharing, real-time, and batch processing capabili-ties starting at a purchase price of $400,000.

▷ terminal network data concentration, providing up to 16 full-duplex lines operating at up to 9600 bps each.

The DECsystem-10's hoped-for-success in presenting a "first alternative" to IBM in the commercial and manufac-turing markets may well depend upon: (1) the availability of fully supported applications programs, (2) the com-pany's ability to respond to user requirements for higher-performance peripheral devices to support advanced customer applications, and (3) attractive lease terms not only for the new peripherals, but for the basic DECsystem-10 as well. □

▶ 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 simulta-neous 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. Instruc-tion look-ahead is provided on the KI10, where the next

sequential instruction is decoded during execution of any given instruction.

PAGING: The KI10 Processor provides a mapping capa-bility 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 signifi-cant 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 con-catenated 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 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 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 ▶

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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.

INTERRUPT STRUCTURE: The KA10 has seven standard prioritized channels which transfer 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.

MASS STORAGE

RM10G DRUM SYSTEM: Provides an RC10 Drum Control, an RM10B Fixed Head Drum, and a DF10 Data Channel. The RM10B Drum permits moderately fast random-access storage of 345,000 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. The RM10B has 540 fixed heads, each permanently assigned to one track. 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 program libraries.

RP02G DISK SYSTEM: Provides up to eight on-line RP02 Disk Pack Drives, an RP10 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 minimum RP02G Disk System consists of two RP02 Disk Pack Drives, which may 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 RP02G single-channel systems may be connected to a DECsystem-10 to provide up to 163.84 million words (983.04 million 6-bit characters) of on-line storage.

RP03G 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 RP02G System described above at up to 32% less cost. The RP03 Double-Density Disk Drives, which currently are purchased from Itel, use industry-standard RP03P Packs similar to the RP02P Pack described above 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. RP03P Packs can be read only on the RP03G System. 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 RP03G Disk System consists of four RP03 Disk Pack Drives, which may be expanded in one-drive increments to the maximum of eight drives on-line. The total storage capacity of the RP03G equals twice that of a full-size RP02G system: 81.92 million words (491.52 million 6-bit characters). RP02 Disk Drives may be substituted for RP03 Disk Drives or used in combination with them on the RP10C Controller to form a low-level entry disc system for new user or a compatibility approach for current PDP-10 users with installed (purchased) RP02 drives. The single-channel RP03G Disk System was announced with the DECsystem-10 for first delivery in early 1972. A maximum of four RP03G systems may 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. 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.

TM10G MAGNETIC TAPE SYSTEM: Available in 9- and 7-track NRZI versions, which record on standard 1/2-inch tape in IBM-compatible formats. Up to eight TU10 Tape Units may 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 TU10F 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 TU10E 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 TU10E and TU10F, 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.

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▶ TU40G MAGNETIC TAPE SYSTEM: Includes a DF10 Data Channel, a TM10B Control, and two 9-track TU40 or 7-track TU41 Tape Units in any combination. 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.

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. Both card readers have built-in controllers.

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 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.

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.

LP10A LINE PRINTER: Prints at 300 lpm using a 64-character drum with 132 print positions per line. A single-channel controller which connects the LP10A 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.

LP10C LINE PRINTER: Prints 1000 lpm using the same 64-character set as the LP10A. This drum printer has 132 print positions per line and connects 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 adjustably prints 6 or 8 lines per inch.

XY10 PLOTTER CONTROL: Interface for the CalComp 500 and 600 Series Digital Incremental Plotters. The single-channel XY10 may connect one plotter device.

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 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 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 cabinet space and power supplies for various combinations of line equipment. Half-duplex or full-duplex interfacing to data sets is accomplished by the DC10C 8-line Telegraph Relay Assembly and DC10D Power Supply. The minimum 8-line capability of the DC10 system may be expanded with the DC10B 8-line group up to the 64-line maximum. Additional cabinet space is available with the DC10F Expander Cabinet if required.

DC68A BASIC PROGRAMMABLE COMMUNICATION SYSTEM: Built around the 680/I Communications version of the PDP-8/I minicomputer, the 680/I is capable of servicing up to 63 communications lines, handling 8-level serial teletype code at speeds of 110, 150, or 300 bits/second. One M750 Dual Serial Line Adapter is required on the 680/I for each line handled. The first 48 local teletypewriters are handled by a DC08B Local Line Panel. Additional local teletypewriters require a second DC08B. Up to 32 dual modem control units can be attached to the DC08F Modem and Control Multiplexer, which in turn can handle up to 64 asynchronous lines. The standard DC68A Configuration includes a PDP-8/I-D computer (4K words of memory with MP8/I Parity Option, and an ASR33 Teleprinter), DA10 Interface, DL8/I Serial Line Adapter, DC08A Serial Line Multiplexer, and 3 clocks for line frequency operations.

DC71A OR DC71B REMOTE BATCH TERMINAL: Consists of a PDP-8/I remote batch 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.

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 DC71 Remote Batch Terminal to interface a remote batch station, 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.

VB10 GRAPHIC DISPLAY SYSTEM: Provides both alphanumeric and graphic display capabilities to represent ▶

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DEC's new "dual-density" disk drive, the RP03, features a storage capacity of 61.44 million 6-bit characters, a 35-millisecond average head-positioning time, and a data transfer rate of 400,000 characters per second.

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 VB10 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 uppercase 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 300 bits/second.

VT06 ALPHANUMERIC DISPLAY TERMINAL: Provides similar capabilities to the VT05 described above and the Datapoint 3300, (DEC purchases this system OEM from Computer Terminal Corporation.) The display screen can contain 25 lines, resulting in 1800 characters per display. Communications rates as high as 2400 bits/second can be handled.

SOFTWARE

OPERATING SYSTEMS: A single Operating System and Command Control Language is provided for all DECsystem-10 models. The DECsystem-10 Monitor is an improved version of the TOPS-10 Operating System used on the PDP-10, and 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 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 1/2 second for execution. Jobs which do not issue I/O requests during their 1/2-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.

Non-resident DECsystem-10 Monitor software is usually stored on drum or disc 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 ▶

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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 five single- and dual-processor DECsystem-10 models. This hierachy 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.

On the DECsystem-1040, the resident Monitor requires from 15-20K words of main memory; on the 1050 and 1055 from 20-35K words; and on the 1070 and 1077 from 25-40K words.

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 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, for example, cards or tape. 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.

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 ▶

The CR10E, fastest of the three new card readers introduced with the DECsystem-10 family, reads 80-column cards photo-electrically at 1200 cards per minute.

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▶ 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.

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 12K-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.

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 5K words of main storage 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 10K words of "pure" (re-entrant) code and a minimum of 6K words for each user's portion.

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 6K 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 8K words of main storage, and each user's portion requires a minimum of 3K 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.

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 ▶

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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 program segments in a minimum of 2K words for sharable code; and FILEX to convert files to various formats. 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, DECU-SCOPE. 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	DECUS European Secretary
Digital Equipment Corp.	DECUS International Office
146 Main Street	81 Route de L'Aire
Maynard, Mass. 91754	1227 Carouge
	Geneva, Switzerland.

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 32K words of core memory (160K 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), eight local DC10 Data Lines, a CR10F Card Reader (300 cpm), and an LP10A Line Printer (300 lpm). Monthly rental (5-year lease) and purchase prices are $11,053 and $436,000, respectively.

DECsystem-1050: Consists of a central processor with 80K words of core memory (400K 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 LP10C Line Printer (1000 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $17,627 and $705,000, respectively.

DECsystem-1055: Consists of two central processors with 128K words of core memory (640K 7-bit characters), two operator's consoles with two KSR-35 Teletypewriters and two Paper Tape Reader/Punches (300/50 cps), an RM10B

Swapping Drum, four RP03 Disk Drives, two TU40 Tape Units (120KC), a CR10D Card Reader (1000 cpm), an LP10C Line Printer (1000 lpm), and 32 local DC10 Data Lines. Monthly Rental (5-year lease) and purchase prices are $28,726 and $1,160,000, respectively.

DECsystem-1070: Consists of a central processor with 128K words of 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 LP10C Line Printer (1000 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $31,269 and $1,275,000, respectively.

DECsystem-1077: Consists of two central processors with 256K words of 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 RPD3 Disk Drives, four TU40 Tape Units (120KC), a CR10E Card Reader (1200 cpm), an LP10C Line Printer (1000 lpm), and 32 local DC10 Data Lines. Monthly rental (5-year lease) and purchase prices are $45,225 and $1,870,000, 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. An upcoming typesetting applications package will be the first of this type.

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 standard 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. ∎

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EQUIPMENT PRICES

BASIC SYSTEMS		Purchase Price	Monthly Maint.* 12-hour	Monthly Maint.* 24-hour	Approx. Monthly Lease Price (5-year lease)**
DECsystem-1040	Basic System consisting of:	400,000	1,700	2,300	8,400
KA10	Central Processor				
2 ME10	Core Memories (32K words); 1.0 microsecond				
DK10	Real Time Clock; programmable to 10 microseconds				
RP02G	Disk System; 10.24 million words (RP10 Control, 2 RP02 Disk Drives, DF10 Data Channel)				
TM10G	Magnetic Tape System; 36KC (TM10A Control, 2TU10 units)				
DC10	Data Line Scanner; 8 local lines (DC10A Control, DC10B 8-Line Group)				

Substitutions for DECsystem-1040 Basic System: ***

TU40R	TU40G Magnetic Tape System (120KC) replacing TM10G Magnetic Tape System (36KC)	52,000	271	374	1,092
RP03R	RP03G Disk System (40.96 million words) replacing RP02G Disk System (10.24 million words)	73,000	475	664	1,533
MD10R	64K words of 1.8-microsecond core memory replacing 32K words of ME10 memory (1.0 microsecond)	40,000	223	263	840
DECsystem-1050	Basic System consisting of:	655,000	2,650	3,800	13,755
KA10	Central Processor				
4 ME10	Core Memories (64K words); 1.0 microsecond				
DK10	Real Time Clock; programmable to 10 microseconds				
RM10G	Drum System; 345,000 words (RC10 Control, RM10B Drum, DF10 Data Channel)				
RP02G	Disk System; 10.24 million words (RP10 Control, 2 RP02 Disk Drives, DF10 Data Channel)				
TM10G	Magnetic Tape System; 36KC (TM10A Control, 2 TU10 units)				
CR10D	Card Reader; 1000 cpm				
LP10C	Line Printer; 1000 lpm, 132 positions				
DC10****	Data Line Scanner; 32 local lines (DC10A Control, 4 DC10B 8-Line groups)				

Substitutions for DECsystem-1050 Basic System: ***

TU40R	TU40G Magnetic Tape System (120KC) replacing TM10G Magnetic Tape System (36KC)	52,000	271	374	1,092
RP03R	RP03G Disk System (40.96 million words) replacing RP02G Disk System (10.24 million words)	73,000	475	664	1,533
CR10R	CR10E Card Reader (1200 cpm) replacing CR10D (1000 cpm)	4,000	14	46	84
DECsystem-1055	Basic System consisting of:	1,010,000	3,850	5,500	21,210
2 KA10	Central Processors				
5 ME10	Core Memories (80K words); 1.0 microsecond				
MX10	Memory Port Multiplexer				
DK10	Real Time Clock; programmable to 10 microseconds				
RM10G	Drum System; 345,000 words (RC10 Control, RM10B Drum, DF10 Data Channel)				
RP03G	Disk System; 40.96 million words (RP10C Control, 4 RP03 Disk Drives, DF10 Data Channel)				
TU40G	Magnetic Tape System; 120KC (TM10B Control, 2 TU40 Units, DF10 Data Channel)				
CR10D	Card Reader; 1000 cpm				
LP10C	Line Printer; 1000 lpm				
DC10****	Data Line Scanner; 32 local lines (DC10A Control, 4 DC10B 8-Line Groups)				

Substitutions for DECsystem-1055 Basic System: ***

Same as those for DECsystem-1050, described above.

DECsystem-1070	Basic System consisting of:	1,175,000	4,150	6,050	24,675
KI10	Central Processor				
6 ME10	Core Memories (96K words); 1.0 microsecond				

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

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

*** Prices for DECsystem-10 replacement equipment are in *addition* to the basic system price.

**** The 32-line DC10 Data Line Scanner may be replaced at no charge by a 32-line DC68A Programmable Communication System consisting of a DC68A processor, DC08B Local Line Panel, and 16 M750 Serial Line Adapters.

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EQUIPMENT PRICES

BASIC SYSTEMS		Purchase Price	Monthly Maint.* 12-hour	Monthly Maint.* 24-hour	Approx. Monthly Lease Price (5-year lease)**
DK10	Real Time Clock; programmable to 10 microseconds				
RM10G	Drum System; 690,000 words (RC10 Control, 2 RM10B Drums, DF10 Data Channel)				
RP03G	Disk System; 40.96 million words (RP10C Control, 4 RP03 Disk Drives, DF10 Data Channel)				
TU40G	Magnetic Tape System; 120KC (TM10B Control, 3 TU40 Units, DF10 Data Channel).				
CR10E	Card Reader; 1200 cpm				
LP10C	Line Printer; 1000 lpm				
DC10****	Data Line Scanner; 32 local lines (DC10A Control, 4 DC10B 8-Line Groups)				
DECsystem 1077	Basic System consisting of:	1,680,000	5,250	7,600	35,280
2 KI10	Central Processors				
8 ME10	Core Memories (128K words); 1.0 microsecond				
MX10	Memory Port Multiplexer				
DK10	Real Time Clock				
RM10G	Drum System; 690,000 words (RC10 Control, 2 RM10B Drums, DF10 Data Channel)				
RP03G	Disk System; 40.96 million words (RP10C Control 4 RP03 Disk Drives, DF10 Data Channel				
TU40G	Magnetic Tape System; 120KC (TM10B Control, 4 TU40 Units, DF10 Data Channel)				
CR10E	Card Reader; 1200 cpm				
LP10C	Line Printer; 1000 lpm				
DC10****	Data Line Scanner; 32 local lines (DC10A Control, 4DC10B 8-Line Groups)				

PROCESSOR FEATURES

		Purchase Price	12-hour	24-hour	Lease Price
ME10	Core Memory (16K words); 1.0 microsecond, including memory ports	50,000	172	248	1,050
MD10G	Mass Memory System (96K words); 1.8 microseconds	140,000	567	759	2,940
MD10E	Additional 32K-word module for MD10G Mass Memory System; 1.8 microseconds	50,000	138	198	1,050
MD10H	Mass Memory System (224K words); 1.8 microseconds	220,000	843	1,155	4,620
MX10	Memory Port Multiplexer (direct memory access for eight additional DF10 Data Channels)	4,500	19	26	95
DK10	Real Time Clock; 10 microsecond resolution	4,500	12	17	95

MASS STORAGE

		Purchase Price	12-hour	24-hour	Lease Price
RM10G	Drum System; 345,000 words (includes DF10 Data Channel, RC10 Control, RM10B Drum)	83,000	286	499	1,743
RM10B	Additional Drum Unit; 345,000 words	50,000	182	350	1,050
RP02G	Disk System: 10.24M words (includes RP10 Control, 2 RP02 Drives, DF10 Data Channel)	77,000	—	—	1,617
RP02	Additional Disk Drive; 5.12M words	18,000	175	238	378
RP03G	Double-Density Disk System; 40.96M words (includes RP10C Control, 4 RP03 Drives, DF10 Data Channel)	150,000	—	—	3,150
RP03	Additional Disk Drive; 10.24M words	25,000	210	285	525

INPUT/OUTPUT UNITS

		Purchase Price	12-hour	24-hour	Lease Price
TU40G	Magnetic Tape System (includes DF10 Data Channel, 2 TU40 or TU41 Units, TM10B Control)	90,000	—	—	1,890
TU40	Additional Unit; 30/83.4/120KC, 9-track	25,000	196	266	525
TU41	Additional Magnetic Tape Unit; 30/83.4/120KC, 7-track	25,000	196	266	525
TM10G	Magnetic Tape System; 9/25/36KC, 7- or 9-track (includes 2 TU10E or F units, TM10A Control)	40,000	—	—	840
TU10E	Additional Magnetic Tape Unit; 36KC, 9-track	6,950	98	133	146
TU10F	Additional Magnetic Tape Unit; 9/25/36KC, 7-Track	6,950	98	133	146
TD10G	DECtape System; 15KC, 3/4-inch (includes TD10 Control, TU56 Dual DECtape)	20,000	75	87	420
TU56	Dual DECtape Unit	4,700	42	57	99
CR10D	Card Reader (incl. control) 1000 cpm	14,000	112	152	294
CR10E	Card Reader (incl. control); 1200 cpm	18,000	126	198	378
CR10F	Card Reader (incl. control); 300 cpm	8,000	72	108	168
CP10A	Card Punch (incl. control; 200-365 cpm	35,000	115	165	735

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

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

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EQUIPMENT PRICES

INPUT/OUTPUT UNITS		Purchase Price	Monthly Maint.* 12-hour	24-hour	Approx. Monthly Lease Price (5-year lease)**
LP10A	Line Printer (incl. control); 300 lpm, 132 positions	28,000	125	178	588
LP10C	Line Printer (incl. control); 1000 lpm, 132 positions	44,000	182	261	924
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
COMMUNICATION DEVICES					
DC10 Data Line Scanner					
DC10A	Scanner and Control Unit (includes 4 units of cabinet space)	10,000	20	28	210
DC10B	Eight-Line Group Unit (uses 1 unit of cabinet space)	5,500	19	26	116
DC10C	Eight-Line Telegraph Relay Assembly (uses 2 units of cabinet space)	3,000	20	28	63
DC10D	Telegraph Power Supply for DC10C (no cabinet space required)	500	8	12	11
DC10E	Expander Data Set Control (uses 2 units of cabinet space)	5,500	20	28	116
DC10F	Expander Cabinet (provides 8 units of cabinet space)	2,000	0	0	42
DC68 Basic Programmable Communications System					
DC68A	Communications Processor (includes PDP-8/I-D Processor with 4K words of memory, PDP-8/PDP-10 Interface, and Serial Line Multiplexer)	31,000	185	291	651
DC08B	Local Line Panel (for 48 local Terminals)	1,000	3	5	21
DC08F	Modem Interface and Control Multiplexer	3,400	11	18	74
DC08G	Dual Modem Control Unit	300	3	5	6
M750	Serial Line Adapter (two full-duplex channels)	100	3	5	2
DC71 Remote Batch Stations					
DC71A	Communications Processor (includes PDP-8/I Processor, Teletypewriter, 300-cpm card reader, 250-lpm Line Printer)	41,000	289	414	861
DC71B	Communications Processor (includes PDP-8/I Processor, Teletypewriter, 300-cpm Card Reader, 250-lpm Line Printer)	42,500	289	414	893
DC71D	Teletype Concentration Package (includes 8 lines) 8 lines)	11,500	89	146	242
DC71E	Additional 8 lines for DC71D	5,500	41	70	116
DC75 Synchronous Programmable Communications System					
DC75A	Communications Processor (includes PDP-11/20 Processor, Synchronous Modem Interface, and 8 lines)	50,000	246	361	1,050
DC75D	Expander Option for Multiple Synchronous Modem Interfaces (Includes Synchronous Modem Interface, PDP-11 Processor, additional memory interface, and 8 lines)	30,000	225	332	630
DC75E	Additional 8-Line Group for Synchronous Modem Interface	10,000	28	40	210
DS10	Synchronous Line Interface Unit	12,000	23	33	252
DISPLAYS					
VB10C	Graphic Display System	35,000	–	–	735
VT05	Alphanumeric CRT Terminal	2,795	49	67	59
VT06	Alphanumeric CRT Terminal	3,950	49	67	83
TERMINALS FOR LOCAL DC10 (DC68) USE					
LT33A(C)	Teleprinter (KSR-33)	1,200	35	48	25
LT33B(H)	Teleprinter (ASR-33)	1,800	42	57	38
LT35A(C)	Teleprinter (KSR-35)	3,000	31	42	63

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

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