# Digital Equipment DECSYSTEM-20

## MANAGEMENT SUMMARY

Digital Equipment Corporation is highly regarded in the industry for such well-known products as the PDP-11 and VAX minicomputers. DEC also has a strong and loyal following for its 36-bit DECSYSTEM-20 mainframes.

There are three models available, the 2020, 2040, and 2060. These systems combine DEC's timesharing expertise with batch and distributed processing technologies in cost-effective, compact packages. A recent enhancement to the line allows multiple, independent DECSYSTEM-20s to be connected in loosely coupled multiprocessor/multi-device configurations.

The three systems are built around two different processors: the KS10 for the 2020, and the KL10 for the 2040 and 2060. All three use the same operating system, TOPS-20, as well as a wide variety of high-level languages. TOPS-20 is a virtual memory operating system that will support various operations, such as concurrent multi-language interactive time-sharing and multi-stream batch processing. It has an easy-to-learn, easy-to-use command language. All three models are sold as packaged systems.

DEC designed the low-end 2020 to reduce facilities requirements. It uses standard 110 volt current and draws only about 1400 watts of power, making it ideal for an office. Its compact size (the CPU needs only 3' x 3' of floor space) eliminates the need for a separate computer room.

Compatibility of programming languages and operating systems, as well as system packaging, makes it easy to upgrade to a larger system. Programs written on a 2020 can run on a 2060, and applications written on the larger machine can run on the smaller one, provided there are sufficient resources available on the 2020, such as memory and I/O capability.

**A family of small-to-medium-sized mainframes, the DECSYSTEM-20 serves interactive timesharing users, provides communications, and performs multiprogramming, batch processing simultaneously. Up to four DECSYSTEM 2040s or 2060s can be linked in any combination for multiprocessing. Digital Equipment Corporation was again one of the favorites in overall mainframe user satisfaction in Datapro's 1983 User Ratings of Computer Systems.**

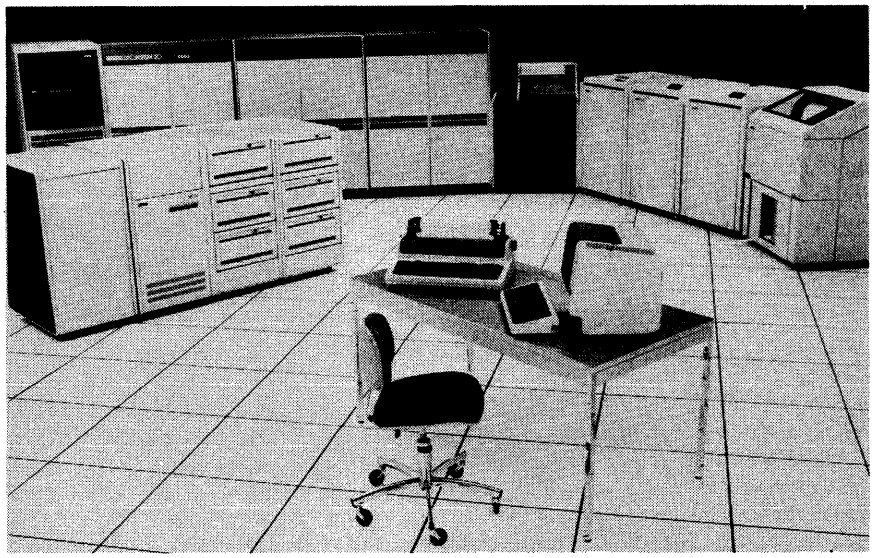
**MODELS: DECSYSTEM-2020, 2040, and 2060.**
**CONFIGURATION: All models are uniprocessors; memory ranges from 256K to 2,048K 36-bit words; and up to 8 high-speed channels and 128 communications lines can be attached.**
**COMPETITION: IBM System/370, 4300 Series, and 303X Series; NCR V-8400 and V-8500 Systems; and Univac 1100 Series.**
**PRICE: Purchase prices range from $133,000 fro a 2020 to $446,000 for a 2060.**

## CHARACTERISTICS

**MANUFACTURER: Digital Equipment Corporation, Large Computer Group, One Iron Way, Marlborough, Massachusetts 01752. Telephone (617) 467-5111.**

**In Canada: Digital Equipment of Canada Limited, 165 Atwell Drive, Rexdale, Ontario, Canada M9W5Y5. Telephone (416) 675-2580.**

**DEC is a worldwide corporation and one of the world's largest manufacturers of minicomputer systems. In addition**



*An enhanced DECSYSTEM-2060 has an improved price-performance capability. This system offers a new Intelligent Mass Storage Server, the HSC50, which will support high-performance disk and tape drives RA81, RA60, and TA78.*

# Digital Equipment DECSYSTEM-20

While the DECSYSTEM-20 and its predecessor, the DECsystem-10 (Report 70C-384-01), are functionally similar, the DECSYSTEM-20 is targeted for in-house time-sharing, batch, and distributed processing applications. The DECsystem-10 is generally used in large-scale commercial, educational, and scientific time-sharing operations.

A key feature of the DECSYSTEM-20 is packaging. Components such as the CPU, memory, and up to eight mass storage controllers (in the 2040 and 2060) are housed in the same cabinet. Peripheral subsystems are designed to support in-house time-sharing and batch processing.

The minimum DECSYSTEM-20 for any model configuration includes 256K 36-bit words of memory, a single- or dual-ported disk drive, a tape drive. 16 asynchronous communications lines, and an I/O console. Maximum configurations include up to 2048K words of memory, 56 disk drives, a card reader, a card punch, 2 printers, 16 magnetic tape drives, and up to 128 asynchronous communictions lines.

The DECSYSTEM-20 models 2040 and 2060 can be expanded up to 8 megabytes (2048K words) of main memory. The first 6 megabytes (1536K words) are housed in the CPU cabinet. An external cabinet holds the additional 2 megabytes on two backplanes.

An important feature of the DECSYSTEM-20 family (the 2020 and 2060) is a fast-access cache memory. It consists of four blocks of 512 words each (one block on the 2020). Access time is 133 nanoseconds on the 2060 and 330 nanoseconds on the 2020. DEC estimates that about 90 percent of all memory requests will reference information already in the cache, resulting in efective memory cycle times averaging around 195 nonoseconds.

The DECSYSTEM-20 also features memory mapping to extend the addressing range of the CPU beyond the 256K-word limitation. The mapping system increases the addressing range to 4096K words of physical memory.

Physical memory is divided into 512-word pages. A 512-entry page address map is contained in CPU hardware. Eighteen-bit effective addresses are translated into 22-bit physical addresses by appending a 13-bit entry from the page table to the low-order nine bits of the effective address. The page entry also includes a 3-bit protection code that indicates what type of accesses can be made to this page (no entry, read-only, read-write, writen, etc.) Two page tables exist, one for user mode and one for executive mode.

A PDP-11 front-end processor controls all low-speed peripherals and communications lines, and provides extensive diagnostic facilities to the DECSYSTEM-20. It is used only on the 2040 and 2060. The PDP-11 constantly monitors the data paths and control lines of the KL10 CPU. The DECSYSTEM-20 includes a special diagnostic bus that permits various testing routines. There is also a dedicated asynchronous line which can be connected, through a modem, to a remote service center for DEC diagnostic services.

**to its involvement in the production of interactive time-sharing and medium- to large-scale computer systems, the firm also manufactures peripherals, software, logic modules, and microcomputers. DEC employs over 67,000 persons worldwide and maintains sales and service offices in all major U.S. cities as well as major cities throughout Canada and the Western world.**

**MODELS: DECSYSTEM-20 Model 2020, 2040, and 2060.**

**DATE ANNOUNCED: See Table 1.**

**DATE OF FIRST DELIVERY: See Table 1.**

**NUMBER INSTALLED TO DATE: Approximately 650 nationwide.**

## 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, 72-bit doublewords, 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 in the KL10 processor. Single-precision floating-point uses one word, consisting of a 27-bit plus-sign fraction and an 8-bit exponent, including a sign. The first 36-bit word of a double-precision floating-point operand consists of the 18-bit exponent-and-sign and the most significant 27-bits of the fraction. The second word contains a sign bit and the 35 least significant bits of the fraction.**

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

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

## MAIN STORAGE

**STORAGE TYPE: See table.**

**CAPACITY: See table.**

**CYCLE TIME: See table.**

**CHECKING: A parity bit with each 36-bit word is generated with writing and is checked with reading in all systems except the 2020. Error-correcting memory, which detects and corrects all single-bit errors and detects all double-bit errors, is employed in the 2020, 2040, and the 2060. Error-**

# Digital Equipment DECSYSTEM-20

**TABLE 1. CHARACTERISTICS OF DECSYSTEM-20 FAMILY**

| | 2020 | 2040 | 2060 |
|---|---|---|---|
| SYSTEM | | | |
| Date of announcement | Feb. 1978 | March 1978 | Feb. 1978 |
| Date of first delivery | July 1978 | July 1978 | July 1979 |
| Maximum On-line disks storage, megawords (36-bit words) | 316.8 | 5,041 | 5,041 |
| Maximum communications lines: | | | |
| Asynchronous | 32 | 128 | 128 |
| Synchronous | 2 | 14 | 14 |
| 2780/3780 | 2 | 6 | 6 |
| DECnet | 2 | 8 | 8 |
| Maximum card readers | 1 | 1 | 1 |
| Maximum card punches | 0 | 1 | 1 |
| Maximum paper tape units | 0 | 1 | 1 |
| Maximum printers | 1 | 2 | 2 |
| Maximum magnetic tape drives | 4 | 16 | 16 |
| CPU | KS10-A | KL10-E | KL10-E |
| Number of instructions | 396 | 398 | 398 |
| System capacity, no. of users | 32 | 64 | 128 |
| Concurrent jobs | 25 | 36 | 120 |
| Relative CPU performance | 1.0 | 2.0 | 6.0 |
| MEMORY | | | |
| Minimum capacity, 36-bit words | 256K | 256K | 256K |
| Maximum capacity, 36-bit words | 512K | 2048K | 2048K |
| Increment size, 36-bit words | 64K | 256K | 256K |
| Memory control unit ports | 1 | 1 | 1 |
| Words accessed per cycle | 1 | 4 | 4 |
| Memory type | MOS | MOS | MOS |
| Memory cycle time, microseconds | 1.05 | 1.05 | 1.05 |
| Read access time | 0.467 | 0.467 | 0.467 |
| Read cycle time, 1 word; microsec. | 0.667 | 0.667 | 0.667 |
| Read cycle time, 4 words; microsec. | NA | 1.267 | 1.267 |
| Memory interleaving (software selectable) | — | 4-way | 4-way |
| Cache memory, words | 512 | — | 2048 |
| Access time, microseconds | 0.320 | — | 0.133 |
| I/O CONTROLS | | | |
| Type of controllers | Integrated | Integrated | Integrated |
| Maximum number of controllers | 2 | 8 | 8 |

The 2020 does not feature a front-end processor. All peripherals except the console are attached via a Massbus to Unibus adapter combination. Mass storage devices connect to the Unibus via an RH11-C Massbus Adapter.

DEC offers a wide choice of peripheral devices for the DECSYSTEM-20. Each system includes a 176-megabyte RP06 disk drive (a 67-megabyte RM03 disk can be substituted for the RP06 in the 2020), 16 asynchronous communictions lines, and two RH20 peripheral controllers (2040 and 2060 only). Optional disk drives include the 929-megabyte RP20 and the recently announced RP07, with 498 megabytes. A new Intelligent Mass Storage Server, HSC50, offloads traditional mass storage I/O overhead. Supported by HSC50 are the new high-performance disk and tape drives RA81, RA60 and TA78. Two different 9-track tape systems are available: the TU72, with 1600 bpi PE or 6250 GCR formats, and the TU78, with 800 bpi NRZI or 1600 bpi PE. Several drum and Charaband printers provide print speeds up to 1500 lpm. Along with various unit record devices, DEC offers a large variety of teleprinter and video display terminals, including the LA120 DECwriter III and the VT100 CRT.

**correcting memory uses a Hamming code and special algorithm as the method of detecting bit errors.**

**RESERVED STORAGE: Two 512-word pages are reserved by the TOPS-20 software for the Executive Process Table (EPT) and the User Process Table (UPT). The EPT includes channel status information and is used for communications between the KL10 CPU and the front-end PDP-11 minicomputer (2040 and 2060). The UPT includes an arithmetic overflow vector address and contains the output from memory and instruction processor clocks. For the overflow vectors, only the user incurring the overflow is affected, leaving the system unaffected.**

**STORAGE PROTECTION: The KL10 CPU includes storage protection as a standard feature. A paging system reserves up to 256K 36-bit words of memory in as many as 512 pages of 512 words each. The individual pages need not be located in contiguous memory locations, thus eliminating the need to shuffle program segments in memory to counteract checkerboarding. The paging registers effectively permit addressing of 4 million words of memory through use of special hardware. Three bits are used to denote the type of access possible for each page such as read/write, read-only, proprietary, or denial of access.**

# Digital Equipment DECSYSTEM-20

Communications is a strong point for the DECSYSTEM-20. Using DECnet communications software, a wide variety of configurations are possible, particularly in the area of distributed processing. Remote job entry (RJE) is easily supported, as are such IBM protocols as 2780, 3780, and HASP. Both synchronous and asynchronous lines can be configured, which can accommodate line speeds up to one million bits per second. Connection of asynchronous lines is handled by the DZ11 multiplexer (2020) and DC20 front end (2040 and 2060). Synchronous lines are interfaced in all systems via the DN20 controller.

Software is included in all DECSYSTEM-20 packages, as well as on-site consulting for application software development. Included in the system software package is the TOPS-20 operating system, the GALAXY batch processing system, the macro assembler, the linking loader, the editor and other utilities. Programming languages and the SORT-20 utility are separately priced at charges ranging from $3,450 for the SORT package to $34,500 for the DBMS-20 data base management system.

TOPS-20 is a multi-user, multi-mode, virtual memory operating system that supports multi-language interactive processing plus multi-stream batch processing. Multiple batch jobs can be run concurrently with interactive processing, since the same command language is used for both time-sharing and batch operations. Batch jobs appear as time-sharing jobs and can be run by the TOPS-20 monitor. The GALAXY batch processing software, in effect, runs as a job under TOPS-20.

The current version of TOPS-20 permits main memory up to 2048K words, and includes PDP-11 based remote job entry. HASP multi-leaving, and dynamic recognition of tape or disk drives associated with the system. It also features a command interface that incorporates scheduler controls, a program called Watch that prints out system performance statistics, and four error logging routines.

The TOPS-20 Common File System, CFS-20, is the software that implements loosely coupled multiprocessing on DECSYSTEM-20s. It represents a major functional enhancement to the capabilities of the TOPS-20 systems.

The programming languages supported by TOPS-20 include IBM-compatible Cobol and APL, Basic, BLISS, Algol, Fortran, PL/1, DBMS-20, a Codasyl-compatible data base management system, and IQL-20, an interactive query language. All language processors are shareable and reentrant under TOPS-20, and are compatible under batch and time-sharing.

One key reason why the DECsystem models typically are less expensive than functionally comparable IBM systems is that DEC competes only in systems environments which favor the DECsystems particular strengths. Those strengths are largely derived from the DEC operating systems' ability to function in a "multi-mode" environment, including online interactive processing, local, and remote batch processing. plus computer network requirements. The firm's

## CENTRAL PROCESSORS

**There are three processors employed in the DECSYSTEM-20. The 2040 and 2060 use the KL10 CPU and a PDP-11/40 front-end processor, which provides control for all low-speed peripherals and system initialization. The third CPU, the KS10, is used exclusively with the 2020 system.**

**System initialization on the 2040 and 2060 is accomplished through a dual-access disk drive that contains the system microcode. When the system starts, the PDP-11 performs a brief system checkout, after which it configures memory and loads the microcode into the KL10. The system software is then loaded into the DECSYSTEM-20 main memory and normal operation begins.**

**The front-end processor also controls all communications lines to user terminals, including the operator console, which is treated as any other user terminal. In addition to the initializing functions and low-speed peripheral control, the front-end processor is interfacd to all KL10 control data lines and constantly monitors them. In the event of failures, the PDP-11 reports the problem through the console terminal, and allows module-level diagnosis. The front-end processor is connected to the KL10 by the DTE-20 interface. The front-end processor then directly accesses the KL10 internal structure concurrently with normal processing activities. Through the DTE-20 interface, maintenance personnel may interrupt, examine and deposit data in registers, change data in main memory or registers, or transfer data during time-sharing operations.**

**On the 2020, system initialization is accomplished through the console. In addition, the operator can perform microcode load and check, perform memory modification and examination, start and stop the CPU clock, single step the CPU clock, execute a given instruction and start the machine at a given location.**

**In addition to system initiation, the KS10 differs from the KL10 in that the KS10 employs a microprocessor-based simulator of the larger 36-bit KL10 processor. The KS10 processor is built from AMD 2901 bit-slice microprocessors and is implemented on four printed circuit boards. In comparison, the KL10 processor requires 52 printed circuit boards.**

**The KS10 processor, because it is a simulator, is slower than the KL10 processor, giving the DECSYSTEM-2020 about one-half the internal performance of the DECSYSTEM-2040. The KS10 also includes a smaller cache memory than the KL10 (512 words compared to 2048 words), and the cache replacement algorithm implemented in the KS10 is not as sophisticated as the one implemented in the KL10 processor.**

**The actual processor employed in both the 2040 and the 2060 is the KL10-E.**

**CONTROL STORAGE: See Table 1.**

**REGISTERS: The KL10 and the KS10 processors have 128 integrated-circuit general-purpose registers, contained in 8 blocks of 16 registers each, that can be used as accumulators, index registers, or for other high-speed memory functions. Register blocks are assigned to the operating system and to individual user programs to provide for rapid context switching.**

**In addition, the KL10 has five clock registers that are used for accounting and performance evaluation. These include the interval timer, the time base, the performance analysis**

# Digital Equipment DECSYSTEM-20

marketing efforts for mainframes in the 80s should continue to concentrate on in-house time-sharing applications, with greater attention to batch and distributed processing.

Many potential DEC customers, particularly in DEC's targeted market areas, are used to purchasing or leasing their systems. And DEC customers, as indicated in the 1981 survey of computer users, prefer to purchase their systems by 5 to 1. DEC arranges both full-payout leases and monthly rental agreements, with the terms and prices quoted on an individual basis.

DEC's fundamental approach to the marketplace for the DECsystems is to avoid head-on encounters with IBM except upon DEC's terms. These terms specify a sophisticated user (generally in the top 20 to 30 percent of current computer installations) and one who generally meets the criteria outlined earlier. (For example, general-purpose commercial batch-oriented installations are definitely not sought after, if not actually discouraged.) Furthermore, DEC has historically been conservative in accepting business that is predicated upon heavy systems responsibility. This approach has resulted in a very high level of customer loyalty and has contributed to steady 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-20 at a pace satisfactory to DEC.

## USER REACTION

Response to Datapro's 1983 Computer System User Survey was received from 24 DECSYSTEM-20 users. A total of 36 systems were in use and had been installed for an average of over four years at the time of the survey. The distribution of system models was as follows: 2020, eleven users; 2040, one user; and 2060, sixteen users. Twelve users purchased their systems; ten leased from a third party; and two users did not indicate. Looking at a cross-section of the business types, the largest number of responses was in manufacturing followed by education, health care, chemical and service bureaus. Seventeen of the users were running accounting applications. The next most frequently reported applications were payroll, purchasing, mathematics and statistics, order processing and inventory control. Applications were usually developed in-house for all users as well as procured from a software vendor (about 63 percent).

All users reported they had local terminals installed, and 21 told us they also had remote terminals in use. Most users had some type of communications monitor, as well as a data base management system (DBMS). Half of the respondents used an outside vendor's DBMS system.

When asked their plans for 1983, better than half said they wanted more hardware and proprietary software. Slightly less than half wanted to increase their communications activities. All users except one did not plan to replace their DECSYSTEM-20s in 1983. One user planned to switch vendors.

**counter, and two accounting meters. The interval timer is a programmable interrupt source with an interval range from 10 microseconds to 4096 milliseconds; the time base is a one-microsecond-based time-of-day clock used by the monitor for system accounting; the performance analysis counter monitors either the duration or rate of occurrence of designated hardware conditions; the two accounting meters are the instruction processor meter, which measures the amount of instruction processor time used, and the memory reference meter, which measures user-program accesses to memory.**

**ADDRESSING: Programs are capable of directly addressing 256K words through the 18-bit address field in each instruction. These addresses can be indexed through any of 16 accumulators in each register set. Multi-level indirect addressing can be combined with indexing (preindexing).**

**INSTRUCTION REPERTOIRE: The KS10 processor uses 396 standard instructions and the KL10 processor has 398 instructions. All instructions are one word in length, and are capable fo directly addressing a full 256K of memory without resorting to base registers, displacement addressing, or indirect addressing. Instructions may, however, use indirect addressing and indexing to any level. Immediate mode addressing is provided where the result of the effective address calculation is used directly as an operand.**

**In addition, the Business Instruction Set includes four double-precision, fixed-point opertions and a string instruction that can be used for nine separate functions including editing, decimal to binary conversion, binary to decimal conversion, character detection, string move and string compare in both offset and translated mode. The Business Instruction Set affords faster processing because there are specific instructions for performing comprehensive string operations. Internal codes such as ASCII and EBCDIC can carry these instructions.**

**INSTRUCTION TIMING: In the table below, all timings are in microseconds and are for the executive mode, using direct addressing without indexing and assuming no effects for multiprogramming, such as segment relocation, etc.**

| **Fixed and Floating Point for 2040 and 2060** | |
|---|---|
| **Fixed-point add/subtract (36 bits)** | **0.43** |
| **Fixed-point multiply** | **2.1** |
| **Floating-point add/subtract (single precision)** | **1.57** |
| **Floating-point add/subtract (double precision)** | **2.0** |
| **Floating-point multiply/divide (double precision)** | **4.1/8.6** |
| **Jump** | **0.3** |

**Fixed and floating point instruction times on the 2020 are not available.**

**CACHE: The 2020 and 2060 systems include a fast-access MOS cache memory with 330- and 133-nanosecond access times, respectively. The 2040 does not have a cache memory. The cache is 2,048 words on the 2060 and 512 words on the 2020. On the 2060, the cache actually consists of four caches, each with a capacity of 512 words (or one page) that operate in parallel. Each cache is a two-dimensional array consisting of 128 horizontal lines and 4 vertical columns containing one word of data each. Data is loaded into the cache from main memory four words at a time, thereby providing an instruction lookahead feature.**

# Digital Equipment DECSYSTEM-20

**TABLE 2. MASS STORAGE**

| Subsystems | RM03 | RP06 | RP07 | RP20 | RA60 | RA81 |
|---|---|---|---|---|---|---|
| Cabinets per subsystem | 1 | 1 | 1 | 2 | 3 | 3 |
| Disk packs/HDAs per cabinet | 1 | 1 | 1 | 2 | 1-3 | 1-3 |
| Capacity: Bytes Words | 67MB* | 176MB* per drive | 498MB* per drive | 483MB* per spindle | 205MB* per disk | 456MB* per disk |
| Tracks/segments per drive unit | 823 per surface | 19 per cylinder | 537 per inch | 957 per inch | 779 per inch | 960 per inch |
| Average access time, milliseconds | — | 28.5 | 31.3 | 25.0 | 50 | 28 |
| Average rotational delay | — | 8.33 | 8.33 | — | 8.3 | 8.3 |
| Data transfer rate: Bytes/second Words/second | — | 806KB | 2.2MB | 2.0MB | 2.0MB | 2.2MB |
| Controller model | — | RH20 | RH20 | RH20/DX20 | HSC50 | HSC50 |
| Comment | Disk Pack Drive | Disk Pack Drive | Winchester Disk Drive | Winchester Disk Drive | Removeable disk | Winchester Disk Drive |

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As usual, DECSYSTEM-20 users told us they were quite happy with their systems. Some of the key areas of satisfaction were 1) ease of expansion/reconfiguration, 2) use of productivity aids to keep costs down and 3) good response time. Just about everyone (21 out of 24 users) felt the system performed as expected. Three indicated they haven't decided. Eighteen users said they would recommend the system to another user, five said they haven't decided, and one said he would not. A summary of the user ratings on the DECSYSTEM-20 appears in the following table.

| | Excellent | Good | Fair | Poor | WA* |
|---|---|---|---|---|---|
| Ease of operation | 17 | 7 | 0 | 0 | 3.71 |
| Reliability of mainframe | 13 | 8 | 3 | 0 | 3.42 |
| Reliability of peripherals | 3 | 15 | 4 | 2 | 2.79 |
| Maintenance service: | | | | | |
| Responsiveness | 7 | 11 | 5 | 0 | 3.09 |
| Effectiveness | 5 | 13 | 4 | 1 | 2.96 |
| Technical support: | | | | | |
| Trouble-shooting | 3 | 11 | 7 | 2 | 2.65 |
| Education | 2 | 7 | 12 | 2 | 2.39 |
| Documentation | 1 | 16 | 5 | 1 | 2.74 |
| Manufacturers software: | | | | | |
| Operating system | 14 | 10 | 0 | 0 | 3.58 |
| Compiler & assemblers | 6 | 15 | 3 | 0 | 3.13 |
| Application programs | 2 | 12 | 5 | 1 | 2.75 |
| Ease of programming | 12 | 9 | 2 | 1 | 3.33 |
| Ease of conversion | 5 | 10 | 4 | 0 | 3.05 |
| Overall satisfaction | 9 | 14 | 1 | 0 | 3.33 |

Weighted Average on a scale of 4.0 for Excellent.

The popularity of DEC's mainframe systems is apparent in the industry, and the results of our 1983 survey again bear this out, with an overall satisfaction rating of 3.33. To find out more reasons why the DECSYSTEM-20 has such strong support, Datapro telephoned several users around the country for their comments.

**PAGING: The KL10 adn KS10 processors provide a mapping capability from physical memory address of up to 4 million words (which require 22 bits for representation) to shorter effective addresses contained in 18 bits. The most significant half of the 18-bit effective address is used as an index to a page table which contains up to 4096 physical page numbers. The referenced physical page number is concatenated with the low-order 9 bits of the effective address (which indicates one of the 512 words on a page) to produce a 22-bit main memory address that can reference any of the 4 million words.**

**PROCESSOR MODES: The KL10 and KS10 processors have two modes: User Mode and Executive Mode. The Monitor operates in the Executive Mode, in which addresses are not relocated and all memory locations are accessible. User programs execute in the User Mode, and are relocatable and subject to memory protection restrictions. 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 TOPS-20 Monitor, which handle system I/O and any functions which affect all users of the system. The rest of the 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 permits the execution of all instructions except those which would cause interference with other users or the integrity of the TOPS-20 Monitor. User Mode is subdivided into the Public Submode and the Concealed Submode. Concealed Submode protects any program in that category from being copied or modified, even by the program itself, and is normally used for proprietary software. Concealed Submode programs can read, write, execute, and transfer to any Public location, while Public programs can access addresses in Concealed programs only by transferring to locations which have ENTRY instructions. In User Mode, a program can access up to 256K words.**

**INTERRUPT STRUCTURE: The KL10 and KS10 have seven standard prioritized channels associated with the I/O**

# Digital Equipment DECSYSTEM-20

## TABLE 3. INPUT/OUTPUT UNITS

| Magnetic Tape Units | Number of Tracks | Recording Density, Bits/Inch | Encoding | Tape Speed Inches/Sec. | Transfer Rate, Bytes/Sec. |
|---|---|---|---|---|---|
| TU72 | 9 | 1600 | PE | 125 | 200,000 |
| TU72 | 9 | 6250 | GCR | 125 | 750,000 |
| TU77 | 9 | 800 | NRZI | 125 | 100,000 |
| TU77 | 9 | 1600 | PE | 125 | 200,000 |
| TU78 | 9 | 1600 | PE | 125 | 200,000 |
| TU78 | 9 | 6250 | GCR | 125 | 781,250 |
| **Printers** | **Printing Speed** | **Print Positions** | **Horizontal Spacing, Chars./Inch** | **Vertical Spacing, Lines/Inch** | **Form Size, Inches** |
| LP14 | 660 or 900 lpm | 132 | 10 | 6 or 8 | 4 to 16.75 width |
| LP26 | 450 or 600 lpm | 132 | 10 | 6 or 8 | — |
| LP07 | 1500 lpm | 132 | 10 | 6 or 8 | 5.25 to 18.75 width |
| LP27 | 800 or 1200 lpm | 132 | 10 | 6 or 8 | 3.5 to 18.75 width |
| LP05 | 300 lpm | 132 | 10 | 6 or 8 | 4.0 to 16.75 width |
| **Punched Card Equipment** | **Columns** | **Speed Cards/Min.** | **Input Hopper Capacity** | **Output Stacker Capacity** | **Options** |
| CD20AA (tabletop) | 80 | 300 | 1000 | 1000 | — |
| CD20CA (free-standing) | 80 | 1200 | 2250 | 2250 | — |

A service bureau vice president in New England was most responsive to our phone inquiry regarding his DECSYSTEM-2060. The firm services companies in construction, engineering, manufacturing, retailing, and professional legal and accounting firms. He expressed a good deal of satisfaction with his DEC equipment indicating that he felt the "reliability of the hardware and software is excellent," with no major downtime experienced in five years. He was also very satisfied with the TOPS 20 operating system, and felt it was user friendly.

A hospital in the East selected a DECSYSTEM-20 last year primarily for use as backup to critical jobs running on other inhouse DEC systems. This organization stated they have used DEC equipment for approximately 10 years and have been very satisfied with the performance of both the hardware and the software.

Because it is a backup system, the DP manager indicated it is deliberatley not fully utilized so that critical jobs such as direct patient care applications, on-line lab results, etc., can be switched to this system if required. There are, however, some batch and interactive applications running. Approximately 10 or 12 terminal users have access to the system with as many as up to 32 terminals capable of being switched over in an emergency. It was noted by the user that Digital Equipment systems are very user friendly.

**bus that transfer interrupt signals between system devices and the I/O bus. The KL10 has an additional priority level (0) of higher priority than the seven programmable levels. This interrupt level is reserved for the front-end processor. 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 up to 135 Programmed Trap Instructions are available. 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.**

### INPUT OUTPUT CONTROL

**I/O CHANNELS: The DECSYSTEM-20 uses integrated channel controllers for tape and disk drives. These connect to the internal channel bus and operate either synchronously or asynchronously. Each controller has a 16-word buffer for input operations. The channel bus is a physically short, high-speed data path between the memory control unit and**

# Digital Equipment DECSYSTEM-20

A manufacturer in the midwest with a DECSYSTEM-2020 leased his equipment from a third party. Used for both manufacturing and accounting type of applications, his application programs include packaged programs from the manufacturer, house developed packages along with programs from outside vendors. He rated his system good for the most part, but was only partially satisfied with ease of conversion.

Another respondent was a health care service in California whose work consists in part of accounting, insurance, underwriting, productivity reporting and statistical-type applications. This manager indicated that his organization had experience on the DEC 10 series via an outside time-sharing service, and selected the DEC 2040 because the programs were transferrable, and because his organization needed greater processing power. He noted that a good source of information on DECsystems and software was from the DEC Users Group, because the Group was so helpful in sharing information; and he would encourage potential DEC users to talk to members of this group.□

**the integrated controllers. It has a peak I/O bandwidth of 6 million 36-bit words per second, and operates synchronously in a time-division multiplexing mode, permitting multiple concurrent memory accesses by the mass storage controllers.**

**The basic DECSYSTEM-20 is provided with integrated controllers, capable of handling either disk or magnetic tape. Depending on the model, up to eight disk or tape drives can be connected to a disk controller. Four TU78 tape drives can be connected to a tape controller. In turn, two tape controllers can be connected to a tape channel, thereby placing up to eight tape drives on a single channel.**

**Only high-speed mass storage devices are connected to the internal channel bus. On the 2040 and 2060, all low-speed devices interface through the PDP-11 front-end processor that is incorporated in the system. On the 2020, all devices are interfaced through Massbus/Unibus adapter except the I/O console. Low-speed devices offered with the DECSYSTEM-20 include line printers, a card reader, and communications lines. A card punch and paper tape reader/punch are also offered and are connected through a separate I/O interface.**

**SIMULTANEOUS OPERATIONS: Each of the integrated controllers is capable of transferring data to or from memory through direct memory access. DECSYSTEM-20 main memory is single-ported, but the 2040 and the 2060 memory control units can queue four words transferred sequentially over the bus from the M—box and write these four words are read from MOS storage simultaneously. In a read cycle four words are read from MOS storage simultaneously and are queued for sequential bus transmission to the M—box. The 2020 memory writes or reads only one word in MOS storage per cycle.**

## CONFIGURATION RULES

**2020: Devices integral to the processor cabinet in addition to the KS10-A processor include up to 512K words of MS10 memory (64K, 128K, or 256K words are optional), the console subsystem and two Unibus adapters. The first RM03 of RP06 disk drive is bundled in the system package. RM03s and RP06s may be mixed on the same system. Maximum configuration is 8 disk drives per system. Disk drives are attached to the 2020 via the RH11-C Massbus Adapter, which connects to one of the two Massbus/Unibus adapters.**

**A TAU77-EC/ED Master Tape Drive must be ordered with each package system as field service contracts require one tape drive. Maximum configuration is 4 tape drives per system. The LP14 and LP26 are the only line printers supported on the 2020 at this time. DEC Field Service contracts require a hard copy printer device. Maximum configuration is one line printer per system. The DNHXX-AA/AB Expansion Cabinet is required and used only for the card reader controller. Maximum configuration is one card reader per system. The first 16 asynchronous EIA communication lines are bundled in the system package. Maximum configuration is 32 asynchronous lines per system. The additional 16 lines are provided by DZ11-AA (8 lines) and DZ11-BA (8 lines). Up to two synchronous lines may be attached through the DN20-BA (one line) and DN20-BB (one line). Synchronous lines operate under TOPS-20 only, and require the DECnet-20 software package (QTD20-AM). The magnetic tape subsystem, printer, communications lines, and punched card equipment are all attached through the second Massbus/Unibus adapter.**

**2040 and 2060: With the exception of cache memory, both systems share similar components: 1) up to 3072K words of memory, 2) a PDP-11 front-end processor, 3) synchronous front ends, 4) eight peripheral massbusses (include one tape and one disk drive interface standard, and 5) one optional I/O interface. A chache memory is provided in the 2060 only.**

**Both the TU72 and TU78 tape systems can be connected to the 2040 and 2060. Each TU78 tape controller can have a maximum of four TU78-AF/AJ tape drives. These systems may be varied in configuration but must not exceed 12 tape drives per channel. On a second channel up to eight TU72 tape drives can be connected to a TX02 tape controller.**

**When using the high-capacity RP20 disk drives: 1) only one RTP20 controller/drive per RH20 channel can be connected, 2) the RTP20 controller cannot share the RH20 channel with any other device, 3) as many as six RTP20 controllers can be connected to a KL10 CPU, 4) the remaining two RH20 channels on a KL10 must be used for an RP06 disk drive and any tape drive, and 5) the RP20 drive cannot be used as a front-end device, hence the need for at least one RP06 drive.**

**Up to two line printers and either one card reader or paper tape reader/punch can be connected. The I/O console and all asynchronous lines are attached through the PDP-11 front-end processor. The DN20-C synchronous front-end handles up to eight lines in the 2040 and 2060. Each line can support up to 56K bps, in several combinations.**

**The rules for asynchronous communications on the 2040 and 2060 are contained in the following table.**

| | Features required | | | |
|---|---|---|---|---|
| Async. Lines | DC20AA | DC20DA | DC20CC | DC20-EC/ED |
| 16 | 1 | 1 | | |
| 24 | 2 | 1 | | |
| 32 | 2 | 2 | | |
| 40 | 2 | 2 | 1 | 1 |
| 48 | 2 | 3 | 1 | 1 |
| 56 | 3 | 3 | 1 | 1 |
| 64 | 3 | 4 | 1 | 1 |
| 72 | 4 | 4 | 1 | 1 |
| 80 | 4 | 5 | 1 | 1 |
| 88 | 5 | 5 | 1 | 1 |
| 96 | 5 | 6 | 1 | 1 |
| 104 | 5 | 6 | 1 | 2 |
| 112 | 5 | 7 | 1 | 2 |
| 120 | 6 | 7 | 1 | 2 |
| 128 | 6 | 8 | 1 | 2 |

# Digital Equipment DECSYSTEM-20

On all DECSYSTEM 20 processors, hardware internally is EIA with support for EIA lines and terminals only. All 20ma current loop terminals must be converted to EIA for use with DECSYSTEM-20. For asynchronous speeds up to 2400 bps, cabling must not exceed 1000 feet; for asynchronous speeds up to 9600 bps, cabling must not exceed 250 feet.

## MASS STORAGE

Disk drives are listed in Table 2.

## INPUT/OUTPUT UNITS

Magnetic tape units, printers, and punched card equipment for the DECSYSTEM-20 are listed in Table 3.

LA38 DECWRITER IV HARD-COPY TABLE-TOP TERMINAL: The LA38 is designed for entry-level applications with a maximum print speed of 30 characters per second. This model is an addition to the DECwriter IV series and features serial printing by 9-by-7 dot matrix, a 128-character buffer, and communication speeds of 110 or 300 bps. In the LA38, paper movement is by use of tractor feed. The unit prints 128 ASCII upper-and lower-case characters. The LA38 also has a 19-key pad for rapid entry of numerical data. Like other terminals from DEC, the LA38 is microprocessor-based and incorporates a self-check feature as standard.

LA120 DECWRITER III: This terminal has a maximum print speed of 180 characters per second. It is designed for hightly interactive time-sharing applications. The standard character set features 128 ASCII symbols, uses a 7-by-7 dot matrix bidirectional printing mechanism, and a tractor paper-feed. The LA120 uses 132 print positions, and will accept data at 15 standard rates between 50 and 9600 bps; a 100-character buffer is standard, with 4000 characters optional. The LA120 is microprocessor-based and incorporates a self check feature as standard. The LA120 uses a typewriter-style keyboard with optional 14-key numeric pad. The keyboard generates any of 128 ASCII character codes. Control functions include Line Feed, Return, break, Escape, Repeat, Caps Lock, Tab, Delete, Bell, Space, Backspace, Shift, and Control Shift. The keyboard also contains a cluster of 8 function keys and 5 status indicators.

LA120-RA DECPRINTER RECEIVE-ONLY TERMINAL: The LA120-RA is a serial impact printer that prints at the rate of 180 characters. It is a matrix unit that prints the full 128 characters per second. ASCII set using a 7 x 7 dot matrix. It also prints rows of 132 characters. Horizontal spacing is 10 characters per inch, and vertical spacing is 6 lines per inch. The LA120-RA will accept data at standard rates between 110 and 9600 bps. Operation can be full duplex, half duplex, or echoplex. The LA120-RA is manufactured by DEC.

For additional details on the LA38, LA120, and LA120-RA teleprinters, please see Report 70D3-384-01.

VT100 VIDEO DISPLAY TERMINAL: This performance-oriented family of terminals contain 12-inch screens with either 80 characters by 24 lines or 132 characters by 14 lines displays and detachable keyboards with 18-key numeric/function keypads. The VT100 displays a 7 x 9 dot matrix character font on a 10 x 10 space, and includes a large variety of standard and optional features. Data rates range from 50 to 19,200 bps. The asynchronous terminal is equipped with an EIA RS-232-C or 20ma current loop interface. All operating parameters are established via the keyboard in the Set-Up mode. The VT100 is manufactured by DEC. For more details, refer to Report 70D2-384-01.

## COMMUNICATIONS EQUIPMENT

All terminals, including the operator console terminal, connect to the 2040 and 2060 through the PDP-11 front-end processor. The DC20 communications subsystem interfaces all system terminals.

DC20 COMMUNICATIONS SUBSYSTEM: The interfaces in this system support up to 128 asynchronous lines on the model 2040 and 2060. The DC20-AA multiplexer is standard with both systems and terminates 8 lines. It can be expanded to 16 lines using a DC20-DA8-line expansion unit. Through additional DC20-AA and DC20-DA units, plus up to three DC20-EC expansion cabinets, the maximum of 128 lines can be obtained.

DZ11 ASYNCHRONOUS LINE INTERFACE: These devices are designed exclusively for the DECSYSTEM 2020. Up to 32 lines can be connected to a 2020 that can be programmed to handle anywhere from 50 to 9600 bps. Controls are provided for the operation of a 300 bps data set (Bell 103 or equivalent).

DN20 DATA COMMUNICATIONS FRONT END: Two different processors are available for synchronous communictions: the DN-20 CA, with 32K words of core memory, and the DN20-MA, with 1238K words of MOS memory and used with DECnet-20 Version 2. Up to two DN20-CA or DN20-MA processors can be connected to a 2040 or 2060. The DN20-CA can support up to 1 DECnet line and the DN-20-MA can support up to 8. Up to 6 bisync lines (2780/3780) are supported on both processors under TOPS-20. When the system is running 2780/3780/HASP the maximum number of lines on each processor is 4 running 2780/3780 and 2 running HASP, DECnet-20, 2780/3780, and 2780/3780/HASP software is ordered separately. Transmission speeds ranging from 2400 to 1,000,000 bps can be supported.

DN200 REMOTE STATION: Used for remote job entry (RJE) operations, this terminal is connected to DN20 front end and si supported by the TOPS-20 software. The DN200 can connect up to 2 synchronous and 32 asynchronous lines, in various combinations, and can support a card reader and line printer as well. Up to 12 DN200s can be configured per DN20.

## SOFTWARE

The DECSYSTEM-20 has a virtual-memory, multi-mode operating system and an extensive repertoire of programming languages and utilities. Included among the languages are Fortran, Cobol, Algol, APL, Basic, BLISS, a version of PL/1, and a macro-assembler. These languages are all priced separately. The operating system TOPS-20, includes features that support full-language time-sharing for program development and for interactive and terminal-oriented applications, as well as concurrent multi-stream batch processing.

TOPS-20 has been designed to function as a stand-alone system with minimal operator requirements. Any remote or local user terminal can function as the operator console simply by identifying itself as the console, and more than one terminal can perform console functions. The system

# Digital Equipment DECSYSTEM-20

treats all terminals equally, and relies on passwords from users to determine authority rather than accepting commands only from designated priviledged terminals. Certain functions can be restricted to specific terminals on an individual basis, though.

TOPS-20 is a full virtual-memory, process-structured monitor. The interface to the command processor is highly interactive, providing prompting at any point during the specification of a task or job.

An important feature of TOPS-20 is memory space reduction. Significant portions of the TOPS-20 operating system including the command processor, are non-resident and are brought into main memory through demand paging in the same manner as user programs. The system also makes use of re-entrant program modules, but still can generate private, dedicated copies of pages within modules whenever integrity is threatened.

The major portions of TOPS-20 include the following components:

- System Scheduler: Controls the scheduling of processes using either a single-level dynamically-recomputed scheduling algorithm or an accounting system-based "class" scheduler. The Scheduler determines which user program is to be run during a given interval. In addition to the scheduling algorithm, two other components are used. The Memory Allocator provides access to sharable system resources and the Context Switcher saves and restores program conditions when paging.

- Page Manager: The Page Manager is responsible for all transfers of disk pages from memory to disk and back. It moves jobs between disk and main memory after the Scheduler determines which user programs are to be in memory for a job to run. The Page Manager also determines which programs are to be removed from memory based on their inactivity and scheduling priority.

- I/O Service Routines: These routines process user program requests for I/O devices, and consist of three noncyclic routines. The System Call Handler traps user service requests to the operating system and is the only means by which the user can switch to Exec Mode for operating system service. Input/output routines are initiated by the System Call Handler to manage data transfers between peripheral devices and user programs in memory. The disk I/O service routine includes optimization techniques for disk accesses, which according to DEC result in 25 to 50 percent 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 logical device names and allows the user to have device independence. The File Handler permits users to define protected output files for permanent storage.

- TOPS-20 File System: Provides up to 4000 user accounts/directories per structure on a 2020 or 2040 and up to 12,000 on the 2060. The file system provides a multi-level directly structure and interuser security through directory and file access protection mechanisms.

- Common File System, CPS-20: This system supports Loosely Coupled Systems (LCS) in multiprocessor configurations by managing the file systems in the multiprocessor environment.

- RSX-20F Operating System: This feature of TOPS-20 controls the front-end processor of the 2040 and 2060.

- TOPS-20 Exec: Implements the system command language for interactive and batch processing. The Exec also provides file handling, and operator level, and system information commands.

- Device Allocator: This feature schedules and allocates requests for peripheral device usage.

The DECSYSTEM-20 Monitor allows three basic concurrent modes of operation: interactive time-sharing, batch, and remote communications. Up to 128 interactive terminals can be handled by the Monitor. The DECSYSTEM-20 Monitor, as well as the Command Language for the Monitor, is common to all modes of operation. This hierarchy of capabilities within one operating system, as well as the flexible hardware boundaries between the models, permit relatively simple upward growth 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.

In multiprogramming mode, users are scheduled on a modified round-robin basis by the queue manager program, using disk to hold paged-out segments. Control informtion is passed through the Executive Bus to initiate swapping or memory transfers. Multiprogramming batch mode allows operation of up to 14 jobs concurrently with time-sharing. 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.

TOPS-20 provides a demand-paged virtual memory environment that allows each job a unique 256K-word address space in 512-word pages. The system divides the pages of each active job into two groups, the working set and the balance set. The working set consists of all pages that have been referenced within a particular recent time interval.

Memory mapping and page-level access protection are provided through hardware and microcode. These features permit page sharing between programs and reduce context switching overhead. Page status and age information are maintained in tables and are automatically updated for each page in main memory by microcoded routines. The system is supported by two hardware registers in the KS10 and KL10 CPUs that contain pointers to locate the physical pages in memory which contain mapping information for the operating system and the currently active user.

TOPS-20 GALAXY MULTIPROGRAMMING BATCH PROCESSING SYSTEM: Enables the DECSYSTEM-20 to execute multiple batch jobs with time-shared jobs. GALAXY is executed as a single-user job and uses the same command language as time-shared programs. Batch users can enter jobs using traditional card decks, with control cards defining the command options for a job, or create and submit a control file through a user terminal. This control file is then intercepted by the batch system and processed in the same manner as a job submitted on cards. GALAXY also provides automatic line printer and card reader spooling plus job accounting functions. Jobs can be run in any order, and the user may specify the number of times each job is run.

TOPS-20 LINK: Besides the standard loading functions, Link provides a single-region tree-structured overlay facility; load-time defined overlay structure independent of Fortran, Cobol, or Algol programs; a diagramming facility to portray the program overlay structure; and relocatable overlays.

# Digital Equipment DECSYSTEM-20

TOPS-20 SORT/MERGE: A disk sort utility which operates stand-alone or in configuration with Cobol-68/74 and Fortran-IV, Sort/Merge reorders the records as ASCII files, six-bit files, EBCDIC files, and binary files produced by Cobol and Fortran in a sequence determined by the sorting parameters prepared by the user. Sort/Merge automatically controls the use and allocation of disk work space with user specified memory limits. The merging of files into a single sorted file can be invoked either standalone or via the Cobol MERGE verb. Optional support of magnetic tape for input or output is provided by Sort/Merge.

ALGOL-60 (under TOPS-20): Consists of a one-pass, single-phase compiler capable of processing up to 5,000 Algol lines per minute, according to DEC; this speed assumes disk I/O with 24 unpacked significant symbols per line. Algol-60 on the DECSYSTEM-20 also features a built-in debug utility. The minimum hardware required for Algol-20 is a 128K-word system.

APL-BASIC AND APL-SF (under TOPS-20): A conversational programming language that is particularly well suited for operating on numeric and character array-structured data, the DEC APL system runs under the DECSYSTEM-20 time-sharing Monitor, APL-BASIC and APL-SF differ primarily in the APL-SF support of file I/O, APL-SF provides user level file access to standard ASCII sequential files, internal format random access files, internal format sequential files, binary random access files, and immediate-mode I/O via any supported output device through the OUTPUT command.

BASIC-20: This is an extended implementation of the language. It is fully re-entrant, and provides these additional features: sequential access file handling for both data and text, random access capability for numeric and string files, file opening and closing under program control, string handling capability, and up to nine files open simultaneously. The minimum hardware required for BASIC-20 is 96K words of main memory.

BLISS-36: A high-level language developed by DEC for building compilers, realtime processors, utilities, and operating systems. BLISS is intended to complement DEC's other languages, such as Cobol, Fortran, or Basic. Programs written in BLISS can be compiled and executed either in batch or interactive mode under TOPS-20.

FORTRAN (F-77): A new Fortran compiler that contains extensions to the ANSI 1966 Fortran-IV standard plus global and local optimization capabilities for improving execution times. Both the compiler and Object Time System are re-entrant. Fortran under TOPS-20 requires a 96K-word DECSYSTEM-20.

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 PLUS—2 (under TOPS-20): Compatible with the BASIC PLUS-2 compiler developed for the DEC PDP-11 minicomputers. Some of the features included in this latest Basic compiler include program manipulation commands that permit saving, running, and retrieving Basic programs; immediate mode statements to simplify debugging; optional automatic line-by-line syntax checking; up to 30-character variable names; and IF/THEN/ELSE programming constructions. BASIC PLUS-2 Version 2.1 is the latest update, and includes Record Management Service (RMS), which permits sharing of indexed files with Cobol-68/74 Version 12B using multikey ISAM. The minimum hardware required for BASIC PLUS-2 is 128K words of main memory and allocation of 50K words of permanent file storage.

COBOL-68, COBOL-74 (under TOPS-20): A complete implementation of American National Standard Cobol X3.23 (Level 4). Both the 1968 and 1974 versions are implemented. 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 can be used for line-by-line compilation or for batch compilation. The latest Cobol update, Version 12B, includes support for Record Management Service (RMS) Version 1.0, conforms to federal specifications FIPS Pub. 21-1, and includes a flagging capability to highlight errors in syntax. The minimum hardware requirement is any DECSYSTEM-20 with 96K words of memory.

CPL (under TOPS-20): DEC's Conversational Programming Language is an interpreter supporting a subset of the ANS PL/1 language. CPL is designed for beginning programmers or even nonprogrammers. It provides users with the option of immediately executing statements or saving them in a file for later execution. Nearly all PL/1 arithmetic, mathematical string-handling, array, and storage control functions are supported by CPL. The minimum hardware requirements for CPL are a 128K-word system, with at least 50K words available as user space and 50K words of permanent file storage space.

DECmail/MS: A set of tailorable software programs used to send and receive messages to local users and, on DECSYSTEM-20s across networks. DECmail/MS provides facilities for filing, retrieving, editing, and discarding of messages through the use of English-like commands and prompting capabilities.

DECNET-20: DECnet permits users to create communications networks merely by adding appropriate software and hardware to existing computer systems.

DECnet allows customers to:

- Transmit data files across a room or around the world, with less expense and greater speed than is generally possible through other media.
- Share expensive peripherals among several CPUs, some of which may be remote.
- Use another tool in the creation of high-availability (super-reliable) systems, adding to the Unibus links and multi-port options that Digital already supplies.
- Make more extensive use of memory-only systems.
- DECNET Phase III protocols support network topologies with multi-passing and route-through.

DECnet is also the collective name for the set of software products which extend various DEC operating systems so they can be interconnected with each other to form computer networks. The DECnet user can configure a variety of networks by choosing the appropriate CPUs, line interfaces (and speeds) and operating systems software. Such networks typically fall into one of three classes: 1) those that move data from one physical location to another; 2) file-oriented networks, often the case for remote job entry systems; or 3) line-oriented networks, as occurs with the concentration of interactive terminal data.

# Digital Equipment DECSYSTEM-20

DECnet programs are designed to simplify network configuration and generation and to provide computing networks for industrial, commercial, scientific, and educational markets. The programs allow "dynamic reconfiguration," the ability to switch lines without interrupting service in case of malfunction. A full point-to-point interconnect capability allows disk-to-task communications by which programs running on separate networks can exchange data. Remote resources access for use of peripherals at another node and remote sequential I/O files are also supported.

DECnet-20 supports full-duplex transmission in point-to-point operation using serial synchronous facilities. On a DECSYSTEM-2040/2060, DECnet-20 supports one point-to-point link. On a DECSYSTEM-2020, two point-to-point synchronous links may be supported with the proper hardware configuration. Only one physical link may connect any pair of nodes.

The synchronous line units interface to Bell System 208A modems for operation at speeds up to 4.8K bps to ICC COMLINK II modems for speeds up to 19.2K bps, and to Bell 303 modems (using a CCITT V.35 converter), for speeds in excess of 19.2K bps. Equivalent modems can also be used.

DECnet-20 is implemented as an ancillary process under TOPS-20 with Digital-supplied monitor-level components and user-level utilities. DECnet-20 is implemented in two forms: for the DECSYSTEM-2040/2060. DECnet-20 resides in part in the central processor and in part in a dedicated communication front-end, the DN20; for the DECSYSTEM-2020. DECnet-20 resides entirely in the central processor.

TOPS-20 2780/3780/Multileaving: Enables a DEC-SYSTEM-20 equipped with a DN20 communications front end to submit 2780/3780 remote entry jobs to an IBM 360/370 and to process jobs submitted from 2780/3780 terminals.

TOPS-20 2780/3780/HASP Multileaving: Enables a 2020 with TOPS-20 to act as a remote station to an IBM host in emulation mode. DN22 also allows the 2020 to act as a host and ommunicate with 2780/3780 or HASP-multileaving style terminals to termination mode. With DN22, two communications lines are provided in any mix of emulation or termination. DN22 requires one DN20-B synchronous line from the 2020 with either synchronous modems for remote use or a single synchronous null modem for local use.

TRAFFIC-20 (TRANSACTION ROUTING AND FORM FORMATTING IN COBOL): A collection of CRT screen formatting and program-to-program communications subroutines available to DECSYSTEM-20 Cobol programs. Traffic-20 includes a set of Transaction Formatting Routines; a set of Transaction Routing Routines, and a stand-alone utility program for defining and saving CRT screen format descriptions. The Transaction Formatting Routines enable a Cobol program to send formatted CRT displays to and receive data messages from user terminals. The Transaction Routing Routines enable a Cobol program to send and receive packets to and from cooperating Cobol programs.

DATA BASE MANAGEMENT SYSTEM: DBMS-20 is a full-scale data base organization and management system that uses both Cobol and Fortran as host languages and provides a data management language (DML) based largely upon the April 1971 Codasyl Data Base Task Group (DBTG) specifications. DBMS-20 supports hierarchical data structures in simple tree format or in more complex network structures and provides a high degree of data independence from physical devices as well as user application programs. Owner and member relationships are defined by chained pointers. DBMS-20 permits access to data through the DIRECT, CALCULATION, or VIA set location modes, permitting clustering of records normally accessed in groups. In addition to the Schema, multiple subschemas can be associated with the Schema to minimize the program modifications required due to the addition of data and new relationships to the files. A temporary subschema area is used to permit program testing on data without jeopardizing the integrity of the data base. A detailed analysis of DMBS-20 can be found in Report 70E-384-01.

IQL-20: The DEC Interactive Query Language is an information retrieval and report writing system that uses English-like requests to read a file or group of files and process data contained in those files. IQL-20 extracts, summarizes, reorganizes, and copies file information, and produces reports in specified formats. The language interfaces both the file management system of the operating system and DBMS-20. Data files can be sequential DBMS data bases, or index-sequential with fixed and/or variable record length. IQL-20 can perform sorting; conditional processing; computation, including multiply and divide; perform built-in functions, such as tallies, totals, and averages: generate multiple reports in nine or more formats; perform matrix reporting through manipulation of summaries or individual items; define, modify and examine dictionaries for the pre-sorting of files, records, or items; and operate in either interactive or batch mode.

IQL-20 contains a DBMS interface. In interactive mode, IQL operating under control of a terminal front-end module can define dictionaries reflecting schema files for DBMS data bases.

## PRICING

CONTRACT TERMS: DEC offers a purchase agreement for immediate ownership of the DECSYSTEM-20, conditional sales agreement, and full-payout accrued-equity lease contracts. The conditional sales agreement is used primarily by non-profit institutions and state and local governments. This agreement carries a three- to seven-year term and is noncancelable with the title passing to the user, DEC retaining a security interest. The most common is a five-year accrued-equity contract that yields DEC a full payout in four years. An end-of-contract option permits the direct purchase of the system for the then-fair market value, which DEC estimates will be 10 percent of the original purchase price. The montly charges for accrued-equity contracts for new DECSYSTEM-20 systems are negotiated on an individual basis in order to reflect prevailing interest rates. These full payout leases may extend from three to seven years and are noncancelable. Five years is typical. There are no extra-use charges for the equipment, although maintenance contracts can be negotiated for any amount of daily maintenance from 8 to 24 hours (see below). Liberal educational discounts are given to qualified institutions.

SOFTWARE: A system software package is included with each system. This package includes the TOPS-20 operating system with the GALAXY batch processor, the linking loader, editor, and other utilities; and the macro assembler. All other language processors and the SORT utility are licensed separately. License fees are listed in the Software Prices section of this report.

USER GROUP: The worldwide DEC Users' Society (DECUS) was founded in 1961 and currently has about 30,000 members in over 40 countries. This group is directly supported by DEC and schedules two international meetings annually in addition to publishing a bi-monthly newletter, DECU-SCOPE. DECUS is composed of four chapters (listed below), special interest groups (such as the DECsystem

# Digital Equipment DECSYSTEM-20

interest groups (such as the DECsystem 10/20 Group), local users groups, and the national users group. Symposia are held throughout the year in each of the DECUS chapters. The DECUS Program Library Catalog lists more than 2,600 programs written by DEC users, most of which are available at no charge, or in some cases for a nominal handling fee. DECUS Membership is limited to DEC users, although some meetings are opened to general attendance. Inquiries should be directed to:

DECUS Austrialia

P.O. Box 384

Crows Nest

New South Wales 2067 Australia

61-2-439-2566

DECUS Canada

P.O. Box 11500

Ottawa, Ontario

K2H 8K8 Canada

613-592-5111 Ext. 2115

DECUS Europe

12 Avenue des Morgines

C.P. 510

1213 Petit-Lancy I

Geneva, Switzerland

022-93-33-11

DECUS U.S.

One Iron Way

Marlboro, Massachusetts 01752

617-467-5111

SUPPORT: System software is installed by DEC, followed by 90 days of software warranty support. The warranty support includes telephone and on-site assistance, and software maintenance periodicals, documentation, and software product updates that are released during the software warranty period.

Included with each system is a consulting services package that provides up to 50 days of applications consulting support to aid users in development of their aplications software. These 50 days must be used within one year of operating system installation.

The types of service offered by DEC include the following: Self-Maintenance Service for Software (SMS) is designed for companies with the technical expertise to maintain their own system. SMS provides software product and documentation updates, program change orders, dispatches (bi-monthly), and software performance reports. Self-Maintenance Service is available for $238 per month.

Basic Maintenance Service provides for a higher level of service than SMS. Basic Service is designed for companies with the technical expertise to maintain their own system with occasional help. Basic Service provides telephone support, software product and documentation updates, program change orders, dispatches (bi-monthly) and software performance reports. Basic Maintenance Service is $475 per month.

DEC Support Service for software is designed for companies who require uninterrupted system performance, yet do not want the added expense of training and maintaining their own staff. DEC support provides scheduled preventive maintenance, on-site remedial support, telephone support, software product and documentation updates, program change orders, dispatches (bi-monthly), and software performance reports. DEC Support Service is $925 per month.

Ninety days of installation support (warranty) are provided at no charge following delivery of a system on an 8 hours per day, 5 days per week basis. More intensified coverage over a shorter period of time is also available (for example, 24 hours per day, 7 days a week for 50 days). Thereafter, systems integration assistance and field support by DEC's Systems Engineering Group are available at several prices, depending upon the level of support provided.

The DECservice agreement for hardware provides on-call remedial maintenance between 8 a.m. and 5 p.m. and preventative maintenance between 8 a.m. and 8 p.m., both Monday through Friday.

Remedial efforts will continue until the problem is corrected. There is a guaranteed four hour response for service calls placed during the contract period and on-call maintenance on a best effort basis at per call rates with no charge for materials outside the contract period. The following table gives premiums to be added to regular rates (Monday-Friday, 8 a.m.-8 p.m.) for service outside the standard period.

**DECservice**

| Guaranteed response times | 4 hours | 8 hours | 16 hours |
|---|---|---|---|
| Distance From Service Center | 0-100 mi. | 101-200 mi. | Over 200 mi. |

**Eight hours per day five days per week uplifts**

| | 16 hours | 24 hours |
|---|---|---|
| Five days | 8% | 16% |
| Seven days | 30.4% | 43.2% |

The basic service agreement for hardware provides maintenance between 8 a.m. and 5 p.m. Monday through Friday and priority response (typically next day) during hours of coverage.

EDUCATION: Each DECSYSTEM-20 user is entitled to 10 man-weeks of training. On-site training, including course materials, is provided for specialized customer requirements at individually arranged rates.

Currently available courses include the DECSYSTEM-20 User Course, Administration Course, Assembly Language Programming, Programming, Operating System, Cobol, and Operator Course.

UPGRADE POLICY: DEC offers a trade-in policy giving credits toward the purchase of more advanced DECsystem

# Digital Equipment DECSYSTEM-20

devices. Older PDP-10 equipment or slower DECsystem equipment may be upgraded to higher-performance devices. Traded-in equipment must be in generally good condition (i.e., DEC-maintained by Field Service) or is subject to a refurnishing charge. Allowances depend upon device type and vary widely from about 20 to 50 percent of the original purchase prices.

EQUIPMENT: The following systems are representative of the types of DECSYSTEM-20 configurations that are normally used and supported by the TOPS-20 operating system. All necessary controllers, processor features, and interfaces are included in the indicated prices.

MINIMUM DECSYSTEM 2020. Consists of KS10-A CPU with 256K words of MS10 Error Correcting MOS memory; a 14.89 megaword (67 megabyte) RM03 Disk Drive; a TAU77 magnetic tape subsystem; an LA120 DECwriter III Console Terminal; an LP20-A Line Printer; 16 asynchronous lines; the TOPS-20 operating system including the GALAXY batch system, link loader, editor, and utilities; the macro assembler; installation and 90-day warranty; and 50 days of application software consulting. Purchase price is $182,300 and monthly hardware maintenance charge is $1,572.

MINIMUM DECSYSTEM 2040: Consists of KL10-E CPU with 256K words of memory; and RP06-B 39.6 megaword Disk Drive; a TAU77 9-track, 800/1600 bpi tape subsystem; an LP20-A Line Printer; an LA120 DECwriter III console terminal; 16 asynchronous communications lines, asynchronous multiplexer; the TOPS-20 operating system including the GALAXY batch system, linking loader, editor, and utilities; the macro assembler; installation and 90-day warranty; and 50 days of application software consulting. Purchase price is $430,400 and monthly hardware maintenance charge is $2,850.

MINIMUM DECSYSTEM 2060: Consists of a KL10—E CPU with 2048 words of 160-nanosecond cache memory and 256K words of memory; an RP06-B 39.6 million-word disk drive; a TAU77 9-track, 800/1600 bpi tape subsystem; an LP20A Line Printer; an LA120 DECwriter III console terminal; 16 asynchronous communications lines; the TOPS-20 operating system including the GALAXY batch system, linking loader, editor, and utilities; the macro assembler; installation and 90-day warranty; and 50 days of application software consulting. Purchase price is $504,300 and monthly hardware maintenance charge is $3,008.

## EQUIPMENT PRICES

| | | Purchase Price | Monthly Hardware Maint.* |
|---|---|---|---|
| **PACKAGED SYSTEMS**** | | | |
| | DECSYSTEM 2020 Systems include the KS10-A CPU with 256 word virtual address cache memory, 384K words of 1.05-microsecond MS10 MOS Memory, and one integral data channel; an LA120 DECwriter III Console Terminal; 32 asynchronous communications lines; 10 training credits; hardware install 90-day warranty; software installation and 90-day warranty, one set software notebooks and 90-day software update service; five sets of manuals; 25-day consulting services package; utilities; and macro assembler; 3 software units | | |
| 2020 ME/MF | DECSYSTEM 2020 with one RP06 Disk Drive and TOPS-20 Operating System | 133,000 | 940 |
| | DECSYSTEM 2040 Systems include the KL10-E CPU with 512K words of 0.67 microsecond MF20 MOS Memory, and two integral data channels, an LA120 DEC- writer III Console Terminal; 16 asynchronous communications lines; TOPS-20 Operating System plus utilities and macro assembler; 10 training credits; hardware installation and 90-day warranty, software installation with 90-day warranty; one set of software notebooks and 90-day software updating service; five sets of manuals; and 50-day consulting services package. | | |
| 2040 SE/SF | DECSYSTEM 2040 with one RP06-B Disk Drive | 250,000 | 2,325 |
| | DECSYSTEM 2060 Systems include the KL10-E CPU with 133-nanosecond cache memory, 256K or 512K words of 0.67-microsecond MF20 MOS Memory, and two integral data channels; an LA120 DECwriter III Console Terminal; 16 asynchronous communications lines; TOPS-20 Operating System plus utilities and macro assembler, 10 training credits; hardware installation and 90-day warranty, software installation with 90-day warranty; one set of software notebooks and 90-day software updating service; five sets of manuals; and 50-day consulting services package. | | |
| 2060-PK/PL | DECSYSTEM 2060 with one RP06-B Disk Drive (256K word memory) | 446,000 | 2,257 |
| 2060-PH/PJ | DECSYSTEM 2060 with one RP06-B Disk Drive (512K word memory) | 466,000 | 2,470 |
| **SYSTEM UPGRADES** | | | |
| 2060-UA-UB | 2040 to 2060 Upgrade; includes cache memory (MCA-20) and TOPS-20 with extended features; may also include KLPV | 225,000 | |
| **MEMORY** | | | |
| MS10-BA | MOS memory modules for 2020 (error correcting): 64K words | 6,000 | 73 |
| | MEMORY FOR 2040 AND 2060: | | |
| MF20-LA/LB | Expansion controller (first backplane) with 256K-word memory module | 50,400 | 618 |
| MF20-LC/LD | Expansion unit (second backplane) with 256K-word memory module | 50,400 | 402 |
| MF20-LH/LJ | External expansion controller (first backplane) with 256K-word memory module | 50,400 | 618 |
| MF20-LK/LL | External expansion unit (second backplane) with 256K-word external memory module | 50,400 | 402 |
| MF20-E | MOS memory modules (two max. per backplane) | 30,000 | 244 |

*Monthly maintenance is 5-day, 12 hours per day DECservice except for 2020 packages and terminal products; MS10–BA, MS10–HA, MS10–LA, RM03–A, TAU77–EC/ED, DZ11–AA, DZ11–BA, DF01–A, LA38–G, LA38–H, LA120–BA, LA120–RA, VT100–A and VT1XX–A. For 2020 products, the quoted figure is DECservice for an eight hour day, 5 day week. For terminal products the quoted figure is the eight hour Basic maintenance.
**All minimum systems require a magnetic tape subsystem and a line printer in addition to the basic package.

# Digital Equipment DECSYSTEM-20

## EQUIPMENT PRICES

| | | Purchase Price | Monthly Hardware Maint.* |
|---|---|---|---|
| **MASS STORAGE** | | | |
| RP06-AA/AB | 39.6-megaword Add-On Single-Access Disk Drive for use with integrated controllers on 2020 and DH20 Controller on the 2040 or 2060 | 34,000 | 273 |
| RP06-BA/BB | 39.6-megaword Add-On Disk Drive; dual-access version of RP06-A above; max. 7 per subsystem | 39,140 | 302 |
| RP06-C | Dual-access kit, converts one RP06-A single-access drive to RP06-B dual- access drive; not for 2020 | 5,150 | 29 |
| RP07-AA/AB | 498-megabyte Winchester Disk Drive; max. 8 per system | 38,000 | 214 |
| RM03-AA/AD | 14.89-megaword Disk Drive for 2020; max. 8 per system | 20,300 | 200 |
| RH20 | Massbus Conroller for disk or tape | 19,000 | 36 |
| RTP20 | Disk Drive Subsystem, for use with 2040 or 2060, includes controller and one RP20 1.2 gigabyte disk drive | 149,000 | 649 |
| RP20 | 929-megabyte Add-On Single Access Disk Drive; max. 3 per RTP20 subsystem | 51,000 | 308 |
| CI20-AA/AB | KL10 CI Port Adapter | 19,500 | 179 |
| SC008-AC | Eight node star coupler with cabinet | 7,500 | 26 |
| SC008-AD | Star coupler upgrade for 9 to 16 nodes | 5,500 | 26 |
| HSC50-AA/AB | Intelligent mass storage server | 32,500 | 113 |
| HSC5X-A | Disk data channel for HSC50-AA/AB | 7,100 | 30 |
| HSC5X-CA | Tape data channel for HSC50-AA/AB | 7,100 | 30 |
| RA60-AE | Removable media 210MB disk drive, no cabinet | 15,000 | 95 |
| RA60-CE/CJ | RA60-AE with cabinet and space for 2 additional disk drives | 17,000 | 95 |
| RA81-AE/AJ | Fixed media 463MB disk drive, no cabinet | 19,000 | 107 |
| RA81-CE/CJ | RA81-AE/AJ with cabinet and space for 2 additional disk drives | 21,000 | 107 |
| RA81-EE/EJ | Three RA81-AE/AJ with cabinet | 50,000 | 321 |
| **MAGNETIC TAPE EQUIPMENT** | | | |
| TAU77-EC/ED | Magnetic Tape Subsystem with tape controller and TU77 Tape Drive; for 2020 | 36,800 | 373 |
| TU77-AF/AJ | Add-On Tape Drive for TAU77-EC/ED and TU77-CB/CD; 125 ips, 800/1600 bpi, NRZI/ PE; maximum of three | 23,800 | 251 |
| TU77-CB/CD | Magnetic Tape Subsystem with tape controller and TU77 Tape Drive; for 2040 and 2060 | 36,800 | 327 |
| TX02-EE/EF | Magnetic Tape Controller and DX20 Channel for TU72 Series Tape Drives; requires RH20; for 2040 or 2060 | 96,800 | 650 |
| TU72-EC/ED | Add-On Tape Drive for TX02-E; 125 ips, 1600/6250 bpi, PE/GCR | 35,300 | 216 |
| TX03-A | Two Channel Switch for TX02-EE/EF | 7,040 | 16 |
| TX03-EE/FF | Two Channel Switch option and DX20 channel for TX02-E | 54,600 | 270 |
| TX03-FB | Two Channel Switch option for two TX02-E | 12,800 | 29 |
| TX05-EC/ED | Two control unit tape switch option and one TX02-E, requires one TX02-E | 74,400 | 410 |
| TX05-FB | Two control unit tape switch option; requires two TX0-E | 25,700 | 29 |
| TA78-BF/BJ | 1600/6250 bits per inch, 125 inches per second dual access master tape drive with 2 STI intercabinet cables | 52,000 | 405 |
| TA78-UG | Upgrade kit TU78-AB/AD to TA78-BF/BJ | 15,000 | — |
| TU78-AB/AD | Single access magnetic tape subsystem including formatter and 1 master tape drive, 125 inches per second, 1600/6250 bits per inch expandable to maximum of 4 tape drives/ formatter | 48,000 | 364 |
| TU78-AF/AJ | Add-on magnetic tape drive, 125 inches per second, 1600/6250 bits per inch | 25,500 | 221 |
| **PRINTERS** | | | |
| LP20-CA/CB | Line Printer and Controller; 132 positions; 64-character, EDP font; 900 lpm | 36,500 | 355 |
| LP20-DA/DB | Line Printer and Controller; 132 positions; 96-character, EDP or scientific font, 660 lpm | 37,900 | 355 |
| LP20-J | Line Printer and Controller; 132 postions; 64 96-character EDP Charaband; 600/450 lpm | | |
| LP00-BA/BB | Line Printer and Controller; 132 positions, Charaband-type mechanism; includes software, long line interface, and diagnostics; does not include Charaband; 900/1200 lpm/ not for 2020 | 54,600 | 551 |
| LP07-Y | Charaband for LP200-B line printer, dual-sided; choice of 64- and 96- character EDP fonts, two 64-character EDP fonts, two 96-character EDP fonts, 64- and 96-character OCR-A fonts, two 96-character scientific fonts, 96- character EDP and scientific fonts, two 96-character Swedish/Finnish fonts, 64- and 96-character British fonts, two 64-character open Gothic fonts, or customer specified character fonts | 4,300 | — |
| LP27-2A/2B | Band line printer with LP20 controller, 800/1200 lpm | 30,990 | 348 |
| **PUNCHED CARD EQUIPMENT** | | | |
| CD20-AA/AB | Card Reader and Controller; tabletop mounting; 300 cpm | 7,920 | 129 |
| CD20-CA/CB | Card Reader and Controller; free-standing, 1200 cpm | 27,960 | 220 |

*Monthly maintenance is 5-day, 12 hours per day DECservice except for 2020 packages and terminal products; MS10–BA, MS10–HA, MS10–LA, RM03–A, TAU77–EC/ED, DZ11–AA, DZ11–BA, DF01–A, LA38–G, LA38–H, LA120–BA, LA120–RA, VT100–A and VT1XX–A. For 2020 products, the quoted figure is DECservice for an eight hour day, 5 day week. For terminal products the quoted figure is the eight hour Basic maintenance.
**All minimum systems require a magnetic tape subsystem and a line printer in addition to the basic package.

# Digital Equipment DECSYSTEM-20

## EQUIPMENT PRICES

| | | Purchase Price | Monthly Hardware Maint.* |
|---|---|---|---|
| **ASYNCHRONOUS COMMUNICATIONS DEVICES** | | | |
| DC20-AA | Basic Asynchronous Multiplexer; 8 lines, can be expanded to 16 lines with one DC20-DA expander, max. 7 per system; for 2040 or 2060 | 6,160 | 109 |
| DC20-DA | Expansion group for use with DC20-AA above; 8 lines, max. 1 per DC20-AA | 1,870 | 96 |
| DC20-EC/ED | Communications Expansion Cabinet; required for over 64 communications lines, includes one DC20-AA basic 8-line group; max. 1 per system; for 2040 or 2060 | 12,980 | 234 |
| DC20-CC | Cables and Distribution Cabinet; for configuration between 32 and 128 lines | 2,585 | — |
| DZ11-AA | Asynchronous Line Interface and Distributor Panel; for 8 lines; required when more than 16 lines are ordered | 2,570 | 43 |
| DZ11-BA | Asynchronous Line Interface; for 8 lines; required when more than 8 or 24 lines are ordered; requires DZ11-A | 2,050 | 36 |
| **SYNCHRONOUS COMMUNICATIONS DEVICES** | | | |
| DN20-MA/MB | Data Communication Universal front end with 128K words of MOS memory | 37,620 | 193 |
| DN20-BA | Synchronous Line Controller; one allowed per DN20-C; includes DN20-BB; for all processors | 4,235 | 39 |
| DN20-BB | Synchronous Line Unit; for expansion of DN20-BA; max. of 3 DN20-BB per DN20-BA | 1,650 | 17 |
| DN21-BA | Synchronous Line Controller and Interface for speeds between 19.2K and 56K bps; for 2040 or 2060 | 3,200 | 38 |
| DN22-AA/BB | IBM 2780/3780/HASP Multileaving Emulator/Terminator for 2020 | 14,740 | 164 |
| DN200-AA | Remote job entry terminal; connects up to 2 synchronous and/or 32 asynchronous lines | 22,800 | 131 |
| DN20-DA/DB | Synchronous expansion drawer including one low-speed line interface expandable to 4 lines with the addition of DN20-BA | 11,770 | 38 |
| DMR11-AA | Remote synchronous interface, V.24/EIA RS232-C, speeds up to 19.2K bits per second | 4,400 | 46 |
| DMR11-AB | CCITT V.35 synchronous interface speeds up to one million bits per second | 4,400 | 46 |
| DMR11-AC | High speed local synchronous interface with integral modem for local connection; speeds up to one million bits per second | 4,400 | 46 |
| DMR11-AE | EIA RF-422 synchronous interface speeds up to one million bits per second | 4,400 | 46 |
| DN21-JA/JB | Communication expansion drawer and one DB11-A bus repeater | 9,500 | 31 |
| **TERMINALS** | | | |
| LA38-AA | DECwrite IV Hard Copy Table-Top Terminal 30 cps; KSR; 132 positions, EIA interface, 14 position keypad | 1,750 | 23 |
| LA38-BA | With Universal power supply | 1,850 | 23 |
| LAX34-CL | 20 mA Current Loop Interface for LA38 | 120 | 4 |
| LA120-DA | DECwriter III; 180 cps, numeric pad, EIA interface | 2,800 | 42 |
| LA120-RA | DECprinter; 180 cps, serial, EIA interface | 2,700 | 37 |
| LA12X-AL | 20 mA Current Loop Interface for LA120 | 140 | — |
| VT100-AA/AB | CRT Terminal with detached keyboard, EIA interface, EIA interface supported in the VT52 compatible mode only | 2,150 | 23 |
| VT1XX-AA | 20 mA Current Loop Interface for VT100 | 140 | 5 |
| VT1XX-AB | Advanced Video Option | 150 | 5 |
| VT125-AA/AB | VT100 with graphics option | 3,800 | 35 |
| **HARDWARE** | | | |
| DNHXX-AA/AB | Expansion Cabinet for 2020 | 9,600 | — |

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**All minimum systems require a magnetic tape subsystem and a line printer in addition to the basic package.

# Digital Equipment DECSYSTEM-20

## SOFTWARE PRICES

| | | One-Time License Fee | Monthly Self-Maint. Fee |
|---|---|---|---|
| **TOPS-20** | | | |
| QT002-AM | Algol-60; binaries and source code supplied | 11,500 | 66 |
| QT014-AM | APL; same as APLSF, but without file I/O; binaries only supplies | 11,500 | 79 |
| QT012-AM | APLSF; binaries only supplied | 23,000 | 132 |
| QT027-AM | Basic-Plus-2; binaries only supplied | 11,500 | 97 |
| QT099-AM | Cobol-74 plus Sort/Merge; binaries and source supplied | 16,500 | 115 |
| QT009-AM | CPL (ANS-76 PL/1 subset interpreter; binaries only supplied) | 6,900 | 58 |
| QT001-XM | Fortran-77; binaries and source supplied | 11,500 | 105 |
| QT007-AM | Sort/Merge; binaries and source supplied | 3,450 | 31 |
| QT008-AM | DBMS-20; binaries only supplied | 34,500 | 242 |
| QT016-AM | IQL extended with DBMS interface, both ISAM and sequential; binaries only supplied | 19,600 | 106 |
| QT025-AM | APL to APLSF upgrade | 17,300 | — |
| QT028-AM | Basic to Basic-Plus-2 upgrade | 5,200 | — |
| QT024-AM | Sort/Merge to Cobol-68 Sort/Merge | 11,500 | — |
| QT115-AM | BLISS-36 | 13,800 | — |
| QT042-XM | 2780/3780 Software for 2040, 2050, or 2060 (TOPS-20); binaries and source supplied | 8,600 | 132 |
| QTD01-AM | DECnet-20 for 2040, 2050, or 2060; binaries only supplied | 8,600 | 88 |
| QTD20-AM | DECnet-20 for 2020; binaries only supplied | 8,600 | 88 |
| QT037-AM | Traffic-20; binaries only supplied | 6,900 | 88 |
| ZH008-CM | Maintenance Programs for the KL10-E | 50,600 | — |
| ZT001-YM | Maintenance Programs for the KS10-A | 25,300 | — |
| QT046-YM | KS10 Microcode | 50,600 | — |
| QT052-XM | 2780/3780/HASP Software for TOPS-20 | 10,000 | 117 |
| QT225-AM | Common File System software for TOPS-20 loosely coupled systems | 85,000 | 916 |
| QT225-DZ | Write to copy license for QT225-AM | 5,000 | — |
| Source Code | | | |
| QT029-EK | TOPS-20 Front End Source Code on RP06 Disk | 23,000 | — |
| QT030-EM | TOPS-20 Monitor Source Code on 9-track tape | 28,800 | — |
| QT038-EM | TOPS-20 Executive Sources (Command Scanner) on 9-track tape | 8,100 | — |
| QT040-EL | TOPS-20 Source Package; includes QT030, QT029, QT038; supplied on RP04 or RP06 Disk | 46,000 | — |

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