

DEC PDP-11 Family



The PDP-11/70 represents the high end of one of the most extensive minicomputer product lines in existence today. In the foreground is the LA37 DECwriter II terminal, one of the numerous terminals now offered with the PDP-11 processors. The PDP-11/70 is a high-performance machine with integral cache memory and high-speed 32-bit data paths. The system also has memory management, look-ahead, and internal memory expansion capability up to 2048K bytes.

MANAGEMENT SUMMARY

During its relatively short history, Digital Equipment Corporation has pioneered the minicomputer concept, taken advantage of its early lead, and maintained its position as the largest minicomputer manufacturer in the world. In large part, the company's success can be attributed to the PDP-11 family of processors and packaged systems. Introduced in 1970, the PDP-11 product line remains highly viable, due primarily to the continual growth and strengthening of the line with new products and technologies on a timely basis. Digital's moves, while successfully maintaining product viability, can be characterized as conservative in an industry not known for conservatism. These moves have, however, ensured the production of consistently reliable and generally cost-effective systems.

EVOLUTION OF THE LINE

The original PDP-11, the 11/20, introduced in March 1970, defined the architecture that was eventually to become 15 models using 4 basic processors. Over a year later, in April 1971, an OEM version of the PDP-11/20, the

DEC's broad PDP-11 family of 16-bit processors includes products ranging from the low-priced LSI-11 microcomputer to the powerful PDP-11/70 minicomputer. Nine processors are active members of the family at present, and they are available either as stand-alone products or as part of packaged systems. Most members of the PDP-11 product line are available for both OEM and end-user sales.

CHARACTERISTICS

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

DEC is a worldwide corporation and the world's largest manufacturer of minicomputer systems. The company employs about 23,000 persons and maintains sales and service offices in all major U.S. cities and in major cities throughout Canada and the Western world.

MODELS: See Model Availability Chart on page M11-384-302.

DATE ANNOUNCED: See Model Availability Chart on page M11-384-302.

DATE OF FIRST DELIVERY: See Model Availability Chart on page M11-384-302.

NUMBER INSTALLED TO DATE: See Model Availability Chart on page M11-384-302.

DATA FORMATS

BASIC UNIT: 16-bit word plus two parity bits. The processor can also handle 8-bit bytes, and is capable of bit manipulation.

FIXED-POINT OPERANDS: 16-bit words or 8-bit bytes are used as operands in both single- and double-operand instructions. Bit manipulation is provided through Boolean AND/OR instructions.

FLOATING-POINT OPERANDS: Optional 32-bit single-precision operands with an 8-bit exponent and signed 24-bit fraction on the LSI-11, LSI-11/2, and the 11/34A and larger models; or 64-bit double-precision operands with an 8-bit exponent and signed 56-bit fraction on the 11/34A, 11/45, 11/55, 11/60, and 11/70.

The sign is the high-order bit in both single- and double-precision operands and precedes the exponent. The exponent is in excess 128 notation, allowing exponent values between -128 and +127. All fractions are assumed to be normalized, so that the high-order fraction bit (which is always 1) is not represented directly. This allows one extra bit of resolution to be achieved.

Single- and double-precision hardware via a floating-point processor is optionally available on the 11/34A, 11/45, 11/55, 11/60, and 11/70. This hardware includes a dedicated set of six 64-bit accumulators. The LSI-11 can have an optional plug-in, ROM-implemented extended instruction set (EIS) for fixed-point arithmetic and a floating-point instruction set

DEC PDP-11 Family

DISTINGUISHING CHARACTERISTICS OF THE PDP-11 FAMILY MEMBERS

	LSI-11/2	LSI-11, 11/03	11/04	11/34, 11/35	11/45, 11/55	11/60	11/70
Processor Characteristics	Uses same basic four-chip set as the LSI-11; 350-nanosecond microcycle time; CPU mounted on 5 by 8.5 inch board; optional floating-point instructions	11/35 instruction set with speed approaching 11/45; unique internal architecture; floating-point optional	"Standard" PDP-11 architecture first appears; standard instruction repertoire; ROM hardware diagnostics	850-nanosecond CPU plus 32-bit floating-point on 11/35; extra and extended instructions first appear; self test feature	300-nanosecond CPU using Schottky logic; 64-bit floating-point, floating-point processor (FPP); 150-nanosecond microcycle time	Twice the CPU power of the 11/34; choice of firmware or fast floating-point processor (FPP)	300-nanosecond CPU using Schottky logic; 64-bit fast floating-point through FPP
Memory Usage	No CPU on-board memory; 16K dynamic MOS chips employed; memory refresh every 1.67 ms by on-board logic	Supports up to 64K in addressing capability, less in std. chassis; core, dynamic RAM, PROM	Supports up to 64K in address capability; core or MOS	Memory management feature; 11/35 uses core only; 11/34 has opt. cache memory	Memory management (map) feature; intermixed core and bipolar memories	532-ns effective cycle time; 2K cache memory; user, extended, and diagnostic control store options; memory management	Memory management (map) feature; interleaved core & cache memory management
Bus Structure	LSI Bus ("Sub-Unibus") that is low-cost & asynchronous		"Standard" Unibus, which lends flexibility across this range of the PDP-11 family		Unibus plus an internal solid-state bus for I/O memory reference overlap or multi-processor use	Standard 56-line Unibus	Unibus plus 32-bit internal data buses between core & cache and between high-speed controllers & cache
Operating Software (typical, and "intent" of usage)	Run-time version of RT-11 supporting BASIC, APL, Focal, Macro-11, FORTRAN, and Q-bus products	RT-11 & RSX-11S support; "one program for life" intent	RSX-11M, RT-11, RSX-11S; usually dedicated to an application	RSTS/E time-sharing runs in this range of the PDP-11 family; the intent is for many similar programs or dedicated real-time or time-sharing applications running concurrently		Multiple-purpose, using IAS, or maximum power using RSX-11M (real-time) or RSTS/E (time-sharing) or DSM-11 (time-sharing data base management)	

➤ PDP-11/15, was introduced. This new model employed the same CPU as the 11/20, and differed only in market orientation.

In October 1971, the first update to the infant PDP-11 line appeared in the form of the OEM-oriented PDP-11/05. This new unit, announced with the PDP-11/45 and 11/50, was a functional replacement for the 11/20 (and the OEM 11/15), repackaged into a more cost-effective unit that offered performance comparable to that of the older 11/20. Introduced at the same time, the 11/45 and 11/50 models each featured extensions to the PDP-11/20 capabilities, as well as the newer packaging techniques found in the 11/05. The PDP-11/45, like the other PDP-11's, was a core-only machine, but this new model included memory management circuitry that raised the maximum memory capacity from 56K bytes to 248K bytes.

➤ (FIS) for single-precision numbers. ROM implementation of EIS is available for the 11/34 and 11/35; FIS for the 11/35. The 11/60 has a full firmware-implemented instruction set as standard. Floating-point software subroutines are available for all PDP-11's.

INSTRUCTIONS: PDP-11 instructions are 16 bits long. If program counter addressing is employed, then an additional 16 bits are added to the instruction length. Instruction formats are numerous, varying from one PDP-11 model to another. Common formats throughout the PDP-11 line occur in instructions of the single operand group, the double operand group, branch group, subroutine return, and condition code operators group. Operation codes vary from 4 bits to 16 bits in length.

➤ **INTERNAL CODE:** ASCII for text-oriented data; binary for calculations.

PDP-11 MODEL AVAILABILITY SUMMARY

	LSI-11/2	LSI-11	11/03	11/04	11/05*	11/10*	11/15*	11/20*	11/34, 11/34A	11/35	11/40*	11/45	11/55	11/60	11/70
Date Announced	1/78	2/75	12/75	11/74	10/71	1/73	4/71	3/70	2/76	10/73	8/72	10/71	12/75	3/77	2/75
First Delivery	3/78	5/75	—	7/75	2/72	2/73	6/71	8/70	3/76	1/74	1/73	4/72	3/76	5/77	5/75
Typical Purchase**	\$1.1K	\$1.6K	\$10K	\$17.3K	—	—	—	—	\$20.9K	\$29.9K	—	\$41.8K	\$66.2K	\$40K	\$100K
Number Installed	—	29,000		9100	11,000		4250		750	8000		3000		400	1100

* System is no longer actively marketed.

**Includes memory and I/O configurations; quantity prices are shown for the LSI-11 and LSI-11/2.

DEC PDP-11 Family

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
MAGNETIC TAPE		
TE10W, TU10W	Transport; 9-track, 800 bpi, NRZI, 10.5-inch reels, vacuum columns, 45 ips, industry-compatible; 36 KBS	DEC
TE16, TU16	Transport; 9-track, 800/1600 bpi, NRZI/PE, industry-compatible, 10.5-inch reels, vacuum columns, 45 ips, forward and reverse read; 36/72 KBS	DEC
TE10W-BE, TU1DF	Transport; 7-track, 200/556/800 bpi, NRZI, 10.5-inch reels, vacuum columns, 45 ips, industry-compatible; 9/25.02/36 KBS	DEC
TU45	Transport; 9-track, 800/1600 bpi, NRZI/PE, 10.5-inch reels, vacuum columns, 75 ips, industry-compatible; 60/120 KBS	Pertec
T503	Transport; 9-track, 800 bpi, NRZI, 7-inch reels, tension arms, 12.5 ips, industry-compatible; 10 KBS	Kennedy
TA11	Dual Drive Cassette Unit; 1-track, 350 to 700 bpi, up to 92,000 bytes, PE, 9.6 ips, Philips type cassettes; 562 bytes per second	DEC
PRINTERS		
LA11-P	Serial impact; 7 x 7 dot matrix, 132 positions, 128-ASCII character set, 3 to 14.9-inch paper (width), 6 lines per inch, 10 characters per inch; 180 cps	DEC
LP11-C	Drum; 132 positions, 64-character set, 4- to 19-inch paper (width), 6 or 8 lines per inch, 10 characters per inch; 900 lpm	Dataproducts 2290
LP11-D	Same as LP11-C but 96-character set; 660 lpm	Dataproducts 2290
LP11-R	Drum; 132 positions, 64-character set, 4- to 19-inch paper (width), 6 lines per inch, 10 characters per inch, 12-channel VFU; 1250 lpm	Dataproducts 2470
LP11-S	Same as LP11-R but 96-character set; 925 lpm	Dataproducts 2470
LP11-V	Drum; 132 positions, 64-character set, 4- to 16.8-inch paper (width), 6 or 8 lines per inch, 10 characters per inch; 300 lpm	Dataproducts 2230
LP11-W	Same as LP11-V but 96-character set; 230 lpm	Dataproducts 2230
LP11-Y	Same as LP11-V but 600 lpm	Dataproducts 2260
LP11-Z	Same as LP11-Y but 96-character set; 436 lpm	Dataproducts 2260
LV11-B	Electrostatic Printer/Plotter; 132 positions, 96-character set, 7 x 9 dot matrix, 8 lines per inch, 12.5 characters per inch, 100 points per inch, 11-inch paper (width); 500 lpm	Versatec LP 1150
PUNCHED CARD UNITS		
CD11-A	Reader; 80-column, 1000-card input hopper and output stacker, 12-bit parallel read; 1000 cpm	Documation M1000L
CD11-E	Reader; 80-column, 2250-card input hopper and output stacker, 12-bit parallel read; 1200 cpm	Documation RS1200
CM11-F	Reader; 80-column, optical mark or punched card, 550-card input hopper and output stacker, 12-bit parallel read; 285 cpm	Documation M200
CR11	Reader; 80-column, 550-card input hopper and output stacker, 12-bit parallel read; 285 cpm	Documation M200
PAPER TAPE UNITS		
PC11	Reader/Punch, uncoiled 8-channel paper tape, fanfold tank; 300/50 cps	Remex

➤ The 11/45 actually represented a new processor that incorporated Schottky TTL logic and had a special high-speed internal memory bus in addition to the normal Unibus. This new bus was identical to the Unibus, and in some systems was connected to it as an extension. But the major purpose of the new bus was to interface DEC's new dual-ported 300-nanosecond bipolar and 450-nanosecond MOS memories, which represented significant enhancements to the system. The new memories, although more expensive at that time, enabled the 11/45 to perform at levels twice those of the PDP-11/20. In addition to the new memories, the 11/45 also featured an optional FP11-b floating-point processor, capable of handling 64-bit double-precision operands. The PDP-11/50, announced along with the 11/05 and 11/45 models, was merely a PDP-11/45 with MOS memory instead of core.

➤ **MAIN STORAGE**

General aspects, including type, cycle time, and capacity, are covered for the entire family in the Main Storage Characteristics table (page M11-384-305). The categorized entries in the text that follows emphasize exceptions and noteworthy features. It should be noted that all storage capacities allow for the 8192 bytes (4096 words) that are reserved for use by the I/O system. Non-DEC storage choices are listed in Report M13-100-101, Minicomputer Add-On Memories.

STORAGE TYPE: Magnetic core, dynamic MOS, and bipolar are the three types most commonly used within the PDP-11 family. Core is available in a variety of speeds and can be used in every PDP-11 except the LSI-11/2. Bipolar memory is available only for the 11/45 and 11/55. Dynamic MOS is available for all PDP-11's except the 11/35, 11/45, and 11/55.

DEC PDP-11 Family

PERIPHERALS/TERMINALS (Continued)

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
TERMINALS		
LA35	DECwriter II; serial impact printer, 7 x 7 dot matrix, 132 positions, 63 or 95 ASCII character set, 3 to 14.9-inch paper (width), 6 lines per inch, 10 characters per inch, 20-ma interface; 10/15/30 cps	DEC
LA36	Same as LA35 but with keyboard; 96 or 128 keyboard characters, keyboard includes 14-key numeric pad; 20-ma interface, full or half duplex operation; 110 to 300 bps	DEC
LA37	Same as LA36 but with full APL keyboard; EIA or 20-ma interface; 110 to 300 bps	DEC
LA180	DECwriter III, serial impact printer/keyboard; 7 x 7 dot matrix, 132 positions, 96 or 128 ASCII character set, 3 to 14.9-inch paper (width), 6 lines per inch, 10 characters per inch, multi-key rollover keyboard, with 68 keys, optional 14-key numeric pad; 180 cps; full duplex, half duplex, or echoplex operation; 110 to 9600 bps	DEC
VT11	Graphic Display Processor; 9.25 x 9.25 inch viewing area, 1024 x 1024 viewable dot matrix, 96 standard plus 31 special characters, 8 intensity levels, light pen standard, keyboard optional	DEC
VS60	Same as VT11 but 12 x 12 inch viewing area	
VT50	DECscope CRT; 960 characters, 12 lines x 80 characters, 5 x 7 dot matrix, 64 ASCII character set, upward scroll, hold screen mode, standard typewriter keyboard, numeric pad, four standard function keys, full duplex with/without local copy, switch selectable parity, 20-ma interface; 75 to 9600 bps	
VT52	DECscope CRT; 1920 characters, 24 lines x 80 characters, 5 x 7 dot matrix, 64 ASCII character set, upward scroll, hold screen mode, standard typewriter keyboard plus keypad (11 numeric keys, 4 cursor keys, 3 user-definable keys, and an enter key), direct cursor addressing, full duplex with/without local copy, EIA or 20-ma interface; 75 to 9600 bps	DEC
VT55	Graphic Display; capabilities as an alphanumeric CRT, graphic display, and printer/plotter; two displays of up to 512 data points at a screen resolution of 512 x 236; alphanumeric display is by 7 x 7 dot matrix on 24 lines of 80 characters each; hard copy via electrolytic process; keyboard is of multiple-key rollover construction and is of typewriter style with separate numeric keypad; full or half duplex, 20-ma interface; 75 to 9600 bps	DEC
VT61	Alphanumeric Display; 1920 characters, 24 lines x 80 characters, 7 x 8 dot matrix, 128-character set, blinking cursor, tabulation, character and line insert/delete, typewriter-style keyboard, four standard function keys, inverse video; half and full duplex; EIA or 20-ma interface; 15 to 9600 bps	DEC
VT62	TRAX Display Terminal; 1920 characters, 24 lines x 80 characters, typewriter-style keyboard; designed for use in TRAX interactive transaction processing system	DEC

➤ The next PDP-11 model, the 11/40, announced in August 1972, could be considered a fill-in-the-gap model. It uses the memory management circuitry originally introduced in the 11/45 and 11/50 models, operates at about twice the speed of the original 11/20 in integer operations, but can have up to 248K bytes of core memory.

The PDP-11/40, 11/45, and 11/50 were primarily end-user processors chiefly because of the size of the systems for which they were intended. As OEM's began offering progressively larger systems, it became apparent that an OEM unit with large memory capability was highly desirable. For this market, DEC announced the PDP-11/35, a CPU identical with the 11/40, offering many 11/40 standard features as options and packaged in a 10.5-inch box.

For over a year after the 11/35 announcement, the PDP-11 family remained stable, at least in terms of CPU's. During this period, DEC turned its attention to packaged systems and support software.

In November 1974, the PDP-11/04 was introduced with a totally new low-end processor. Again, as in the case of the ➤

➤ Read-only memories (ROM's) and programmable ROM's (PROM's) are available for dedicated-function processors (e.g., the LSI-11 used in some other machine) or for specific processor functions (e.g., bootstrap loader or ASCII device console simulation in the 11/04). These take the form of diode ROM, ultraviolet-programmable ROM, and fusible-link ROM. Much of the ROM usage cannot really be classified as storage (e.g., floating-point ROM in the LSI-11).

CYCLE TIME: Both cycle and access times are listed in the Main Storage Characteristics table on page M11-384-305. Cache memory on the 11/34A (optional) has a 150-nanosecond cycle time; on the 11/60, 200 nanoseconds; on the 11/70, 240 nanoseconds.

In some models, the storage access cycle rate (as opposed to the access cycle-time capability of the storage) is a function of the processor, not of the storage; e.g., the constant 1.2-microsecond cycle time of the LSI-11 and LSI-11/2 regardless of storage technology. On the 11/70, DEC states that the main storage bandwidth is easily raised from the basic 4 million bytes per second to 5.8 million bytes per second by interleaving. All 11/70's with more than the minimum memory use memory interleaving. The company also states that a 90 to 95 percent cache "hit" rate on the 11/70 yields an effective 11/70 memory cycle time of less than 400 nanoseconds. On the 11/60, a 77 to 92 percent cache "hit" rate yields an effective memory cycle time of less than 550 nanoseconds. An 86 percent cache "hit" rate on the 11/34A ➤

DEC PDP-11 Family

MAIN STORAGE CHARACTERISTICS

Model	Storage Type	Cycle Time (nanoseconds per word)	Storage Capacity* (bytes)	Increment Sizes (bytes)
LSI-11 & PDP-11/03	Dynamic MOS, core, and/or PROM	550 MOS 390 MOS 1150 core —	8K to 64K 32K to 64K 8K to 64K 1K to 8K	8K 32K 8K 512-byte x 4-bit PROM chip
LSI-11/2	Dynamic MOS and/or PROM	570 MOS —	8K to 64K 1K to 8K	8K, 16K, 32K, or 64K 512-byte x 4-bit PROM chip
PDP-11/04	Dynamic MOS and/or Core	700 MOS 980 core	16K to 64K 16K to 64K	16K to 128K 16K to 128K
PDP-11/34A	Dynamic MOS and/or Core	700 MOS 980 core	32K to 256K 32K to 256K	32K to 128K 32K to 64K (package)
PDP-11/35	Core	980	32K to 256K	32K or 64K; 128K package
PDP-11/45	Core and/or bipolar	980 core 300 bipolar	64K to 256K 8K to 64K	32K or 64K; 128K package 8K
PDP-11/55	Core and/or bipolar	980 core 1200 core 300 bipolar	32K to 256K 6K to 256K 8K to 64K	32K or 64K; 128K package 64K; 128K package 8K
PDP-11/60	ECC MOS or core	1200 MOS 1200 core	64K to 256K 64K to 256K	64K, 128K, 192K 64K
PDP-11/70	ECC MOS and/or core	— MOS 1200 core	128K to 2048K 128K to 2048K	128K, 512K; 1024K package 128K; 512K package

*Does not include optional or standard cache memory; the uppermost 8K bytes of memory are reserved for I/O and registers on all models with a Unibus.

▷ PDP-11/05, this new CPU had the same architecture as the existing family members and incorporated several technological innovations to achieve substantially improved price/performance characteristics. Designated the successor to the PDP-11/05 and PDP-11/10, this new processor, 11/04, used MSI components to reduce the CPU from two boards to a single hex board. While offering slightly better performance levels than the 11/05 and 11/10, the new 11/04 could accept either core or MOS memory. Priced about the same as the PDP-11/05 (a core-only machine), the 11/04 employed a newly developed power supply and less expensive memory modules to provide about 15 percent greater performance levels.

Early in 1975, two innovative PDP-11's were announced at opposite ends of the family line. The LSI-11 micro-computer, for OEM applications, and the PDP-11/70, for very large systems, were both introduced in February 1975. The LSI-11 addressed the rapidly growing market for smaller, less powerful computers for inclusion in very small systems such as intelligent terminals and process controllers. Built from an LSI microprocessor chip, this entirely new low-end PDP-11 featured the same instruction set as the PDP-11/40, but offered only half the performance of the other PDP-11 members, due chiefly to the architecture of the CPU.

At the other end of the scale, the PDP-11/70 still represents the top of the PDP-11 line. (It should be noted, however, that PDP-11 users who outgrow the 11/70's

▶ and 11/60 brings about an effective cycle time of less than 554 nanoseconds.

CAPACITY: See Main Storage Characteristics table on page M11-384-305. Capacity is a function of packaging and/or marketing (e.g., the 16K-byte limit on the 11/04), of busing structure (the Unibus requires the uppermost 8K bytes to be dedicated as I/O registers, thus limiting direct address space to 56K bytes), and of whether memory mapping is available. Memory mapping is automatic effective address translation that enables a 16-bit computer to address memory in excess of 64K words.

CHECKING: Parity on the basis of one bit per byte is available with dynamic MOS memory for the LSI-11/2, 11/04, and 11/34A and with core memory for all PDP-11's except the LSI-11 and LSI-11/2. Bipolar memory, available for the 11/45 and 11/55, also features parity on the basis of one bit per byte. Error correcting and checking (ECC) is a feature of dynamic MOS memory for the 11/60 and 11/70. ECC corrects all single-bit errors and detects all double-bit errors and most multiple-bit errors.

STORAGE PROTECTION: Via the memory mapping (management function on the 11/34A, 11/45, 11/55, 11/60, and 11/70. Mapping automatically provides hardware storage protection.

RESERVED STORAGE: The uppermost 8192 bytes on all models with a Unibus are reserved for I/O registers. This apparent "waste" of storage is more than compensated for by the resulting I/O programming flexibility.

All PDP-11's reserve at most 511 locations (168 in the 11/03) at the low end of memory for interrupt vectors, trap vectors, and floating vectors (not in the 11/03). Floating vectors are

DEC PDP-11 Family

INSTRUCTION REPERTOIRES

Instruction Type	LSI-11, 11/03, LSI-11/2, 11/35	11/04	11/34A	11/45, 11/55*	11/60*	11/70*
Single Operand	16; 2 opt. (EIS)	13; 2 opt.	16	14	15 (incl. EIS)	15 (incl. EIS)
Double Operand	8; 2 opt. (EIS)	7; 2 opt.	8	8	10 (incl. EIS)	10 (incl. EIS)
Memory Management	4 (11/35 only)	None	4	4	4	4
Branch	17	17	17	17	17	17
Subroutine	3	2	3	3	3	3
Program Control	2	1	2	3	3	3
Trap	6	5	6	6	6	6
Miscellaneous	3	4	3	3	3	3
Condition Code Operator	11	12	12	12	12	12
Floating-Point	4 (opt. FIS)	None	46 (opt. FPP)	46 (opt. FPP)	46 (firmware or opt. FPP)	46 (opt. FPP)
User Control Store	1 (WCS)	None	None	None	1	None
Maintenance	None	None	None	None	5	None
TOTALS:						
Standard	66 (70, 11/35)	61	71	70	125	73
Optional	8	4	46	46	46 or 0	46
Combined	74 (78, 11/35)	65	117	116	125	119

*Hardware Multiply/Divide standard.

➤ capabilities can now move up to the VAX-11/780, a powerful 32-bit processor, introduced in October 1977, that can be operated in PDP-11 compatibility mode. The VAX-11/780 is fully described in Report M11-384-401.)

Announced in February 1975, the PDP-11/70 appeared amidst the flurry of 32-bit minicomputers from other companies that reached the market in late 1974 and early 1975. Intended for very large systems, and said to be capable of delivering 75 percent of the throughput of an IBM 370/158, the 11/70 is essentially a PDP-11/45 with a 32-bit bipolar cache memory placed between the CPU and main memory. In addition, the memory management feature used in the 11/70 permits addressing over 4 million bytes, although physical limitations reduce this capacity to 2 million (2048K) bytes. Specially designed mass storage controllers that access the 32-bit cache memory bus also substantially increase system performance.

The PDP-11/55 was next to appear. Announced in December 1975, the 11/55 is a very specialized version of the 11/45 designed primarily for the scientific market, and specifically for use in FORTRAN systems. The 11/55 attains its faster operation through three specific improvements over the 11/45: the use of 300-nanosecond bipolar main memory; incorporation of the more efficient PDP-11/70 microcode (the 11/70 is also 11/45-based); and the use of the FP11-C, a new floating-point processor that is twice as fast as the FP11-B, the standard unit for the 11/45.

In close succession, the PDP-11/03 and 11/34 were introduced. The 11/03, announced in January 1976, responded to OEM buyers' desires for a packaged LSI-11. It is housed in a 3.5-inch chassis, contains a power supply and space for up to 16K bytes of memory, and is intended for use as a single-user terminal system or even as a small distributed processing system.

The 11/34, announced in February 1976, is an outgrowth of the PDP-11/04 and, in fact, uses the same backplane ➤

➤ assigned for communications and other devices that interface with the PDP-11.

CENTRAL PROCESSORS

The "mainstream," or original, PDP-11 family architecture began with the 11/20 and its closely related, stripped-down 11/15 version, each of which contained about 19 boards and some 600 integrated circuits (IC's). The 11/05 and 11/10 were identical to one another, about 20 percent slower internally than the 11/15 and 11/20, and had improved architectural implementation over their predecessors, using only 2 boards and about 200 IC's. The 11/04 and 11/34A processors use one and two boards, respectively.

Subsequent PDP-11 family models offer design improvements that relate closely to each product's intended market objectives. For example, the LSI-11 and LSI-11/2 design drops the Unibus in order to lower cost, and the 11/45 and larger models augment the Unibus for performance gains.

The 11/04 uses TTL in a single-board processor. Multiplexer printed-circuit models, which provide cost advantages from a packaging standpoint and speed advantages due to reduced signal path lengths, are now used throughout the PDP-11 family. The 11/34 uses the same technology, backplane, and chassis as the 11/04, differing only in the addition of memory management to extend user addressing capabilities to 248K bytes. Schottky TTL logic appears in the 11/45 and larger models, as does an autonomous Floating-Point Processor; bipolar cache memory, user control store, extended control store, diagnostic control store, and bipolar cache memory appear in the 11/60; and 32-bit internal data paths and the bipolar cache memory appear in the 11/70.

Mapped memory in any 16-bit machine will limit the address space of any one program to that which is directly addressable within the mapped-to-memory region. Also, the automatic mapping process may add processor overhead. In the 11/34A, this amounts to 120 nanoseconds per address mapped; and in the 11/45 and 11/50, it totals 90 nanoseconds per address. In the 11/70, however, mapping is concurrent, with no overhead time. DEC has not made these timings available for the 11/35 or the 11/60.

The 11/34A, 11/35, 11/45, 11/55, and 11/60 can access up to 248K bytes of main memory, through memory mapping. In the 11/70, mapping allows up to 4 million bytes to be accessed. ➤

DEC PDP-11 Family

INSTRUCTION TIMES IN MICROSECONDS

Instruction	11/04 (MOS)	11/34		11/35	11/45 & 11/55		11/70
		MOS	Core		Core	Bipolar	
Fixed-Point (16 bits):							
Load/Store	2.9/3.5	2.5	2.3	2.32/2.58	2.01/2.13	0.75	0.95/1.4
Add/Subtract	3.2	NA	NA	1.07	0.97	0.30	0.40
Multiply/Divide	9.9/11.3	8.9/12.6	8.8/12.5	9.16/11.58	3.89/8.39	3.3/7.8	3.4/7.9
Branch/No Branch	2.6/1.9	2.3/1.76	2.2/1.76	1.07/2.36	0.97/1.18	0.3/0.6	0.4/0.7
Floating Point (32 bits)*:							
Load/Store	NA	NA	NA	NA	7.0/6.38 (10.8/10.0)	5.34/4.72 (7.52/6.7)	5.54/5.62 (7.93/8.5)
Add/Subtract	NA	NA	NA	26.8/27.1	5.67 (6.97)	5.67 (6.97)	5.67 (6.97)
Multiply/Divide	NA	NA	NA	33.4/51.1 (11.4/23.0)	7.62/8.62 (11.4/23.0)	7.62/8.62 (11.4/23.0)	7.62/8.62 (11.4/23.0)
Compare & Branch	NA	NA	NA	NA	4.26 (4.87)	4.62 (4.87)	4.62 (4.87)

*Times for 64-bit operands are shown in parentheses.

➤ and memories. It bears the same relationship to the 11/04 that the 11/40 had with the 11/05; the PDP-11/34 is based on the same CPU as the 11/04, but has the memory management feature that permits main memory capacities of up to 248K bytes. Like the 11/04, the 11/34 can use either MOS or core memories. From a performance standpoint, the 11/34 is more than 50 percent faster than the 11/04; and, since both computers use the same backplane, the 11/04 can be upgraded to 11/34 status. Cache memory has been made available in the PDP-11/34A, the latest version of the 11/34.

In March 1977, DEC added a new mid-range member, the 11/60, to its extensive PDP-11 minicomputer line. The PDP-11/60 offers performance levels between those of the PDP-11/34 and the PDP-11/70. Designed as a FORTRAN machine, the 11/60 has memory expandable to 256K bytes, and memory relocation and protection are built in. Hardware multiply, divide, and 32- and 64-bit single- and double-precision floating-point arithmetic are standard.

The 11/60 CPU represents a new design and incorporates a combination of features found in the smaller PDP-11's and the high-end PDP-11/70, plus a few features that represent innovations for the company. From the PDP-11/70 have come the 11/60's cache memory feature and floating-point instruction set. From the other PDP-11 models, the 11/60 draws the fundamental 16-bit architecture, with none of the 32-bit buses found in the 11/70. Innovations in the new CPU include user-accessible microprogramming and a special firmware diagnostic module for improved availability.

User microprogramming marks an important new direction for the world's largest minicomputer manufacturer. DEC had long been a holdout against permitting user microprogramming of its products, but increasing user understanding of this previously "black magic" technology has increased the demand for the capability. DEC is still barring extensive incursions into the inner machine by limiting the amount of control storage available to the ➤

➤ With memory management, the 11/34, 11/35 or 11/60 operates in either a "kernel" or a "user" mode; the user mode prevents programs from modifying key machine states relating to memory mapping and protection. The 11/45, 11/55, or 11/70 with memory management has three modes: kernel, user, or supervisor. The supervisor mode is intended to facilitate multiprogramming by providing a control program state for more efficient and secure system management. A program operating in kernel mode can map users' programs anywhere in memory and thus explicitly protect key areas including the device registers and PSW from the user operating environment. All other PDP-11 family systems operate in basic kernel mode only, i.e., with all available memory (always 64K bytes or less) accessible by all.

Each mode has its own set of active page (address translation) registers and can access up to 8 pages of data and 8 pages of instructions. Each page may be from 64 to 8192 bytes. In the 11/34A, 11/35, 11/45, 11/55, and 11/60, there are 8 active page registers per mode. These processors employ 16-bit virtual and 18-bit Unibus/physical address spaces. In the 11/70, there are 16 active page registers per mode. The 11/70 employs 16-bit virtual, 18-bit Unibus, and 22-bit physical address spaces.

Two or more sets of length registers are used to delineate the bounds of addressability for individual programs, and these together with associated status registers give memory protection for multiprogramming.

All PDP-11 family processors have an instruction stack capability to facilitate the implementation of sharable (re-entrant) routines. The size of the pushdown stacks is limited only by the size of available memory.

CONTROL STORAGE: The LSI-11, LSI-11/2, and 11/03 are controlled by microcoded read-only memories (MICROM's), among whose functions are provision of PDP-11/35 instruction set emulation and automatic refreshing of any dynamic MOS RAM used. Also, the LSI-11 extended arithmetic option (fixed-point multiply/divide and floating-point arithmetic) is achieved by the use of a plug-in ROM chip. Users can create special LSI-11, LSI-11/2, and 11/03 operations by purchasing fusible-link programmable ROM (PROM) chips. These PROM's are packaged 256 words per chip, two chips to a half-board; the LSI-11 accepts half-boards in its backplane sockets. Other ROM-supplied LSI-11, LSI-11/2, and 11/03 functions are standard. They include resident initialization, power fail/auto restart, boot-strap loading, and debugging routines. ROM and PROM speeds in the LSI-11 are largely irrelevant, since they are at ➤

DEC PDP-11 Family

users to 1024 words. In comparison, the Hewlett-Packard 21 MX-E can accommodate up to 8.5K words of user control storage, and the Data General microNova allows up to 4K words.

The 11/60 offers two different types of floating-point processors. The integral floating-processor is a firmware implementation added to the standard PDP-11 instruction set. The second version is a new, faster auxiliary floating-point processor, designated the FP11-E. Using this floating-point unit, the PDP-11/60 is said to be capable of performance levels between 85 and 90 percent of the 11/70 level.

The 11/60 does not have the high-speed Mass-bus used in the PDP-11/45 and 11/70 CPU's, but instead features a Unibus with a broader bandwidth than that of the PDP-11/34. With its unique combination of the Unibus and processor cache memory, the PDP-11/60, like the 11/70, allows I/O transfers to memory to occur simultaneously with central processor accesses from cache memory. I/O transfers do not cause the CPU to halt, and multi-port memories with a more complex bus structure are not necessary.

In January 1978, Digital introduced the LSI-11/2, a fully compatible version of the LSI-11 mounted on a 5-by-8.5-inch board, but without the on-board memory. Associated with the LSI-11/2 are a new family of memory and interface modules, also mounted on 5-by-8.5-inch boards. In addition to size reduction and increased modularity, the LSI-11/2 offers a lower price for a typical system with memory and fewer restrictions on configuring a system.

ARCHITECTURE

A distinguishing characteristic of the PDP-11 family is its common physical architecture, arising primarily from the patented DEC Unibus, a single high-speed, asynchronous, bidirectional communications path to which all system components (CPU, memories, and I/O controllers) are connected. This common bus structure enables all functional elements to communicate with one another independently of the CPU. This ability reduces the time spent by the CPU in supervising I/O operations and allows it to devote more time to actual data processing.

Since memory and I/O controllers alike are residents of the same bus, they are addressed alike. The result is that the PDP-11's do not employ I/O instructions as a separate class; instead, certain addresses are reserved for I/O devices, and each controller can read and write to memory in the same manner as the CPU. Hence, transfers to and from I/O controllers are accomplished in the same way that data is transferred between general-purpose registers and memory. More specifically, the highest 4096 memory addresses (8192 bytes) in any PDP-11 system are reserved for use by I/O controllers and cannot be used for memory.

Two small disadvantages arise from this I/O scheme. First, since 4096 addresses are reserved for I/O usage, they cannot be used for memory. Hence, the maximum

least an order of magnitude faster than the 1.2-microsecond overall LSI-11 processor cycle.

All Unibus-11 processors, including the 11/04, 11/34A, 11/35, 11/45, 11/55, 11/60, and 11/70, have a standard ROM bootstrap loader which provides the features listed below:

M3901 Series	YA	YB	YC	YE	YF	YH
Able to run secondary bootstrap after power up or reboot	Yes	No	—	—	—	Yes
Auto entry to console emulator routine	Yes	Yes	—	—	—	No
All Unibus-11 systems	Yes	Yes	11/70	Yes	Yes	11/60
Needs ASCII terminal	No	Yes	—	—	—	No
Bootstrap for DECnet and communications interfacing options	No	No	No	Yes	No	No
Go/no go diagnostics	Yes	Yes	Yes	No	Yes	Yes

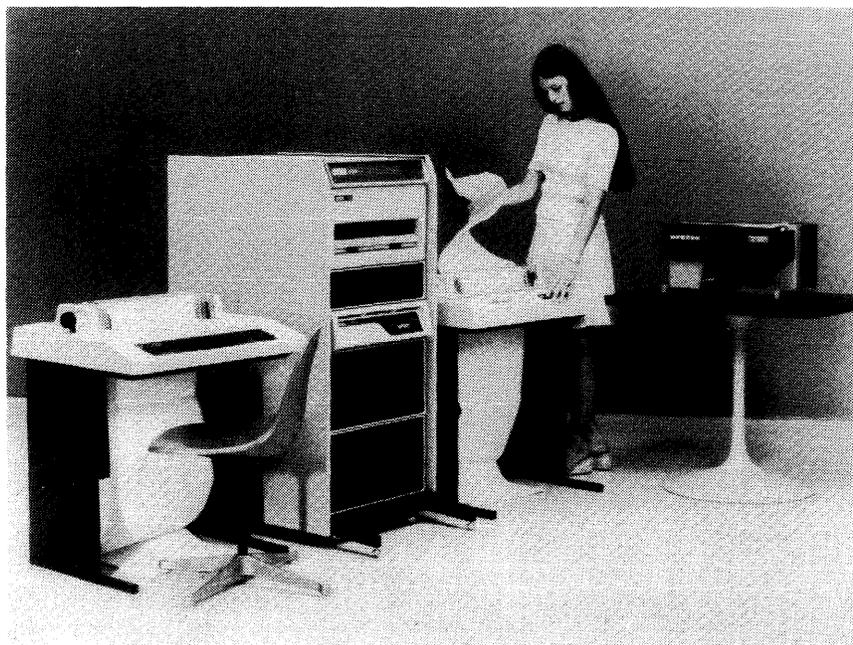
Control storage on the Unibus PDP-11's is not available to the user except on the 11/60. On this processor, a total of 4K words, consisting of 8 pages of 512 words each, can be installed. The first 2560 words (5 pages) of this address space are reserved for the base machine. The remaining 1536 words (3 pages) of address space are used for three immediately available firmware products that offer some user flexibility and provide for future enhancements. Two of the products are User Control Store (UCS—1K address space) and Extended Control Store (ECS—1.5K address space). These products are general-purpose options for use in the development of specific microcode routines for critical applications. The third product is Diagnostic Control Store (DCS—2K address space) and represents a specific, hardware-supported application of ECS. DCS is a fault isolator which facilitates fault isolation in the central processor to the module level.

The PDP-11/60 User Control Store, which permits users to develop their own microprograms for specialized functions, is a significant new addition to the PDP-11 capabilities. UCS provides 1024 48-bit words of RAM for microprogram storage, while ECS offers 1536 48-bit words of ROM for permanent non-destructive storage of microprograms developed with the UCS option.

REGISTERS: The 11/03, 11/04, 11/34A, 11/35, and 11/60 have eight user-accessible 16-bit registers (six general-purpose, one stack pointer, and one program counter), and a 16-bit processor status register.

The 11/45, 11/55, and 11/70 have 16 user-accessible 16-bit registers (two sets of six general-purpose registers, three stack pointers, and a program counter) and a 16-bit processor status register. It should be noted that any one set of general-purpose registers and one stack pointer can be user-accessible at any given time. All user-accessible registers are located in the upper 8K bytes of memory. The FFP's, available with the larger PDP-11 processors, contain a dedicated set of six 64-bit accumulators. Numerous other non-accessible, 16-bit, internal registers are present in various members of the PDP-11 processor family. These include a CPU error register, hit/miss register, maintenance register,

DEC PDP-11 Family



DEC manufactures and sells numerous specialized packaged systems. Typical of these systems is the MSB-11, a compact batch processing instructional computer system that uses student-prepared marked cards coded in either the BASIC or FORTRAN IV programming language. The standard MSB-11 package includes a card reader, PDP-11/04 processor, dual floppy disks, DECwriter II console, 180-cps printer, and the BASIC language.

physical memory that can be incorporated in a particular system is always 4096 words (8192 bytes) less than the *theoretical* maximums. For example, the PDP-11/04 is *theoretically* capable of addressing 65,536 bytes, but only 57,344 bytes can actually be implemented. This limitation arises only in the case of the maximum memory configuration. If the system only required 16,384 words there would not be a problem.

Secondly, the instructions for the I/O controllers address various controller registers as memory locations. Generally, these must be loaded individually through load- and store-type commands. While presenting an easy and understandable I/O system, this technique also precludes the implementation of instructions that perform more complex I/O functions, resulting in higher I/O overhead times.

The second salient characteristic of the PDP-11's, software compatibility, is a result of all CPU's, from the LSI-11 up to the PDP-11/70, using the same basic instruction set. It should be noted, however, that the LSI-11 and PDP-11/03 have "pseudo-Unibus" structure in place of the standard Unibus and cannot presently use DEC's standard Unibus-compatible I/O controllers. Instead, DEC offers two low-to-medium-speed "universal" controllers, one parallel and one serial, that can be adapted to handle most standard peripherals.

CURRENT MODELS

Currently, DEC offers the LSI-11, LSI-11/2, and PDP-11/03 microcomputers, sold by the company's Component Group, and the PDP-11/04, 11/34, 11/35, 11/45, 11/55, 11/60 and 11/70, sold by DEC's other seven market groups. The PDP-11/35, though still listed in the current price list, is generally sold only to existing users for replacement or for hardware conformance. It can be said

control register, memory system error register, high error address register, and low error address register.

ADDRESSING: Eight address modes are provided, with each operand address consisting of three bits to specify address mode and three bits that specify the register used to calculate the address. The modes consist of Register (operand in register), Register Indirect (operand address in register), Auto Increment/Decrement (self-incrementing/decrementing operand address in register), Auto Increment/Decrement Indirect (self-incrementing/decrementing register which points to an address in memory), Indexed, and Indexed Indirect. The eight modes can allow a specific operation code (e.g., MOV, for move) to accomplish register/register, register/memory, memory/memory, memory/stack, and register/stack manipulation.

INSTRUCTION REPERTOIRE: Please refer to the table entitled "Instruction Repertoires" (page M11-384-306) for the individual instruction class makeup of the various PDP-11 family members. The classes are:

- **Single Operand**—General (e.g., clear, increment, decrement, complement, negate, test); Shifts; Multiple Precision (e.g., add and subtract with carry, extend sign); and Rotate. Many of these instructions have word and byte operand versions.
- **Double Operand**—General (e.g., storage-to-storage move, add, subtract, compare); Register Destination (e.g., multiply, divide, Exclusive OR); and Logical. Move and Compare can have word and byte versions; logical instructions can have bit and byte versions.
- **Memory Management**—Move From Previous Data Space, move From Previous Instruction Space, Move to Previous Data Space, and Move to Previous Instruction Space.
- **Branches**—Unconditional; Simple Conditional Branches; Signed Conditional Branches (for testing values of 2's complement arithmetic); and Unsigned Conditional Branches (for testing results of comparing unsigned operands).
- **Subroutine**—e.g., Jump to Subroutine, Mark, and Return from Subroutine.

DEC PDP-11 Family

➤ that the 11/04 and 11/34 systems represent the models from which future DEC products will evolve.

DEC groups the current PDP-11 line into four application levels:

- *Microcomputers*—the LSI-11 and LSI-11/2, for board-level integration into dedicated applications, and the PDP-11/03, for packaged microcomputer applications.
- *Minicomputers*—the PDP-11/04, for dedicated applications.
- *Systems computers*—the PDP-11/34, 11/45, and 11/55, for multi-task applications.
- *Multi-function computers*—the PDP-11/60 and PDP-11/70, for real-time, batch, and time-sharing applications.

The LSI-11 is a board-level microcomputer product specifically designed for sophisticated users who can incorporate the LSI-11 into a product, taking advantage of its PDP-11 family capabilities that were previously unavailable in such packaging. The LSI-11 has the capabilities of a real minicomputer, including a CPU with the 11/40 instruction repertoire, 8K 8-bit bytes of memory, and an I/O bus port on one board. Additional memory on other boards can be used to expand the capacity to up to 57,344 bytes.

The LSI-11/2, like the LSI-11, is a board-level microcomputer product. The main differences are that on the LSI-11/2 main memory is not on the processor board and all boards are the same 5-by-8.5-inch size.

The PDP-11/04 minicomputer provides solutions to dedicated applications in which the computer is used to solve one or two problems and run one or two programs. It is used, for example, in data acquisition, to convert analog signals to digital signals, to analyze pulse heights, and to store data on magnetic tape. As little as 8K bytes of memory can suffice in straightforward applications, but the systems can be expanded to up to 56K bytes in order to handle more complex applications, perhaps coded in a high-level language such as FORTRAN IV or BASIC.

The PDP-11/34, 11/45, and 11/55 system computers are used in multiple-task applications where the computer must solve many problems or run multiple programs. They are being used to automate entire industrial processes, for example, monitoring and controlling multiple operations in real-time while preparing and printing production reports for management. Memory sizes can range from 16K to 248K bytes to accommodate several programs in memory simultaneously. The system speed is dependent on the user's choice of memory, and DEC offers core, MOS, and bipolar for instruction cycle times as fast as 300 nanoseconds.

- ● **Program Control**—e.g., Jump, Subtract One and Branch, and, in some models, Set Priority Level.
- **Traps**—these are calls to emulators, I/O monitors, debuggers, and user-defined interpreters.
- **Miscellaneous**—e.g., Halt, Wait, Reset, and in various models, No Op, Move to/from Previous Instruction/Data Space.
- **Condition Code Operators**—Set/Clear conditionally or unconditionally all of each of the four PDP-11 condition code bits.
- **Floating Point**—the four arithmetic functions for floating-point arithmetic. In models with both single- and double-precision floating-point arithmetic, these instructions have single- and double-precision versions. In the 11/34A, 11/45, 11/55, 11/60, and 11/70, which have autonomous floating-point processors, and in the 11/60 firmware set, the floating point instruction repertoire includes loads/stores for full operands and exponents only, similar compares, floating-point processor condition code operators and set/clear floating-point/integer mode, tests, load/store status, make absolute value, etc.
- **User Control Store**—Extended Function Code appears in one form only.
- **Maintenance**—Maintenance Exam and Dep, Load Microbreak Register, Maintenance Normalization Shift, Maintenance Partial Product, and Maintenance Alignment Shift.

INSTRUCTION TIMINGS: Please refer to the table entitled "Instruction Times" on page M11-384-307. Instruction times for some of the newer processor models were not available at this writing.

INTERRUPTS: All models except the LSI-11 and 11/03 have four automatic hardware priority level interrupts. The 11/45, 11/55, 11/60, and 11/70 can also use any of seven programmable software-supported additional interrupt levels; these have an automatic vectoring instruction held in a reserved main storage location. Each of the interrupt levels can accommodate independently prioritized peripheral devices.

PHYSICAL SPECIFICATIONS: Nominal operating environments for the PDP-11 processors are 50 to 104 degrees Fahrenheit (10 to 40 degrees Centigrade), at 10 to 90 percent relative humidity, with maximum wet bulb of 82 degrees Fahrenheit and minimum dew point of 36 degrees Fahrenheit. These are processor specifications; electromechanical peripherals may be more sensitive to their environments. Recommended operating conditions for a typical system are 70 degrees Fahrenheit ± 2 degrees with a noncondensing relative humidity of 45 percent ± 5 percent.

DEC offers a vast array of PDP-11 family equipment, and it is beyond the scope of this report to present more than generalized information regarding the physical specifications of the processors. Please note that all cabinet-mounting components except the 11/60 processor fit in RETMA-standard (19-inch) cabinet interiors, and that the cabinets generally measure 21 inches wide, 30 inches deep, and 72 or 50 inches high. The standard cabinet for the 11/60 is 27.5 or 46.5 inches wide, 30 inches deep, and 50.5 or 60.5 inches high. A 19-inch rack-mounted version is available for OEM's.

DEC recommends that the air distribution system provide cool, well-filtered air with room air pressure kept higher than the pressure of adjacent areas to prevent dust infiltration. Metal walls and partitions are not recommended unless they are insulated on the conditioned surface. For efficient cooling,

DEC PDP-11 Family

- ▶ The 11/60 is oriented toward high-performance real-time applications and medium-performance, multi-user, multi-task, time-shared applications. This model is targeted specifically for real-time, scientific/engineering, and educational environments.

The multi-function PDP-11/70 can handle simultaneous batch, real-time, and time-sharing applications in its larger configurations, or pairs of these in smaller configurations. It incorporates such advances as integral bipolar cache memory and interleaved core memory to reduce effective memory cycle times to below 400 nanoseconds, fast mass storage devices, and a special high-speed 32-bit data bus to accommodate them.

MARKETING GROUPS

One aspect of the PDP-11 family (as well as other DEC products) that often causes confusion to both prospective and current DEC customers is the many marketing groups within Digital Equipment Corporation. Spokesmen for the manufacturer pictured the company as eight different small companies, each specializing in different applicational markets that have been carefully delineated to have little or no jurisdictional overlap. Each group has been given the freedom to develop products and markets within its own sphere of responsibility, independently of other groups. All groups, however, draw equipment for their products from the common pool of DEC hardware and, to a lesser degree, develop software from the major DEC operating systems.

PPD-11's are sold by DEC's OEM Marketing Group, Industrial Products Group, Distributed Data Processing Group (responsible for data communications, finance, transportation, and government markets), Telco and Engineering Computation Group, Laboratory Data Products Group, and—in Datasystem 500 and Datasystem 320/350 packaging—by the Business Products Group, Education Products Group, and Graphic Arts (Typeset) Group.

The laboratory was one of DEC's first markets, and is still one of its best application areas. The Lab Data Products Group has the charter of developing and promoting laboratory and scientific systems based mainly on the PDP-11 family.

The Business Products Group is responsible for the development and marketing of special PDP-11-based systems for the business market. DEC's business products have become popular with major users in the insurance, manufacturing, finance, transportation, and wholesale distribution fields to perform such functions as order entry, inventory control, billing, payroll, accounts receivable, and other classic general accounting and information handling applications. The PDP-11-based DEC Datasystem 500 Family is fully described in Report M11-385-401, and the Datasystem 320 and 350 Series are the subject of Report M11-385-201.

- ▶ a minimum 30-inch clearance above the equipment should be employed. To avoid static electricity problems, the floor surface material should have a surface resistance of 0.5 megohms to 20,000 megohms at 40 to 50 percent relative humidity and a temperature of 68 to 72 degrees Fahrenheit.

BTU output per hour varies from 4240 for the 11/03 processor to 5889 for the 11/70 processor. A typical 11/60 system would output 17,000 BTU per hour.

INPUT/OUTPUT CONTROL

UNIBUS: The patented Unibus, a single common data path that treats all components or modules of a PDP-11 family system as equal-level devices for data access and transfers, including the processor, memory modules, and peripheral controllers, is part of all PDP-11 family members with the exception of the LSI-11 and the 11/03. The 11/45, 11/55, and 11/60 have a pair of Unibuses for I/O and memory reference overlapping. The 11/70 incorporates a standard Unibus and 32-bit internal buses between core memory and cache memory and between high-speed peripheral controllers (e.g., disk and 1600-bpi magnetic tape) and cache memory. The LSI-11 and 11/03 have a "pseudo-Unibus" structure that eliminates some lines by doubling-up address and data lines through time-sharing them.

The priority of any device connected to the Unibus is determined by its physical position; hence, the processor is normally attached so as to give it the highest priority. There is no logical limit to the number of devices that can be attached to the Unibus, with bus access and control handled by the interrupt system.

The theoretical maximum Unibus data transfer rate is 5 million bytes per second, and attached components communicate in a master/slave manner. The maximum data rate of the 11/45 and 11/55 solid-state bus is 6 million bytes per second, without affecting the Unibus's capability. On the 11/70, the 32-bit bus is fast enough (i.e., 2 million 8-bit bytes per second) to permit overlapped use by the CPU, Unibus, and/or several mass storage units, the fastest of which presently operates at 1 million bytes per second. DEC also states that interleaved core memory raises this 32-bit bus bandwidth to 5.8 million bytes per second. Interleaving is done whenever more than minimum memory is purchased.

It should be noted that the 32-bit bus of the 11/70 connects high-speed peripheral controllers to main memory, through cache memory, for data transfer purposes. The priority arbitration logic within the cache memory controls the timing of data transfers. Cache is not affected except that the involved 4-byte block is "flagged" whenever a write hit on an I/O transfer occurs, so as to indicate that the data in the cache is invalid, but that correct data is in core memory. The Unibus, meanwhile, handles the interrupt requests and transfer protocols for the high-speed units.

It is important to note that the 11/60 lacks the 32-bit internal I/O bus found in the 11/70. Cache in the 11/60 therefore does not function in the timing of data transfers.

The LSI-11 and PDP-11/03 bus has a maximum data transfer rate of 1666K bytes per second.

SIMULTANEOUS OPERATIONS: While I/O using the programmed interrupt structure cannot be simultaneous with processing or other I/O, NPR (non-processor data transfers) can. These are DMA (direct memory access) data transfers via the Unibus (or other buses in the large processors). Examples of NPR data transfers are memory to/from main storage and directly between devices (e.g., disk refreshing a CRT display) in an 11/70. NPR is available to all PDP-11 family members.

DEC PDP-11 Family



These disk drives exemplify DEC's vigorous efforts toward vertical integration of its product line. The RL01 (foreground) employs 5-megabyte disks and can be used with all PDP-11 computers, including the microprocessor-based PDP-11/03. The free-standing RK07 drive (left rear) can be used with PDP-11/04 and -11/34 through -11/70 computers; it has a capacity of 28 megabytes. The RM02 drive (right rear) is used with PDP-11/34 through PDP-11/60 computers and has a capacity of 67 megabytes. All these disk units are now available for volume deliveries, and their prices range from \$3,800 to \$23,000.

► CONFIGURATION RULES

In general, all PDP-11 devices that tie into the Unibus impose a single "bus load." (CPU's and the multi-device bulk storage bootstrap loader impose two bus loads each.) The Unibus can support 20 bus loads before a Bus Repeater must be added. A Unibus repeater allows an additional 18 unit loads and an additional 50 feet of Unibus cable to be added to a system.

In order to physically attach devices to a PDP-11, sufficient mounting hardware must be present. Free-standing and cabinet-mounted devices do not tie up space on the system's chassis.

Each PDP-11 has a basic chassis with a unique number of "system unit" positions in it. Each system unit (SU) is a space for mounting a backplane (backpanel mounting unit). The backplane is a printed circuit board with sockets. Each row of sockets is a slot. Currently available SU's can accommodate either seven hex and two quad slot modules or two hex and two quad slot modules. Quad slot modules have four connector fingers, while hex slot modules have six connector fingers. Each finger fits in its corresponding socket.

In order to expand memory and/or peripherals beyond the space limits permitted by the basic chassis, certain kinds of expander boxes must be used, depending upon the PDP-11 family model.

The basic prewired backplane used in the LSI-11 and 11/03 has 16 slots that are grouped in to eight pairs. Each pair can accommodate one LSI-11-type module. The CPU module, with or without the integral 8K-byte memory, requires two pairs, leaving six pairs for peripherals and options. Most peripherals require only one pair of slots. Semiconductor memory modules, like the CPU Module, require two pairs of slots. Core memory modules are thicker than semiconductor memory modules and, while requiring only two pairs, preclude the use of the adjacent two pairs of slots. Customers must provide DC power for the LSI-11.

The 11/04 and 11/34A are available in either a small chassis with a 9-slot backplane or a large chassis which can mount backplanes with a total of 9 to 22 slots. Additional system expansion is available via BA11 expansion chassis. Beside the basic processors, numerous packaged configurations are offered. Available SU slots (backplane space) and hex and quad slots to be used for expansion in the basic processors and their packaged systems are specified in the equipment price list.

The 11/35 basic chassis has room for nine SU's. Two of these SU positions are reserved for the CPU, extended instruction set, floating-point instructions, real-time clock, memory management option, and console interface. Two more SU positions are used for the basic 64K-byte memory, with room for an additional 64K bytes of memory. The remaining five system unit positions are available for memory expansion or peripheral attachment. If additional memory is required beyond the capacity of the basic chassis (more than 128K bytes), an H960-D Equipment Mounting Cabinet (nine system units) can be added. For additional peripherals, either the H960-D or a BA11 Expander Box can be added.

The 11/45 basic chassis has nine SU positions. Eight of these are prewired to contain the processor, real-time clock, floating-point instructions, memory management option, and 64K bytes of core memory. One SU position is available on the 11/45 for additional memory or peripherals.

The 11/55 is identical to the 11/45 except that only six SU positions are prewired. This results in the availability of three SU positions for peripheral devices or optional core memory in the basic chassis. If more peripherals or main memory are required than can be handled by the basic chassis, either an

► The orientation of the Education Products and Graphic Arts Group is implied in their names. Both are forces with constantly evolving products to offer their respective fields. However, this report does not dwell on their specialized offerings.

The OEM Marketing Group is really composed of two groups, OEM Computer Marketing and Components. OEM (Original Equipment Manufacturers) Marketing sells computers in quantity to industrial and commercial firms who then add value to the computer (e.g., develop a package system for resale) and market it. The Components Group sells the DEC-built minicomputer peripheral line, composed of such products as the LA36 and LA180 DECwriter II, the VT50 and VT52 DECscope CRT terminals, and the LSI-11 and PDP-11/03 microcomputers. This group also operates a direct sales facility open to both OEM's and end users who wish to reduce maintenance and repair costs by performing some of this activity through their own qualified personnel. For this purpose, the Components Group has issued a Direct Sales Catalog that permits ordering supplies, modules, chassis, power supplies, terminals, and microcomputers in the

DEC PDP-11 Family

▷ same way consumers order merchandise from mail order houses. DEC is one of a few pioneers in this service that allows users to take advantage of the substantial savings that can be realized through this do-it-yourself approach.

The final group, the Industrial Products Group, sells hardware and software solutions for data acquisition and process control applications.

SOFTWARE

DEC's approach to software has been to avoid situations that require much "handholding" with customers. Instead, the company prefers to provide users with advanced data processing tools that facilitate development of specialized applications software. With the exception of certain packages offered as integral parts of its specialized product lines, such as Typeset, DEC offers only operating systems, language processors, communications software, and some management tools.

There are five basic operating systems offered for the PDP-11, one of which has three distinct versions, making a total of seven. *RT-11*, one of the oldest and smallest, is a single-user system for interactive program development. It can support both single-job and foreground/background modes of operation. The single-job version requires a 16K-byte system, and the two-partition version requires 32K bytes. *RT11* supports both the FORTRAN IV and BASIC languages for program development.

RSX-11 is a real-time operating system available in three versions that vary widely in functionality and in system requirements.

RSX-11D, the original and most powerful of the three, is an event-driven, disk-based multiprogramming system for the PDP-11/34 and larger systems. Using the memory management functions of these CPU's, *RSX-11D* permits user programs to be loaded and executed anywhere in memory, without modification. At least 96K bytes of main memory and two hard disks (no floppy disk) are required for single-user operations, and 112K bytes of main memory with 4 megabytes of disk storage are needed for multi-user operations.

RSX-11M, also a disk-based real-time operating system, extends the functions of *RSX-11D* to lesser PDP-11 systems, and can be run on any PDP-11 except the 11/03 and the LSI-11. *RSX-11M* requires a minimum of 32K bytes of main memory and one hard disk plus one other disk (which can be a floppy). To perform concurrent program development and real-time processing, at least 48K bytes of memory are required.

Both *RSX-11D* and *-11M* use the same file management modules, providing automatic space allocation and file structures for any block-structured file device.

RSX-11S is a memory-based subset of *RSX-11M* and does not require any disk storage. It does not support ▷

▶ **H960-D Equipment Mounting Cabinet or a BA11 Expander Box** can be added. DEC also provides the 11/55 in packaged configurations. Available SU slots and hex and quad slots to be used for expansion are provided in the equipment price list.

The 11/60 is currently available a packaged or cabinetless system. As a package, it is supplied in either a dual-width H9600-AA High Boy Expansion Cabinet or a 72-inch-high H961-AA Standard RETMA Cabinet. Available Su slots and hex and/or quad slots to be used for expansion are provided in the equipment price list.

The 11/70 contains the CPU, KW11-L Line Frequency Clock, hardware memory management, direct memory access, M9301-YC ROM Multidevice Bootstrap Loader, operator's console, prewired slots for up to four high-speed mass storage control units, floating-point processor, 2K-byte cache memory, LA36 DECwriter II console, and two H960 Equipment Cabinets with fans and power supplies. The 11/70 is also available as a packaged system. Available backplane slots and hex and/or quad slots provided with supplied backplanes are all given in the equipment price list.

Slot requirements for memory, special processor interface features, and peripherals include: FP11-A FPP, one hex slot; FP11-C FPP, dedicated 11/45, 11/55, or 11/70 slots (four); FP11-EA FPP, dedicated 11/60 slots (four); real-time clock for 11/03, double slot; other real-time clocks, one hex slot; memory module for 11/03, single or double slot; cache memory for 11/34A, one hex slot; memory modules for 11/34A, one or two hex slots; memory for 11/35, 11/45, or 11/55, two or four SU slots; memory for 11/60, dedicated 11/60 slot or 2 SU slots; bootstrap loaders, double hex or quad slot; floppy disk subsystem, one quad slot or double 11/03 slot; cartridge disk subsystem, one quad slot or double 11/03 slot; cartridge disk subsystem, one or two SU slots or double 11/03 slot; pack disk subsystem, two SU slots or dedicated 11/70 slot; fixed-head disk subsystem, two SU slots; magnetic tape subsystem, either one or two SU slots or 11/70 slot; most communications options, one hex slot, two hex slots, one quad slot, or single 11/03 slot; asynchronous multiplexers (NPR output), two SU slots; auto dial interface, one SU slot; line printer subsystems, one quad slot; punched card subsystems, one SU or quad slot; punched tape subsystems, one quad slot; backplanes, one or two SU slots; and Unibus extension hardware, one SU slot.

MASS STORAGE

TC11 DECTAPE SUBSYSTEM: A magnetic tape system in which the tape is preformatted into blocks in much the same way that a disk pack is formatted for use. The basic unit contains dual bidirectional drives, each holding a 260-foot reel of 10-track tape. Data is recorded on 3 redundant data tracks, requiring 6 line positions to store a 16- or 18-bit word. Since the tape is preformatted, searches and random access operations can occur much more efficiently than with standard magnetic tape subsystems. The controller can accommodate up to four dual TU56 transports, each capable of storing up to 288K bytes of data in blocks of 1156 bytes each. Data transfer rate is 10K bytes per second. Recording density is 350 bpi, and tape speed is 97 ips in either direction.

RX01 FLOPPY DISK: The RX01 is a single-sided flexible disk drive with a capacity of 256,256 bytes per drive. Up to two drives per controller can be configured. Rotational speed is 360 rpm, yielding an average rotational delay of 83 milliseconds. Data transfer rate is 31K bytes per second including 2-sector interleaving. Track to track, average, and maximum head movement times are 6, 180, and 490 milliseconds, respectively. Head settling time is 20 milliseconds. The surface of the diskette is divided into 77 tracks, each with 26 sectors. Each sector contains 128 bytes. IBM-compatible software sectoring is employed. Bit density is 3200 bits per inch maximum. ▶

DEC PDP-11 Family

➤ program development or a file system, and merely provides a run-time environment for application programs developed on larger host systems. RSX-11S requires only a 16K-byte CPU and a loading device and supports only the smaller mass storage devices.

RSTS/E is DEC's resource-sharing, time-sharing system that supports up to 63 simultaneous users performing either interactive data processing using the BASIC-PLUS language or batch-mode operations using COBOL. RSTS/E also has a more sophisticated file system than RSX-11, supporting both random and sequential files. In addition, the newly announced RMS-11 adds multi-keyed indexed sequential (ISAM) files to the list. RMS-11 enhances the RSTS/E file capabilities with multi-level privacy control and allows both generic and approximate key searches. RSTS/E requires an 11/34 or larger with a minimum of 64K bytes of memory, hard disk, magnetic tape, and a console terminal.

DMS-11 is an interactive multi-user operating system that is optimized for data base management functions, including the random retrieval of string-oriented data from large tree-structured files.

IAS, originally developed to take advantage of the new PDP-11/70 functions, can also run on a PDP-11/45 and PDP-11/60. IAS permits three concurrent operating modes—real-time, interactive, and batch—providing interactive multi-language services for up to 32 simultaneous users. IAS uses the same file management modules as RSX-11D and -11M as well as other control modules. In addition, IAS provides output spooling services to printers and non-interactive terminals, accounting information for both interactive and batch users showing CPU and memory utilization and connect time, automatic error logging on disk, and user-initiated diagnostic routines for confidence checks.

In programming languages, DEC offers PDP-11 users APL-11 under RSTS/E and RT-11; several versions of BASIC under various operating systems; COBOL under RSX-11D, RSTS/E and IAS/RSX-11M; CORAL-66 under IAS/RSX-11M; DIBOL-11; FOCAL under RT-11; several versions of FORTRAN IV under various operating systems; MUMPS-11 under DSM-11; and RPG-11.

Communications software products include IBM HASP, 2780, and 3271 emulators, Control Data 200 and Univac 1004 emulators, and the extensive DECnet communications network software.

TRAX, introduced in May 1978, is an interactive transaction processing system that runs on PDP-11/34, PDP-11/60, and PDP-11/70 computers. The user interface to TRAX is a new microprocessor-controlled application terminal, the VT62. Available only in packaged system form, TRAX supports up to 16 simultaneously active terminals on a PDP-11/34 system and up to 64 terminals on a PDP-11/70 system. ➤

➤ The RX01 can be purchased only as part of an RX11 or RVX11 subsystem, each of which consists of a controller and one or two RX01 drives. The RVX11 is a subsystem designed specifically for the PDP 11/03. The RX01, RX11, and RVX11 are all manufactured by DEC.

RS03 AND RS04 FIXED-HEAD DISKS: The RS03 and RS04, respectively, store 512K and 1024K formatted bytes. Data transfer rates of 500K bytes per second noninterleaved and 250K bytes per second interleaved are possible on the RS03. The RS04 transfers data at 500K bytes per second on all PDP-11 systems except the PDP 11/70, where rates up to one megabyte per second are possible. Recording density is 2200 bpi. There are 64 tracks and 4 spares (RS03) or 8 spares (RS04). Data is stored in blocks of 64 words on the RS03 and in blocks of 128 words on the RS04. The RS03 uses one read/write head at a time; the RS04 optionally uses two heads in parallel. There are 64 heads on the RS03 and 128 heads on the RS04. The higher-capacity RS04 records information on both surfaces of the disk, whereas the RS03 uses only one surface. The number of sectors, 64, is the same, but the RS04 achieves double capacity by recording odd-numbered bits on one surface and even-numbered bits on the other.

Fast track-switching permits "spiral" reading or writing from one track to the adjacent track in a single transfer operation. When the last sector on a track has been transferred, the disk automatically advances to the next track without any delay in the transfer rate. Up to 128K bytes can be transferred in a single operation.

Disk rotational speed is 3530 rpm. Average rotational delay is 8.5 milliseconds, and minimum access time is 6.4 microseconds. (Using 50-Hertz power, these times become proportionally greater.) Up to eight drives of either type can be intermixed on a controller. The RS03 and RS04 are packaged with a controller—the RS03 as the RJS03-B subsystem (for all PDP-11 systems except the PDP-11/70) or the RW03-B subsystem (for the PDP-11/70), and the RS04 as the RJS04-B subsystem (for all PDP-11 Systems except the 11/70) or the RWS04-B subsystem (for the PDP-11/70). Controllers in these subsystems can handle up to 8 intermixed drives of either the RS03 or RS04 type. These units are manufactured by DEC.

RL01 5.2-MEGABYTE CARTRIDGE DISK DRIVE: This is a top-loading drive employing a removable cartridge. Features provided in the RL01 include an embedded servo, allowing control information to be dispersed on each data track for data integrity. Disk rotational speed is 2400 rpm, and average rotational delay is 12.5 milliseconds. Average head positioning time is 55 milliseconds. Data transfer rate is 512K bytes per second.

RL01 packaged products include the RLV11-AK subsystem for the 11/03 and the RL11-AK subsystem for all PDP-11 systems except the 11/03. All subsystems consist of one drive and a controller for up to four drives. The RL01 and related subsystems are manufactured by DEC.

RK05J 2.4-MEGABYTE CARTRIDGE DISK DRIVE: This is a 2315-type removable-cartridge drive that records data at 512 bytes per sector, 12 sectors per track, 203 tracks per surface (including 3 spares), and 2 surfaces per drive. Formatted capacity is 2,457,600 bytes. Recording density is 2040 bits per inch, and track density is 100 tracks per inch. Disk rotational speed is 1500 rpm, and average rotational delay is 20 milliseconds. Track-to-track, average, and maximum head positioning times are 10, 50, and 85 milliseconds, respectively. The data transfer rate is 156K bytes per second (11.1 microseconds per 16-bit word).

RK05J packaged products include the RKV11 subsystem for the 11/03 and the RK11J subsystem for all PDP-11 systems except the 11/03. All subsystems consist of one drive and a controller for up to eight drives. The RK11J subsystem can

DEC PDP-11 Family

COMMUNICATIONS HARDWARE INTERFACES

Unit	Line Interface	Max. Line Speed, bps	Mode	DMA Data Transfer		Lines per Unit	Max. Units per System (1)	Max. System Throughput, cps	Backplane Requirement	DECnet Support	Operating System Support (2)	Comments
				In	Out							
Single-Line Asynchronous:												
DL11-A	20-ma current loop	2400	Fdx/Hdx	No	No	1	16	—	1 quad	—	—	
DL11-B	EIA/CCITT	2400	Fdx/Hdx	No	No	1	16	—	1 quad	—	—	
DL11-C	20-ma current loop	9600	Fdx/Hdx	No	No	1	31	—	1 quad	—	—	
DL11-D	EIA/CCITT	9600	Fdx/Adx	No	No	1	31	—	1 quad	—	—	
DL11-E	EIA/CCITT	9600	Fdx/Hdx	No	No	1	31	2400	1 quad	Yes	All	For Bell 103A, E, F; 113A; 202C or D
DL11-WA	20-ma current loop	9600	Fdx	No	No	1	16	2400	1 quad	Yes	All	Inc. Line Frequency real-time clock
DL11-WB	EIA/CCITT	9600	Fdx	No	No	1	16	2400	1 quad	Yes	All	Inc. line frequency real-time clock
DLV11	20-ma/EIA/CCITT	9600	—	—	—	1	—	—	1 sgl. 11/03	—	RT-11	No modem control
DLV11-E	EIA/CCITT	—	—	—	—	1	—	—	—	—	—	For Bell modems
DLV11-J	EIA	38,400	—	—	—	1	—	—	—	—	—	4 independent units; RS-422, -423
Asynchronous Multiplexers (Programmed I/O):												
DJ11-AA	EIA/CCITT	9600	Fdx/Hdx	—	—	16	16	—	1SU	—	—	No modem control
DJ11-AB	DC08 Teletype line	9600	Fdx/Hdx	—	—	—	16	—	1SU	—	—	Without distribution panel
DJ11-AC	20-ma current loop	9600	Fdx/Hdx	—	—	16	16	—	1SU	—	—	
DZ11-A	EIA/CCITT	9600	Fdx	No	No	8	16	19,200	1 hex	No	All	Inc. control for Bell 103 or 113
DZ11-B	DZ11-A expansion	9600	Fdx	No	No	8	—	—	1 hex	—	All	
DZ11-C	20-ma current loop	9600	Fdx	No	No	8	16	19,250	1 hex	No	All	
DZ11-D	DZ11-C expansion	9600	Fdx	No	No	8	8	38.4K	1 hex	No	All	
DZ11-E	EIA/CCITT	9600	—	—	—	16	—	—	2 hex	—	All	Inc. control for Bell 103 or 113
DZ11-F	20-ma current loop	9600	—	—	—	16	—	—	2 hex	—	All	
DZV11-B	EIA/CCITT	9600	—	—	—	4	—	—	1 sgl. 11/03	—	—	Inc. control for Bell 103 or 113
Asynchronous Multiplexers (NPR Output):												
DH11-AA	EIA/CCITT/20-ma	9600	Fdx/Hdx	No	Yes	16	16	38.4K	2SU	No	All but RT-11	Intermixed lines in groups of 4
DH11-AB	DC08 Teletype line	9600	—	—	—	16	16	—	—	—	—	No level conv. or distribution panel
DH11-AD	EIA/CCITT	9600	Fdx/Hdx	No	Yes	16	16	38.4K	2SU	No	RSTS, 11M, IAS	Includes control for Bell modems
DH11-AE	EIA/CCITT	—	—	—	—	—	16	—	2SU	—	All but RT-11	No modem control
Single-Line Synchronous:												
DU11-DA	Bell 200 Series	9600	Fdx/Hdx	—	—	1	16	—	1 quad	—	—	DDCMP, Bisync, SDLC, HDLC protocols
DUP11-DA	Bell 200 Series	9600	Fdx/Hdx	No	No	1	16	2400	1 hex	Yes	—	DDCMP, Bisync, SDLC, HDLC protocols
DUV11-DA	Bell 200 Series	9600	Fdx	—	—	1	—	—	—	—	—	
DMC11-AL	Local Line	1000K	Fdx/Hdx	Yes	Yes	1	2	250K	1 hex	Yes	All	DDCMP microprocessor module
DMC11-AR	Remote line	19.2K	Fdx/Hdx	Yes	Yes	1	16	4800	1 hex	Yes	All	DDCMP microprocessor module
DQ11-DA	EIA/CCITT	10,000	Fdx/Hdx	Yes	Yes	1	16	2400	1SU	Yes	IAS, RSX	For Bell 201, 208, or 209
DQ11-EA	EIA/CCITT	1000K	Fdx/Hdx	Yes	Yes	1	16	250K	1SU	Yes	IAS, RSX	For Bell 303
Multiple-Line Synchronous/Asynchronous:												
DV11-AA	EIA/CCITT	9600	Fdx/Hdx	Yes	Yes	16	2	38.4K	2SU	Yes	—	NPR I/O transfers; tbl.-driven char. proc.
General-Purpose:												
DR11-B	16-bit parallel direct attach.	—	—	Yes	Yes	—	32	—	1SU	No	RT-11, 11M	NPR operation
DR11-C	16-bit parallel direct attach.	—	—	No	No	—	32	—	1 quad	No	RT-11, 11M	Bidirectional
DR11-K	16-bit parallel direct attach.	—	—	—	—	—	—	—	1 hex	—	RT-11, RSTS	Bidirectional; each line can interrupt
DRV11-B	16-bit parallel direct attach.	—	—	Yes	Yes	—	—	500K	—	—	RT-11	

(1) Usually, more than the number indicated can be physically attached; message processing throughput is the limiting factor.
 (2) RSTS=RSTS/E; RSX=RSX-11S, -11D, -11M; 11M=RSX-11M.

➤ TRAX includes extensive file organization and record access services, restart/recovery, data protection, and forms handling capabilities. Application programs are written in small, structured modules in either the COBOL or BASIC-PLUS II high-level language; terminal screens are formatted using the ATL forms language. Programs are both created and tested interactively. Built-in communications options, using either COBOL or BASIC-PLUS II, enable several TRAX systems to exchange data and process inquiries. TRAX systems can also communicate with mainframe systems using TRAX 3271 protocol emulation.

For data base users, DEC offers DBMS-11, a data base management software system based on Cullinane Corporation's IDMS. This makes two powerful data base management systems available for PDP-11 systems, since Cincom Systems has developed a version of its popular TOTAL system for use on PDP-11's. DEC chose to go with the Cullinane system because it conforms to CODASYL recommendations.

➤ consist of intermixed RK05J and RK05F drives. The RK05J and related subsystems are manufactured by DEC.

RK05F 4.8-MEGABYTE CARTRIDGE DISK DRIVE: A double-density version of the RK05J cartridge disk drive having 406 tracks per surface. It uses a nonremovable cartridge and has a formatted capacity of 4,915,200 bytes. The RK05F drives can be intermixed with RK05J drives on the same controller, although there must be at least one RK05J drive in the subsystem. To the operating software, one RK05F appears as two logical RK05J's. Hence, a maximum subsystem using RK05F's has three RK05F drives and two RK05J drives. For information on RK05F subsystems, see the RK05J Disk Drive, above. The RK05F drive is manufactured by DEC.

RK06 14-MEGABYTE CARTRIDGE DISK DRIVE: This drive accepts a top-loading, dual-platter disk cartridge employing a technology similar to that of the IBM 3330 through the use of a track-following servo system. With this system, the bottom surface of one platter is dedicated to servo control and tracking information. Recording is on three surfaces at 4040 bits per inch and 192.3 tracks per inch. Data is recorded at 512 bytes per sector, 22 sectors per track, and 411 tracks per surface. Formatted capacity is 13,888,600 bytes. Disk rotational speed is 2400 rpm, and average rotational delay is 12.5

DEC PDP-11 Family

▷ A substantial library of user-generated, but not DEC-supported, software is available from two groups within DEC. DECUS, the DEC USers Society, offers a catalog of software packages that includes languages, editors, numerical functions, utilities, display routines, and various other types of applications software. Also, the Educational Products Group publishes the Index and Description of Educational Applicational Software (IDEAS), which lists software packages developed by users specifically for educational purposes. Some of the programs listed in the IDEAS catalog are from the DECUS catalog. Users can obtain copies of these programs on various media for a nominal charge by contacting either of these organizations.

Although DEC sells most of its products on a purchase basis, leasing arrangements are available either through DEC's joint venture with U.S. Leasing Corp. or through TEC Leasing Corp. of New York. Lease rates vary with the prime interest rate, the buyer's volume of business with DEC, and the value of the equipment being leased. DEC software is not sold; rather, it is licensed. Users purchase licenses and distribution rights separately.

Hardware and software maintenance are offered through several levels of optional service. Hardware maintenance options vary from several off-site plans to on-call service and guaranteed four-hour service. Software maintenance is offered through several levels of optional service ranging from a periodic software newsletter to automatic updates of software and manuals via a subscription service.

USER REACTION

Detailed below are the responses of 130 DEC PDP-11 users with 395 installed systems to Datapro's 1977 survey of computer users. The bulk of the systems represented were PDP-11/34's and PDP-11/70's, but the survey also included users with 11/03, 11/05, 11/10, 11/40, 11/50, and 11/55 systems.

Among the users with systems up to and including the 11/35, RSX-11M was the most popular operating system, followed by RT-11 and RSTS/E. For larger systems up to and including the 11/70, RSTS/E was the most popular operating system, followed by RSX-11, IAS, and MUMPS-11 in that order. A small number of users were operating under UNIX and other non-DEC products.

The most popular language by far was FORTRAN; other languages, in the order of their popularity, included BASIC, Assembler, COBOL, RPG, APL, MUMPS, and DIBOL. Non-DEC-supported languages such as LISP and PASCAL were also being used to a limited extent.

The survey reflected both large and small users, with two of the larger companies showing 50 and 55 PDP-11 installations. The systems had been in use for periods ranging from 2 to 84 months, with the average installation showing an operation period of 24 months. The overwhelming majority of systems had been purchased outright from Digital. Third-party lease arrangements had ▷

▶ microseconds. The data transfer rate is 538K bytes per second (3.72 microseconds per 16-bit word). Track to track, average, and maximum head positioning times are 9, 38, and 50.5 milliseconds, respectively.

RK06 packaged products include the RK611-E single-access subsystem and the RK611-F dual-access subsystem. All subsystems consist of one drive and a controller for up to eight drives. RK06 subsystems may not be used with the PDP-11/03. The RK06 drives and related subsystems are manufactured by DEC.

RK07 28-MEGABYTE CARTRIDGE DISK DRIVE: This drive is functionally identical to the RK06, but its formatted capacity is 28 megabytes. RK07 packaged products include the RK711-EA single-access subsystem and the RK711-FA dual-access subsystem. Both subsystems consist of one drive and a controller for up to eight drives. RK07 subsystems may not be used with the PDP-11/03. The RK07 drives and related subsystems are manufactured by DEC.

RM02 67-MEGABYTE DISK PACK DRIVE: This drive, like other disk pack drives offered by DEC for the PDP-11, employs a technology similar to that of the IBM 3330 through the use of a track-following servo system. In this system, one disk surface of each pack is dedicated to servo control and tracking information. The pack contains five platters, with the top and bottom platters employed for protection. Data is recorded on five surfaces. The drives rotate at 2400 rpm, resulting in an average rotational delay of 12.5 milliseconds. Average head positioning time is 30 milliseconds, and data transfer rate is 806K bytes per second.

RM02 packaged products include the RJM02-AA single-access subsystem and the RJM02-BA dual-access subsystem. Both subsystems consist of one drive and a controller for up to eight drives. The RM02 drives can be used on the PDP-11/34A through the PDP-11/60.

RM03 67-MEGABYTE DISK PACK DRIVE: This drive is functionally similar to the RM02 drive. Recording is on five surfaces at 6038 bits per inch and 384 tracks per inch. Data is recorded at 512 bytes per sector and 823 tracks per surface (including 15 spare tracks). Formatted capacity is 67 megabytes. The drives rotate at 3600 rpm, resulting in an average rotational delay of 8.3 milliseconds. Track-to-track, average, and across-all-tracks head positioning times are 6, 30, and 55 milliseconds, respectively. Head positioning is performed by a closed-loop proportional servo system driving a voice-coil actuator. Data transfer rate is 1.2 megabytes per second.

RM03 packaged products include the RWM03-A single-access subsystem and the RWM03-B dual-access subsystem. Both subsystems consist of one drive and a controller for up to eight drives. The RM03 drives are for use in PDP-11/70 systems only. The RM03 is manufactured by Control Data (9762).

RP0X SERIES DISK PACK DRIVES: This series consists of three drives: the RP04 and RP05 88-megabyte drives and the RP06 double-density, 176-megabyte drive. Each of these drives employs a 12-platter disk pack and utilizes a technology similar to that of the IBM 3330, through the use of a track-following servo system. The bottom surface of the pack is dedicated to servo control and tracking.

The RP04 and RP05 drives are nearly identical. Both use IBM 3336-1-type disk packs, recording data on 19 or 20 surfaces. Data is organized on 411 tracks per surface, 22 sectors per track, and 512 bytes per sector. The major difference between the two drives is that the RP05 can be field-upgraded to RP06 status. Recording density is 4040 bits per inch, while track density is 192.3 tracks per inch. Formatted capacity for the RP04 and RP05 is 87,960,576 bytes. ▶

DEC PDP-11 Family

been elected by 18 of the users, mainly those with larger systems in the PDP-11/40 to PDP-11/70 range.

Application programs had been developed primarily by the users themselves. Proprietary programs and applications from Digital appeared most frequently on the larger systems, and ready-made and contract programs on the smaller systems (11/03 through 11/35). The most popular area of application for the larger PDP-11 systems was business data processing. On the smaller PDP-11 systems, real-time control was the most popular application.

The table below shows how the users rated the PDP-11 product line.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	51	68	11	0	3.3
Reliability of mainframe	71	44	14	3	3.4
Reliability of peripherals	37	62	26	6	3.0
Maintenance service:					
Responsiveness	38	48	30	7	2.9
Effectiveness	32	55	27	9	2.9
Technical support	17	44	44	15	2.5
Manufacturer's software:					
Operating system	29	60	23	6	2.9
Compilers and assemblers	26	66	27	2	2.9
Application programs	10	41	26	5	2.7
Ease of programming	36	71	17	1	3.1
Ease of conversion	12	49	24	5	2.7
Overall satisfaction	35	74	18	2	3.1

*Weighted Average on a scale of 4.0 for Excellent.

User comments indicated a high degree of satisfaction with the hardware. Survey respondents frequently used words like "reliable," "versatile," "flexible," and "cost-effective" in describing their systems.

The users' comments on the software were not as complementary, appearing in the main to be of the constructive or critical variety. A recurring comment involved the desire for larger application program sizes. Other comments concerned what the users considered to be inefficient data handling on the 11/70, sparse source-level documentation on the 11/34, a lack of written device drivers on the 11/55, incomplete reliability of RSX-11M, etc.

Technical support, however, was the area where the users were most vocal in their comments and most negative in their ratings. Specific comments included "poor software documentation and support," "need better technical support, both hardware and software," "DEC software support is abysmal," "software support virtually nonexistent," and "poor technical support."

DEC is not alone in its failure to satisfy its users with the current level of technical support. DEC users, however, tend to be more sophisticated and more demanding than most. Based on the company's past performance, DEC will solve this problem. You don't get to be the number one minicomputer manufacturer—or maintain that position indefinitely—by ignoring such complaints. □

► The RP06 is a double-density version of the RP05 drive and uses the IBM 3336 Model 11-type disk pack. Double density is achieved by organizing the disks into 815 tracks. Bit

recording density is the same as in the RP05. Formatted capacity for the RP06 is 174,423,040 bytes.

All three models have identical characteristics. The drives rotate at 3600 rpm, resulting in an average rotational delay of 8.3 milliseconds. The peak data transfer rate is 806K bytes per second (2.5 microseconds per 16-bit word). Track to track, average, and maximum head movement times are 10, 30, and 55 milliseconds, respectively.

Each subsystem includes a controller for up to 8 drives. Two types of controllers are offered: the "W" controller, which takes advantage of the higher I/O rate of the PDP-11/70; and the "J" controllers, usable with all current PDP-11's. Currently available subsystems include either a single-access or dual-access disk drive and controller. A dual-port kit is optional, permitting single-access disk drives to be converted to the dual-access models. Both the "J" and "W" controller can connect to a dual-ported disk pack drive.

The following table shows the product numbers of the currently available subsystems:

	Single Access Subsystems	Dual Access Subsystems
--	--------------------------	------------------------

For 11/70 system:

RP04	RWP04-A	RWP04-B
RP05	RWP05-A	RWP05-B
RP06	RWP06-A	RWP06-B

For other PDP-11 systems:

RP04	RJP04-A	RJP04-B
RP05	RJP05-A	RJP05-B
RP06	RJP06-A	RJP06-B

The RP04, RP05, and RP06 are manufactured by ISS/Univac. The RP06 is the ISS/Univac Model 733-11, while the RP04 and RP05 are the ISS/Univac Model 733-10.

INPUT/OUTPUT UNITS

Please refer to the Peripherals/Terminals Table on page M11-384-303 for information on the DEC peripheral equipment for the PDP-11 computers. Non-DEC peripheral devices that can be used with these and other popular minicomputers are summarized in Reports M13-100-301 through M13-100-601.

DATA COMMUNICATIONS

A discussion of data communications capabilities for the PDP-11 family involves more than a collection of hardware interfaces and a few software packages. Rather, it involves a marketing and engineering group—the Distributed Data Processing Group—which is chartered to develop, market, and generally further DEC's position in data communications. This group has taken its assigned tasks quite seriously and has developed hardware components, systems, and software packages in great numbers—so great, in fact, that the offerings of this group to the market are greater than those of many companies dedicated entirely to data communications.

Of the numerous DEC processor lines, the PDP-11 family was chosen for data communications emphasis. That doesn't mean that only 11's are found in these systems. Quite the contrary. The PDP-8's (see Report M11-384-101) were there initially also, and this family has its representatives in every DEC application line, due mostly to longevity.

Members of the PDP-11 line were selected for data communications use because of the wide spectrum of models with varying capabilities, ranging from the PDP-11/03 to the PDP-11/70. DEC states that it has placed much emphasis on

DEC PDP-11 Family

▶ giving all the PDP-11's considerable data communications capabilities, pointing to their byte-handling capabilities and the Unibus architecture, which does not require additional multiplexing hardware for multiple communications channels or for DMA transfers. Also, all PDP-11 communications interfaces follow standard PDP-11 configuration rules. Special chassis and/or backplanes for communications options are not required, as is the case with some other vendors' equipment.

This section covers both the hardware and software aspects of the PDP-11 data communication equipment, including systems offerings. The software packages, which are the breath of life to the various hardware configurations, are often used to name a specific product line, such as an RSTS/2780 system. RSTS is the name of a software package. This name is also given to product systems which use RSTS to control the associated hardware that makes up the *physical* system. This point has been brought out because the ensuing section will mention product names that may otherwise be considered additional hardware offerings, but which are merely standard components configurations with particular software packages controlling them.

Data communications control for all PDP-11's is supplied by numerous interface controllers. However, each of these has a number of variants and options so that PDP-11's can be connected to almost any type of communication channel (private phone, dial-up phone, 20-ma line, telegraph line), almost any type of terminal, or almost any type of modem. Supplementing these interfaces is additional data communications hardware to provide flexibility in unique situations.

Communications Hardware Interface	Line Adapter	Line Adapter Type
DV11-AA	DV11-BA	8-line; synchronous
	DV11-BB	8-line; asynchronous
	DV11-BC	8-line; 4 lines asynchronous, 4 lines synchronous
DMC11-AL	DMC11-MA	1-line, 1,000K bps, 6000 ft.
	DMC11-MD	1-line; 56K bps; 18,000 ft.
DMC11-AR	DMC11-DA	1-line; Bell 200 Series up to 19,200 bps
DH11-AA	DM11-BB	16-line; Bell 103/202
	DM11-DA	4-line; 20-ma
	DM11-DB	4-line; EIA
	DM11-DC	4-line; EIA/CCITT (req. DM11-BB).

The characteristics of the available interface controllers are summarized in the Communications Hardware Interfaces table on page M11-384-315. The available communications line adapters and their specifications are tabulated below.

The *DL11 Asynchronous Serial Line Interfaces* provide full- or half-duplex line control, changeable under program control. Mode changing, however, is the only programmed change that can be made to this unit. All other characteristics are set when the device is ordered, usually by straps on the board. Those features include a choice of 13 standard data rates between 50 and 9600 bits per second, choice of character size (5, 6, 7, or 8 bits) and stop element size (1, 1.5, or 2 bits), and selection of parity (odd, even, or none). Appropriate parity is appended to outgoing characters, and parity is checked on incoming characters. The unit contains independent two-character buffers (one to transmit data and one to receive data), permitting longer delays between interrupt servicing without annoying rate errors. The DL11 can operate with different input and output line speeds *except* when the 110 or 134.5 bps speeds have been selected. The DL11 is contained on one board.

The *DJ11 Asynchronous Multiplexer* bears some resemblance to the DL11, in that similar functions on both are hardware-selectable. As in the DL11, data rate, character size

and stop element length, and parity check/generation are all set up through hardware (switches or straps). In the case of the DJ11, it's all switches, whereas in the DL11 some of the above functions are selected through straps. Unlike the DL11, this multiplexer has no provisions for data set handshaking.

Another minor difference to note: the DJ11 offers 11 different speeds compared to the 13 offered by the DL11. Character buffering in the DJ11 is also slightly different. A common 64-character buffer serves all 16 lines and can be used to reduce per-character overhead as well as to prevent rate errors if the incoming characters temporarily exceed the CPU's processing rate. The 16 lines are not totally independent of each other. Character formats and speeds are selectable only for four-line groups rather than on an individual-line basis.

Since the DJ11 has no capabilities for modem control signals (handshaking), it can be used only on dedicated lines. It can still be used with a modem to send and receive data between itself and remote terminals, but these have to be connected to dedicated lines. No dial-up interfacing is possible.

The *DZ11 Asynchronous Multiplexers* have characteristics similar to those of the DJ11, but each line can be individually programmed through software control for one of 15 line speeds between 50 and 9600 bps. The DZ11 is a lower-cost, reduced-performance multiplexer and does not have DMA facilities. However, the DZ11 includes enough modem controls to operate a 300-bps data set. Interrupts can be programmed to occur for each character or after 16 characters. The DZ11 is generally transparent to data, but can report parity errors and framing errors. Input characters are buffered with identification hardware in a first-in/first-out (FIFO) buffer or "silo" (in DEC terms).

The *DH11 Programmable 16-Line Asynchronous Multiplexers* have many similarities to the DJ11. The DH11 provides programmed selection of nearly all parameters that are switch-selectable on the DJ11—data rate, character and stop element size, and parity check/generation on receive and transmit lines. A few other differences can also be noted. First, the DH11 offers a choice of 14 data rates plus 2 special rates of the user's choice. Second, each of the 16 lines can operate independently at any speed. As in the DJ11, receive characters for each line are buffered in a 64-word buffer to reduce CPU loads. Transmit characters can be sent directly in blocks from memory (DMA). The DH11 has 16 separate DMA transmitters, each with its own hardware byte count and address registers. Also, special hardware to detect data breaks and to generate program-controlled breaks is provided.

The *Du11 Synchronous Line Interface* is a single-line, double-buffered controller that is fully programmable for sync character, character length (5 to 8 bits), and parity check/generation on receive and transmit (odd, even, or none). Data rates are normally controlled by an attached modem, but an optional clock (DFC11-A) can be used for local connection not requiring a modem. Auto answering can also be selected. This unit cannot be used for DMA transfers.

The *DUP-11 Synchronous Line Interface* is a single-line, program-controlled, double-buffered controller capable of handling both byte-oriented protocols, such as binary synchronous and DEC's DDCMP, and bit-oriented protocols, such as SDLC, HDLC, and ADDCP. The DUP-11 is restricted to 8-bit characters. Bit- or byte-oriented operations are software-selectable. Modem controls are provided, permitting operation with Bell 200 Series or equivalent synchronous data sets at speeds up to 9600 bps.

Additional features of the DUP-11 including calculating and checking of CRC-16 block check characters and bit stuffing. The latter is used in several of the new data communication protocols to preclude data characters from being confused with control characters. Specifically, the DUP-11 inserts "0" ▶

DEC PDP-11 Family

► bits in bit streams containing five or more consecutive "1" bits so that the receiving device will not interpret this stream as a FLAG control character.

The *DQ11 Synchronous Line Interfaces* offer many of the features of the DU11 plus a number of unique qualities. The similar characteristics are modem-controlled data rates (up to 1 megabit per second in this case), optional clock (DQ11-KA) for local connection, and programmable selection of sync character and character size (to 16 bits this time). Unlike the DU11, the DQ11 makes use of DMA, through on-board word count and address registers, for data transfers, which explains the high rate that is possible. Although sync characters are program-selectable, the choice as to whether there will be one or two sync characters per frame is made through a switch on the board. Three different operating modes—auto idle, strip sync, and half-duplex—are also program-selectable. In auto idle mode, sync characters are transmitted continuously until either the CPU or terminal signals its intention to send data. In strip sync mode, only the text portions of received messages are sent to the CPU and main memory. Sync characters are discarded after detection. Straps are provided for the user to designate any three characters as control characters. When any of these characters is received, a vectored interrupt will be generated to the CPU.

Another useful feature of the DQ11 is programmable selection of parity on received data (odd, even, or none) and programmable LRC/CRC generation and checking in hardware. If desired, LRC and/or CRC characters are appended to the transmitted data stream and checked when arriving with the input data stream.

Input and output sides of the DQ11 have two sets of word count and address registers. The DQ11 can be set to automatically switch from one set to another when a buffer is exhausted. This permits longer delays between interrupt servicing without incurring annoying rate errors. This unit furnishes RS-232C/CCITT V.24-compatible control Bell 201 or 303 modems or equivalents. It occupies one slot in a DD11 peripheral mounting panel.

The *DMC11 Network Link* is a complement to the DQ11 and is designed for high-performance interconnection of PDP-11 computers in network applications. Data rates of up to 1 million bps can be obtained over coaxial cable at distances of up to 6000 feet. Lesser data rates can be realized over greater distances.

The DMC11 is a microprocessor-based unit consisting of two modules, the DMC11-AD microprocessor module and one of the DMC11-MA, DMC11-MD, or the DMC11-DA line unit modules. Even though the line units are also mounted on hex-sized modules, they only require an SPC (quad) slot having been cut away to permit mounting over the normal Unibus connector in a DD11 peripheral mounting panel.

The three line modules adapt the DMC11 to various applications. The DMC11-MA contains a built-in modem and is used for local operation at 1 million bps over coaxial cable up to 6000 feet long. The DMC11-MD also contains a built-in modem but is used to send data over distances up to 18,000 feet at rates up to 56,000 bps. The DMC11-DA does not have a built-in modem, and only includes an EIA RS-232C interface. It is intended for use with Bell 208, 209, or equivalent modems at data rates up to 19,200 bps.

The DMC11 is intended specifically for the DDCMP protocol. The microprocessor communicates with the host computer through DMA operations and is assigned a 256-byte memory block by the operating software, for use as a control and status block. Up to seven input and seven output messages can be queued in main memory by the DMC11.

The DMC11 also features a built-in bootstrap, permitting remote program loading and control transfer on CPU's that do not have bootstrap facilities.

The *DV11 Synchronous Preprocessor* is a high-performance, microprocessor-based multiplexer that features DMA data transfers and data rates of up to 9600 bits per second for each of 16 full-duplex lines. (Total throughput capacity is 38,400 characters per second). It can relieve up to 95 percent of the central processor's load in terms of interrupt handling, generating block characters, and special character handling.

A control table scheme tells the DV11 how to act on each incoming data or control character. Table entries specify a number of choices for each possible character: to store or not to store the character in the data buffer, to include or to exclude the character from the block check calculation, to cause or not to cause a vectored interrupt to the CPU. In addition, receipt of a character can designate that a different table is to be used for subsequent characters, thereby enabling the DV11 to detect sequences of control characters without CPU intervention. The DV11 consists of a double system unit and a distribution panel.

The *DR11 General Device Interfaces* are described here because of their possible use in PDP-11 to PDP-11 communications.

The DR11-B is a general-purpose DMA interface to the Unibus. This interface is bidirectional and operates between the Unibus and a user device. Transfers are made at a user-defined rate.

The DR11-C is a general-purpose interface between the PDP-11 Unibus and a user's peripheral device. The DR11-C can also be used as an interprocessor buffer to allow two PDP-11 processors to transfer data between each other. In this case, one DR11-C is connected to each processor bus, and the two DR11-C's are cabled together, thereby permitting the two processors to communicate.

The DR11-k is an integral logic module that forms a self-contained digital I/O interface between the PDP-11 Unibus and a user's peripheral. The DR11-k performs all the necessary tasks to communicate with the PDP-11. Like the DR11-C, the DR11-k may be used as an interprocessor buffer to exchange data.

The following units provide support functions to the line interfaces previously described:

The *DN11 Automatic Call Unit Interface* provides a buffered interface for up to four Bell 801A, 801C, or equivalent automatic all units. The DN11 uses programmed I/O for data transfers and occupies one system unit.

The *KG-11A Communications Arithmetic Option* is a programmable hardware block check character generator. It computes three different cycle redundancy check (CRC) polynomials and two different longitudinal redundancy check (LRC) characters. This single-board unit replaces software routines for generating and checking the standard check characters listed above. The choice of checking polynomials is made through program control. The unit can be used with any PDP-11 synchronous interface.

The KG11-A can be shared between multiple lines by storing interim check characters in main memory and passing the interim character to the KG11-A along with each new character. The KG11-A then computes the desired polynomial, which is read back to the CPU and stored again in main memory as the updated interim check character. In this way, several lines can make use of one unit. ►

DEC PDP-11 Family

OPERATING SYSTEMS COMPARISON TABLE

	RT-11	RSTS/E	RSX-11M	RSX-11S	IAS	DSM-11	RSX-11D
Hardware utilization:							
LSI-11/2	Yes	No	No	No	No	No	No
LSI-11	Yes	No	No	Yes	No	No	No
PDP-11/03	Yes	No	No	Yes	No	No	No
PDP-11/04	Yes	No	Yes	Yes	No	No	No
PDP-11/34A	Yes	Yes	Yes	Yes	No	Yes	Yes
PDP-11/35	Yes	Yes	Yes	Yes	No	Yes	Yes
PDP-11/45	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PDP-11/55	Yes	Yes	Yes	Yes	Yes	Yes	No
PDP-11/60	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PDP-11/70	No	Yes	Yes	Yes	Yes	Yes	Yes
Programming language support:							
APL	Optional	Optional	No	No	No	No	No
BASIC	Optional	Standard#	Optional	Runtime only	Optional	No	Optional
BASIC-Plus-Two	No	Optional#	Optional#	Runtime only	Optional#	No	No
COBOL	No	Optional	Optional#	Runtime only	Optional#	No	Optional
CORAL 66	No	No	Optional	No	Optional	No	Optional
DIBOL	Optional	Optional	No	No	No	No	No
FOCAL	Optional	No	No	No	No	No	No
FORTRAN IV	Optional	Optional	Optional#	Runtime only	Optional#	No	Standard
FORTRAN IV Plus	No	No	Optional#	Runtime only	Optional#	No	Optional
Macro Assembler	Standard	Standard	Standard#	Runtime only	Standard#	No	Standard
DSM-11	No	No	No	No	No	Yes	No
RPG II	No	Optional	Optional	No	Optional	No	No
Type of operating system:							
Single-user	Yes	No	No	No	No	No	No
Multi-user	No	Yes	Yes	Yes	Yes	Yes	Yes
Single-job	Yes	No	No	No	No	No	No
Foreground/background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiprogramming	No	No	Yes	Yes	Yes	Yes	Yes
Time-sharing	No	Yes	Yes (quasi)	No	Yes	Yes	No
Multi-user data base mgmt.	No	No	No	No	No	Yes	No
Libraries:							
System subroutine	Yes	No	—	—	—	Yes	—
Object	Yes	Yes	Yes	No	Yes	No	Yes
Task checkpointing							
Dynamic memory allocation	No	Yes	Yes	No	Yes	Yes	Yes
Memory mgmt. support (swapping)	—	Yes	Optional	No	Yes	Yes	—
Memory mgmt. support (swapping)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min./max. nonmapped memory (bytes)**	16K/56K	96K/—	32K/56K	16K/56K	—	64K/—	—
Min./max. mapped memory (bytes)**	64K/248K	—/1920K	48K/3840K	24K/3840K	128K/3840K	—/1024K	96K/3840K
Overlays	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mapped segments per process	—	2	8	—	8	—	8
Program scheduling:							
By operator	Yes	Yes	Yes	Yes	Yes	Yes	Yes
By event interrupt	Yes	No	Yes	Yes	Yes	Yes	Yes
By another program/task	Yes	Yes	Yes	—	Yes	Yes	Yes
By time of day	Yes	No	Yes	Optional	Yes	Yes	Yes
Other system parameters:							
No. of on-line terminals allowed	16	127	NSL*	NSL*	NSL*	80	NSL*
No. of terminals in use simultaneously	16	63	16	NSL*	32	65	NSL*
Number of concurrent jobs	2	63	NSL*	NSL*	NSL*	65	NSL*
Min. memory required for monitor (bytes)	4K	48K	16K	5K	—	48K	—
Monitor completely memory-resident	No	No	No	Yes	No	Yes	No
DBMS-11 support	No	No	Yes	No	Yes	No	No
Re-entrant I/O	—	—	Yes	No	Yes	No	Yes

* NSL (no software limitation); limited by hardware configuration or performance.

**The upper 8K bytes of memory are reserved for system use. Min./max. represents the smallest/largest processor on which the software runs; individual processor requirements will vary.

Sharable library is included.

► COMMUNICATIONS CONTROL

A variety of communications-oriented software packages is available from DEC. These can be divided into two classes: software for communications between PDP-11's and non-DEC mainframes, and software for communications between PDP-11's and other DEC computers.

For communications with non-DEC systems, emulators provide the necessary software interfaces. DEC offers five IBM 2780 batch terminal emulators that augment the

appropriate operating system and permit communications with IBM System/360 or 370 computers. All of these emulators: 1) support operations over synchronous data links, in point-to-point contention mode, at speeds up to 4800 bps; 2) can transmit data from card readers and mass storage devices; 3) can print received data on a line printer or write it on a mass storage device; 4) can support Bell 201 or 208 or equivalent modems and OS/RTE, OS/HASP, OS/ASP, and DOS/Power; and 5) can receive data in binary form or in the EBCDIC subset that is equivalent to ASCII.

DEC PDP-11 Family

OPERATING SYSTEMS COMPARISON TABLE (Continued)

	RT-11	RSTS/E	RSX-11M	RSX-11S	IAS	DSM-11	RSX-11D
I/O spooling	—	Yes	Yes	Yes	Yes	Yes	Yes
Line printer	—	Yes	Yes	—	Yes	—	Yes
Multiple copies	No	Yes	No	No	Yes	—	No
Specific priority, forms type	No	Yes	No	No	Yes	—	No
Time of day, generic queues	No	Yes	No	No	No	—	No
Card reader	—	No	No	No	Yes	—	No
Output buffering	—	Yes	Yes	Yes	Yes	Yes	Yes
Concurrent batch & I/O spooling	Yes (batch)	Yes	Yes	—	Yes	No	Yes
Disk file support	Yes	Yes	Yes	No	Yes	Yes	Yes
Linked	No	Yes	No	No	No	No	No
Contiguous	Yes	Yes	Yes	No	Yes	Yes	Yes
Mapped	No	No	Yes	No	Yes	Yes	Yes
Fixed & variable-length records	No	Yes	Yes	No	Yes	Yes	Yes
File access methods:							
Sequential	Yes	Yes	Yes	No	Yes	No	Yes
Index sequential	No	Optional	Yes	No	Yes	No	No
Direct access	Yes	Yes	Yes	No	Yes	No	Yes
Multi-keyed index sequential	No	Optional	Optional	No	Optional	No	No
Hierarchical	No	No	No	No	No	Yes	No
Device allocation control	No	Yes	Yes	Yes	Yes	Yes	Yes
Usage accounting	No	Yes	No	No	Yes	No	Yes
Intertask communications	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sharable data files	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sharable libraries	No	No	Yes	Yes	Yes	Yes	Yes
Sharable data areas	No	Yes	Yes	Yes	Yes	Yes	Yes
Task size (bytes) with/without mgmt.	—	56K/—	2000K/20K	2000K/20K	32K/—	1-16K/—	32K/—
Program priority levels	2	255	250	250	250	—	250
Disk/memory program swapping	No	Yes	Yes	No	Yes	—	Yes
System generation on target equip.	Optional	Yes	Yes	—	Yes	Yes	Yes
Security:							
System level	—	Yes	Yes	No	Yes	Yes	Yes
File level	—	Yes	Yes	No	Yes	Yes	Yes
Read/Write	—	Yes	Yes	No	Yes	—	Yes
Execute	—	Yes	No	No	No	—	No
Extend/delete	—	No	Yes	No	Yes	—	Yes
Item level	—	No	No	No	No	Yes	No
Shared data read/write	—	No	Yes	No	Yes	—	Yes
Distribution media:							
DECTape	Yes	No	No	Yes	No	No	No
RK05 disk cartridge	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RK06 disk cartridge	Yes	Yes	Yes	Yes	No	Yes	No
Floppy disk	Yes	No	No	Yes	No	No	No
DECassette	No	No	No	Yes	No	No	No
9-track magnetic tape	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RLO1 disk cartridge	Yes	No	Yes	No	No	No	No
RK07 disk cartridge	No	No	Yes	No	No	No	No

► IAS/2780 requires any standard configuration and a DU11 or DUP11 and KG11. Output devices supported include a line printer or any Files-11 device except DECTape and paper tape punch. Input devices supported include a card reader or any Files-11 device except DECTape. Spooling is supported on reception but not transmission. Forms control supported includes top of form; skip 1, 2, or 3 lines; skip module 8; and horizontal control.

Specifications for RSX-11D/2780 and RSX-11M/2780 are the same as for IAS/2780 except that the RSX-11M version requires 64K bytes of memory and the RSX-11D version requires 112K bytes of memory.

RSTS-E/2780 requires a minimum system consistent with the number of users and expected application plus 16K bytes of memory and DU11 or DUP11 and KG11. Output devices supported include a line printer or any mass storage device except diskette drives. Input devices supported include a card reader, any mass storage devices, or, to a limited extent, magnetic tape units. Spooling is supported. Forms control includes top of forms; horizontal control; and skip 1, 2, or 3 lines.

RT-11/2780 requires a disk-based foreground/background RT-11 system with 32K bytes of memory and DU11 or DUP11 and KW11-L, KG11. Output devices supported include a line printer or any disk supported under RT11. Input devices supported include a card reader, paper tape reader, or any disk supported by RT-11. Forms control consists of top of forms; skip 1, 2, or 3 lines; skip module 8; and horizontal control. Spooling is not supported.

For all-DEC computer networks, there is *DECNET*, which is actually a number of specific products aimed at several broad markets. Announced in April 1975 as a series of hardware and software extensions to standard systems, DECNET permits users to create communications networks merely by adding appropriate software and hardware to existing computer systems.

DECNET is not a turnkey solution. At the very least, customers must purchase communications links such as a telephone line or private wire, one or more of DEC's communications interfaces for each computer in the network, and often a modem for each end of every link. Some of the

DEC PDP-11 Family

► more complicated applications will require considerable programming, as well.

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 CPU's, 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 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 CPU's, line interfaces (and speeds), and operating systems software. Such networks typically fall into one of three classes: 1) these 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.

DECNET includes a set of network protocols, each designed to fulfill specific functions within the network. Collectively, these protocols are known as the Digital Network Architecture, or DNA. The major protocols, and their functions, are as follows. Digital Data Communications Message Protocol (DDCMP) handles the link traffic control and error recovery within DECNET (physical link between the line and the processor). DDCMP has been designed to operate over full- and half-duplex facilities, using synchronous, asynchronous, and parallel facilities. Network Services Protocol (NSP) handles network management functions within DECNET (logical link between the physical line and the user programs) including the routing of messages between systems and within any given system. Data Access Protocol (DAP) enables programs on one node of the network to utilize the I/O services available on other network nodes. Each operating system in DECNET provides facilities for translating its own unique I/O calls into the DAP standard, and vice versa. DAP thus allows remote file access, including OPEN, READ, WRITE, CLOSE and DELETE for sequential and random files, and remote device access for unit record devices.

DDCMP performs the physical line control only for the interfaces noted in the Communications Hardware Interfaces table as DECnet-supported. DDCMP performs line scanning, error detection and error recovery. On half-duplex lines, DDCMP controls the direction of traffic, while on full-duplex lines, DDCMP controls bidirectional traffic; on multi-point lines DDCMP performs the polling function. Outgoing transmissions are enveloped with control characters mainly to enable the receiving device to perform error detection. The CRC-16 polynomial checking technique is employed in creating an error detection code. Incoming transmissions are stripped of control characters after passing error detection checks. To accommodate the relatively long transit times for satellite-destined messages, DDCMP can support the transmitting of up to 255 messages before halting transmission to await acknowledgements for the previously transmitted messages.

DECnet software to handle the DDCMP protocol line handling is intended for use with low or medium-speed communications systems. The software will perform the function for both the program-interrupt and the DMA types of communications hardware interfaces. When volume increases substantially and begins to consume too much central

processor overhead, or when high-speed communications lines are used, the DMC11 interface can be employed. Containing a dedicated microprocessor, the DMC11 will perform, via firmware, the line handling function, thus relieving the central processor's DECnet software of this time-costly burden. With the DMC11, a user could employ DDCMP protocol without using the other functions of DECnet.

When NSP receives a message for transmission from a program, NSP affixes the receiving program's identifier and sends it to the appropriate physical link for DDCMP protocol line handling. Incoming messages are stripped of their envelope characters and given to the appropriate program. When two remotely located programs must talk to each other by passing a high volume of a particular type of data (as in remote program loading), NSP can establish a Dynamic Logical Link between the programs and will pass only the specified type of data through the link.

When a remotely located program wants access to a file, NSP does not supply the request to a user program, but to the DAP DECnet module. This module goes through the same steps a local user program would take to get at data from mass storage. Namely, it issues an open and a read/write command to the File Management System. If the remote command was a Read, DAP would obtain the data and pass it to NSP for transmission. NSP will treat the data as just another outgoing message from just another user. DAP will also interface with the Device Handler software that controls unit record equipment and locally attached terminals.

A goal for the set of DEC products has been to provide as general an interconnection mechanism between specific products as possible, limited only by the technology and cost considerations which constrain each individual member of DECnet. Those latter constraints make totally general interconnectability impractical. The individual DEC Software Product Descriptions for each product should be consulted in order to ascertain whether any particular configuration violates the guidelines for the individual product. The following table lists the DECNET products.

Product	Prerequisite Software
DECnet-11D	RSX-11D Version 6
DECnet-11M	RSX-11M Version 2
DECnet-11S	RSX-11S Version 1
DECnet-E	RSTS/E Version 6C
DECnet-IAS	IAS Version 2
DECnet-RT	RT11 Versions 2 and 3

DEC recently extended the range of its DECnet communications software to include networking among most DEC operating systems and processors ranging from the LSI-11 microcomputer to the 32-bit VAX-11/780.

Changes have been made to the Network Service Protocol (NSP), Data Access Protocol (DAP), and Digital Data Communications Message Protocols (DDCMP) within DEC's Digital Network Architecture. Among the changes are improved support for various systems under DAP and the ability to prevent network overloads under NSP.

Basically, the new and revised 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 resource access for use of peripherals at another node and remote sequential I/O files are also supported. ►

DEC PDP-11 Family

While DECNET represents a generalized approach to computer networks within the DEC family, the company is continuing development of a series of remote terminal emulators for other manufacturers' host mainframes. In the PDP-11 family, the previously discussed IBM 2780 emulator is now available under RSX-11D, RSX-11M, RSTS/E, IAS, and RT-11. Multi-leaving HASP emulation is now available under RSX-11D and RSX-11M, as well as in a stand-alone version. Direct channel interfaces to IBM computers via the DX11 have also been sold in custom situations under RSX-11M.

Remote job entry to Control Data and Univac mainframes is also available under RSX-11D and RSX-11M. Sold under the names MUS-200 and MUS-1004, DEC's RJE emulators offer sophisticated replacements for the Control Data 200 User Terminal and the Univac 1004. The power of DEC's real-time operating systems, coupled with the RJE emulation, provides an attractive price/performance mix.

SOFTWARE

OPERATING SYSTEMS: The major operating systems for the PDP-11 include: 1) the single-user RT-11 disk-based system; 2) the RSTS/E resource-sharing time-sharing system; 3) the RSX-11 real-time multiprogramming systems: RSX-11D, RSX-11M, and RSX-11S; 4) DSM-11 (Massachusetts General Hospital Utility Multi-Programming System); and 5) the multifunction, multilingual IAS operating system. The discussion of these operating systems is augmented by the Operating Systems Comparison Table which appears on pages M11-384-320 and -321.

RT-11 Disk-Based Operating System: RT-11 is an easy-to-use yet powerful operating system that includes two monitors: a single-job and a foreground/background (F/B) monitor. The single-job monitor can support program development or a real-time application for one user, while the F/B monitor can support concurrent real-time execution in the foreground and program development in the background, typically for one user. RT-11 is generally disk-based, with a cassette, magnetic tape, or additional cartridge disk drive needed for backup.

RT-11 also supports punched card equipment; punched tape equipment; laboratory peripheral systems (LPS-11) through BASIC, FORTRAN, and a laboratory applications library (LA-11); an analog real-time system through FORTRAN or LA-11; a graphics display system (VT11) through BASIC, FORTRAN or LA-11; and an electrostatic printer/plotter with plotting supported by BASIC and FORTRAN.

Programs supported by RT-11 include a MACRO assembler, Editor, scientific subroutine package, linker, librarian, PIP file transfer program, and utilities for file converting, dumping, comparing, and verifying. A contiguous file structure is implemented to provide fast response. Program development may be done interactively through the console terminal, or in batch mode. Batch streams can be entered through a card reader or stored and initiated from a mass storage device such as the system disk.

RT-11 Version 3, an enhanced version, is usable on systems ranging from the microprocessor-based PDP-11/03 (LSI-11/2) through the PDP-11/60 with cache memory. The set of English-like monitor commands has been expanded from previous versions of RT-11, and the documentation accompanying the software is now contained in eight manuals written for different levels of expertise ranging from novice to expert.

High-level languages available with RT-11 are the same as in previous versions of RT-11 (see table). Storage media supported by RT-11 include magnetic disks (from diskette to 12-megabyte cartridge drives), magnetic tapes, DECTapes, and cassettes.

When RT-11 Version 3 is used in conjunction with a KT-11 memory management unit, applications programs running under the operating system can access up to 248K bytes of main memory. An optional sysgen program is available for users requiring customized systems with special user-specified options. Up to 15 terminals can be accessed on a system running under RT-11 through use of a foreground/background monitor.

RSTS/E (Resource-Sharing Timesharing System/Extended): RSTS/E is a time-sharing system designed to accommodate large numbers of interactive users. The interactive language is BASIC-PLUS, an enriched version of the popular BASIC language. RSTS/E requires a PDP-11/34A, 11/35, 11/40, 11/45, 11/60, or 11/70 with hardware memory management for memory expansion and protection. A wide range of communications interfaces is supported to allow mixes of local and remote terminals with varying characteristics. For a normal job mix, up to 24 concurrent users can be supported on a PDP-11/34A or 11/35-based system, while up to 32 can be supported on an 11/45 and 63 on an 11/70.

RSTS/E supports a wide range of peripherals, including up to eight line printers, punched card equipment, punched tape equipment, all types of mass storage devices, communications interfaces, and IBM 2741-compatible terminals.

RSTS/E supplies a comprehensive file system. User files may be random or sequential, numeric or alphanumeric. Files can be created, updated, extended, and deleted interactively from a user terminal or under program control. Files can be protected from access on an individual, group, or universal basis; can be accessed by many terminal users simultaneously; and can be updated on-line.

RMS-11K is a file management system designed to run under RSTS/E on a PDP-11/34A, 11/45, 11/60, or 11/70. RMS-11K is a multi-key indexed sequential (ISAM) file management system that supports the ANSI-74 COBOL Level 2 Indexed I/O Module specification. The system permits both fixed- and variable-length records and provides RSTS/E users with sequential, relative, and indexed file organization. This allows sequential, random, dynamic, or direct physical access to data records. Combinations of the above modes can also be invoked. Other significant features of RMS-11K are multi-level privacy control and both generic and approximate key searches in multi-keyed indexed processing. The system manager can, for each user, specify the programmer and project number, the password, the maximum logged-out disk space, and the maximum number of files.

Access to peripheral devices is generally open to all RSTS/E users under the resource sharing concept on a first-come, first-served basis. However, the capability is available to the system manager to intervene in peripheral assignment and permit assignment as he sees fit.

RSTS/E requires a system with a console terminal, real-time clock, and 64K bytes of parity memory with the memory management option (at least 128K bytes of memory are required to support RMS-11-based languages). In addition, the system requires a disk pack system or a dual-drive fixed-head disk or disk cartridge. Magnetic tape is also generally required for software distribution.

RSX-11 Real-Time Operating Systems: The RSX-11 family consists of three compatible operating systems: RSX-11D, RSX-11M, and RSX-11S. Each features event-driven multiprogrammed responses to real-time stimuli. The RSX-11 systems handle many tasks (programs) concurrently, with requests for system resources handled on a priority basis. The compatibility among systems is achieved by a hierarchical structure of Monitor Console Requests (MCR's), File Control System (FCS), and common language processors. RSX-11S is a subset of RSX-11M, which is in turn a subset of RSX-

DEC PDP-11 Family

► 11D. As a result, programs developed for RSX-11S run directly under RSX-11M, and, by relinking, under RSX-11D. The file systems allow easy transportability of data and programs between systems.

RSX-11D Advanced Real-Time Operating System: RSX-11D is the largest and most flexible RSX-11 system. It requires an 11/34 or larger processor with hardware memory management, 96K bytes of main memory, and adequate disk and backup storage for full operation. RSX-11D has the capability to keep many tasks going at once, each with a set priority at one of 250 levels which may be amended as necessary, and all in a totally hardware-protected environment. Tasks are scheduled and executed in response to external stimuli, operator commands, or a function of time, in a multiprogrammed environment. Flexibility is obtained by the use of checkpointing (suspending an executing task, storing it on disk, substituting a higher priority task in its place, and swapping the original task back when the higher priority task is finished) and dynamic allocation of memory (which can change the partitioning of memory and the tasks assigned to partitions in real-time).

Program development can take place concurrently with real-time execution, in either batch mode or interactively. The text Editor is sharable, as can be application program developed under FORTRAN IV-PLUS. The PDP-11 COBOL language processor is also available under RSX-11D, to supplement the business data processing requirements of the real-time operations. A full set of utility programs is included.

Files-11 is a general-purpose file system that provides a facility for the dynamic creation, extension, and deletion of files on disk. The file system employs two types of directory files: the master file directory, created when a volume is initialized, and user file directories, created as needed and used to store pointers to all files associated with a given file name and account number. Files can be organized either randomly or sequentially. Designed into Files-11 is a scheme for volume and file protection which allows the owner of a volume or file to deny all access or certain kinds of access to all users, groups of users, or particular users in the system.

In addition to the RSX-11 Files-11 file system, RSX-11D supports ANSI standard Level 3 format for single- or multi-volume, multi-reel magnetic tape files.

The Monitor Console Routine (MCR) is the interactive terminal interface between the user and the RSX-11 operating system. MCR includes initialization commands, informational messages, task control commands, and system maintenance commands. Some commands are privileged and can be invoked only by privileged users, as defined by the system manager. The organization of MCR allows users to add commands to meet special application needs.

The minimum configuration for RSX-11D includes a central processor with memory management unit and at least 96K bytes of memory, a console terminal, a disk system, and a magnetic tape system. If concurrent program development and applications execution is desired, at least 112K bytes of memory are required.

RSX-11D supports a variety of laboratory, industrial control, and communications equipment, including the AD01 Analog/Digital Converter, LPS11 Lab Peripheral System, ICS/ICR Industrial Control Systems (local and remote), and modem control multiplexers. Standard peripheral devices, such as a card reader, paper tape reader/punch, and line printer, are also supported.

RSX-11M is a subset of RSX-11D that provides less flexibility at a lower overhead. Real-time execution is event-driven by priority in a multiprogrammed environment, as in

RSX-11D, RSX-11M supports checkpointing, and memory allocation is dynamic. The lower overhead allows RSX-11M to operate on PDP-11/04 systems as well as on 11/34's, 11/35's, 11/45's, and up. On the latter systems, hardware memory management is not required, but it can be utilized for memory protection and expansion.

Multi-user program development is accomplished using either of two supplied editors from terminals. The full range of language processors is available. A foreground-only (i.e., real-time execution only) system can operate in as little as 32K bytes, with program development taking place when no tasks are executing. RSX-11M is disk-based and requires a backup/distribution device in addition to the system disk drive.

The RSX-11M file management system is the same file system used in RSX-11D (Files-11), providing automatic allocation and file structures for all block-structured devices, including the RX11 floppy disk. Files can be organized as either random or sequential and can be accessed by file name. A selective protection feature permits file access to specified users. As an option, RMS-11K is available (see RSTS/E).

RSX-11M has a program logical space extension feature that allows execution of very large application programs without requiring disk overlays. A single program can occupy all user space (less the resident system). This feature permits faster execution of larger programs, but at some expense to smaller lower-priority programs that must be stored on disk while the larger program occupies main memory.

RSX-11M runs on any of the PDP-11 processors except the LSI-11-based processors. The minimum configuration requires a central processor with a clock and at least 32K bytes of memory, a console terminal, a disk system, and a backup device. The minimum system requires 16K bytes of memory for the operating system, leaving 16K bytes of memory available for user tasks. If concurrent program development and applications execution is desired, at least 48K bytes of memory are required. Memory can expand to 56K bytes of user memory on systems without the memory management options, to 248K bytes on systems with the memory management unit, or to 3840K bytes on the PDP-11/70.

RSX-11M, like RSX-11D, supports a wide range of laboratory, industrial control, and communications equipment, including the AR11 Analog Real-Time Subsystem, LPS11 Lab Peripheral System, ICS/ICR Industrial Control Systems (local and remote), modem control multiplexers, and the DMS Unibus link. Standard peripheral devices, such as floppy disks, cassettes, a card reader, paper tape reader/punch, and line printer, are also supported.

RSX-11S is a memory-based subset of RSX-11M that requires no disk storage for operation. It is an execute-only system, with program development accomplished on an RSX-11M system. Since there is no disk storage, checkpointing is not supported. The application programs are transported from the RSX-11M development system to the RSX-11S target system through a mutual exchange medium such as cassette. The priority structure and execution of tasks is compatible with RSX-11M.

RSX-11S is suitable for use where harsh environments prohibit disk-based operation, or where dedicated applications do not require the expense and flexibility of a disk. However, RSX-11S supports all the disks (and other peripherals) supported by RSX-11M. Devices with full file directory support (such as disks) under RSX-11M are utilized without directory support under RSX-11S. The system can operate on a PDP-11 with as little as 16K bytes of memory, a terminal, and a program loading device. The system can

DEC PDP-11 Family

► support a console terminal if operator communication is desired. At least 32K bytes of memory are needed to support on-line task loading or the execution of tasks written in FORTRAN.

DSM-11 is an interactive multi-user operating system that is optimized for data base management functions, including the random retrieval of string-oriented data from large tree-structured files. Processors with up to 56K bytes of user memory can have up to 16 user partitions, while larger memory configurations can have up to 40 user partitions. Each partition holds one active user's program, local data, and system overhead data and may or may not be associated with a terminal. Recommended partition size is 4K bytes, but variable sizes are permissible depending on the application.

DSM-11 operates by employing a checkpoint form of time-sharing, whereby a program is allowed to execute until its time slice has expired, plus any additional time required to complete a current operation.

DSM-11 is completely memory-resident and consists of an executive for the supervision of time-sharing/multiprogramming operations; an I/O monitor for terminal supervision, peripheral device I/O, and peripheral device interrupt processing; a language interpreter for MUMPS-language (DSM-11) programs; and a data base supervisor designed to perform all logical and physical control of the data base.

The executive uses a set of priority-weighted queues to administer its scheduling algorithm. These queues include one or more wait-queues and a run-queue (where it receives its time slice). Communication between the DSM-11 language interpreter and the I/O monitor is via buffers, filled and emptied asynchronously by the monitor so as to overlap output with that of the program's processing when possible.

The data base supervisor is actually a group of routines which provide both physical and logical control of mass storage. All file information is referenced symbolically, in the context of hierarchical global variables and arrays. Under this technique, the context and structure of the tree-structured symbol tables are logically mapped into the physical mass storage of the system.

Each user of the DSM-11 system gains access to the system's programs using a special log-in sequence which involves one or two access codes (depending on the privileges of the user). These codes, provided by the system manager, are the User Class Identifier code (or UCI) and the Programmer Access Code (or PAC).

The DSM-11 system can have up to 16 UCIs (classes of users). The UCI code must be entered by everyone who wishes to use the system. It allows access to the programs and globals listed in the program and global directories for that UCI. A user who is permitted simply to run programs needs to know only the UCI and the name of the programs for that UCI.

Users who are allowed to create or modify programs and global files must know the system's PAC. This code permits system operation in direct mode. In direct mode, a programmer can issue DSM-11 commands at the keyboard, as well as create, modify, and delete global data and programs associated with the UCI under which the user logged-in.

The system manager may designate any terminal as "tied" to a given program. During operation, simply striking one key on the tied terminal will cause it to begin executing the assigned program. It is then impossible for the user to go through the log-in procedure.

DSM-11 requires a console terminal, a disk system, and a magnetic tape system in the minimum configuration. The user can add user terminals up to a system total of 64, and these can be connected by as many as 16 remote or local lines and as many as 48 multiplexed local lines. The system supports additional disk controllers (up to a maximum of eight drives per controller), up to four magnetic tape drives, and up to four dual DECtape transports. A line printer, card reader, and paper tape reader/punch are also supported.

IAS (Interactive Application System): IAS is a multi-function, multilingual operating system that can support a mix of concurrent time-sharing, batch, and real-time processing activities. It is geared for operation on a PDP-11/70, but can also be utilized with larger 11/45, 11/55, and 11/60 configurations. IAS is disk-based and supports a wide range of standard peripherals and up to 32 time-sharing users.

The heart of the IAS system is a real-time executive compatible with RSX-11D. When not servicing real-time requests, the executive yields control to the time-sharing and batch supervisor to allow priority processing by interactive terminals and any job that may be active in the batch system. The key to the IAS system's flexibility is its ability to support multiple user interfaces. The system-supplied interface provides program development and execution facilities to an interactive terminal. A number of user-supplied, application-specific interfaces can also be active, and certain terminals can be attached to them. Thus, some terminals can be attached and dedicated to, say, editing, while others are dedicated to data base updating or retrieval, and the rest to general program development.

The IAS executive manages multiprogrammed operations using two schedulers: the event-driven priority scheduler for privileged real-time tasks, and the time-sharing scheduler for control of both interactive and batch processing. IAS employs the RSX-11 family's Files-11 file system.

The interactive time-sharing user's interface program is called PDS (Program Development System). PDS controls access to the system by allowing only valid users to log in at a terminal and gain access to user file accounts assigned by the system manager. PDS accepts and interprets commands typed on the user's terminal and performs the requested operation. The commands are English words that describe the operation to be performed. They can be abbreviated to as many letters as make the command name unique.

The interactive user (when connected to the system interface) can develop programs, call any system utility (such as the editor, linker, or a file utility), execute a program, submit a program into the batch stream, or combine these functions, all from his terminal.

IAS requires a system with at least 128K bytes of memory, two terminals, a disk system and a magnetic tape system. A 192K-byte PDP-11/70 with RP04 system disk is recommended for support of 10 to 12 terminal users performing interactive and batch processing concurrently with real-time processing.

IAS supports the same variety of laboratory, industrial control, and communications equipment as specified under RSX-11M.

Version 2 of IAS, released in December 1977, extends support of the 11/60 and increases peripheral coverage to include subsystems containing RP05 and RP06 disk drives, RX01 floppy disk drives, and LA180 matrix line printers. Additional optional software available with Version 2 includes RMS-11K (see RSTS/E for a description) and DATA-TRIEVE-11, a conversational query language and report writing system. Version 2 also contains new systems utilities, provides support for execution of real-time and time-sharing

DEC PDP-11 Family

► tasks in the same partition, and establishes multi-tasking and sub-tasking capabilities for time-sharing users.

LANGUAGES: The major programming languages for the PDP-11 include: APL-11, which operates under RT-11 and RSTS/E; BASIC (several versions), which operates under RT-11, RSTS/E, RSX-11D, RSX-11M, and IAS; COBOL, which operates under RSTS/E, RSX-11M, RSX-11D, and IAS; CORAL 66, which operates under RSX-11M, RSX-11D, and IAS; DIBOL, which operates under RT-11 and RSTS/E; FOCAL, which operates under RT-11; FORTRAN (several versions), which operates under RT-11, RSTS/E, RSX-11D, RSX-11M, and IAS; Macro Assembler, which operates under RT-11, RSTS/E, RSX-11D, RSX-11M, and IAS; MUMPS-11, which operates under DSM-11; and RPG II, which operates under RSTS/E and IAS.

APL-11 is a conversational language that is particularly well suited for operating on numeric and character array-structured data. Using APL-11, variables can be examined and changed; statements can be altered without recompilation; and program action can be readily traced. Features of APL-11 include dynamically variable user's workspace size, chaining of APL programs to previously prepared run-time programs, multiple statement lines, standard PDP-11 file naming formats, and extended single operators which allow the user to fully evaluate character strings and write user-defined functions to perform output formatting and function editing. The language is built around a set of unique symbols, each of which represents a desired operation. The nature of the language is such that complex expressions are easily constructed by the programmer. According to DEC, APL-11 produces concise code.

APL-11 requires a processor with 48K bytes of memory and any valid RT-11 or RSTS/E configuration.

BASIC-11 for the PDP-11 is implemented as an incremental interactive interpreter, which retains the interactive nature of the language while providing increased execution speeds over conventional interpreters. It is an enhancement of Dartmouth standard BASIC that includes support for string and arithmetic functions. Peripheral support includes routines that can directly interface to the laboratory peripheral systems (AR11, LPS11) and graphics display systems (VT11, GT41, GT43, GT62) through BASIC. Also featured are a CALL interface well as character terminals, the ability to handle virtual arrays (in memory and on disk), and integer and double-precision support.

The BASIC-PLUS language implemented under RSTS/E is an enhanced version of Dartmouth BASIC, featuring more than 40 basic commands, 35 built-in functions, and 3 different data types: integer, string, and floating-point (single and double precision). A commercial extension package is available to provide output formatting features such as comma insertion, floating dollar sign, trailing minus, asterisk protect and sort, line printer spooling, and indexed access file method routines.

BASIC-PLUS II is a compiler for a superset of the BASIC-PLUS, Basic-II/IAS-RSX, BASIC/RT-11, and Dartmouth BASIC languages. Specifically, BASIC-PLUS II supports indexed sequential (ISAM) files, and thus supports DEC's RMS-11 record management system. It also features the CALL statement found in BASIC-11 and is compatible with other DEC BASIC language processors. BASIC-PLUS II also includes debugging aids such as breakpoints, step mode, and change of variables. Other important features include support for block-mode terminals, long variable names, record I/O, and a decimal arithmetic package.

BASIC language processors. BASIC-PLUS II also includes debugging aids such as breakpoints, step mode, and change of

variables. Other important features include support for block-mode terminals, long variable names, record I/O, and a decimal arithmetic package.

BASIC-11 is implemented under various operating systems, with some differences. The BASIC Comparison Table shows those differences and also gives a comparison with BASIC-PLUS and BASIC-PLUS II.

PDP-11 COBOL is implemented as an intermediate-level compiler conforming in language elements, representation, symbology, and coding format to the ANSI-1974 COBOL specification X.3.23-1974. PDP-11 COBOL meets the ANSI full-level (Level 2) specifications for the nucleus, table handling, sequential I/O, random (relative) I/O, indexed I/O, and segmentation modules. The interprogram communications module is implemented on a low level (Level 1), and the library module is implemented on a low level with high-level REPLACING facility. RERUN, ENTER, and ALTERNATE are not included in the PDP-11 COBOL nucleus code set. The COBOL compiler can accept source program input from cards, console terminals, and disks.

PDP-11 COBOL utilizes RMS-11 for I/O handling, and is therefore capable of handling files created under other languages.

Three utility programs are supplied with PDP-11 COBOL: MERGE, which merges ODL files generated by COBOL compilations into a single ODL file; RFRMT, which converts PDP-11 terminal format COBOL programs into conventional format ANSI COBOL programs; and COBRG, a COBOL Report Generator.

Under IAS/RSX, PDP-11 COBOL will run on any valid configuration supplying a user area of at least 54K bytes of memory, at least 3000 free blocks of on-line disk storage, and an LP11 line printer. Under RSTS/E, PDP-11 COBOL will run on any configuration with at least 128K bytes of memory, a user area of at least 48K bytes, at least 3000 free blocks of on-line disk storage, and an LP11 line printer.

CORAL 66 is a high-level block-structured programming language. It is the standard general-purpose language prescribed by the British Government for real-time and process control applications. This language is designed to replace assembly-level programming in modern industrial and commercial applications. It is used for long-life products where ease of maintenance and flexibility are required.

The PDP-11 CORAL 66 compiler operates under the RSX-11M operating system and provides: BYTE, LONG (32-bit integer) and DOUBLE (64-bit floating point) numeric types; re-entrant code at the procedure level; executable generated code; switchable options to select target PDP-11 computer instruction sets, optimize generated code, and check the bounds of array-type variables; and conditional compilation of defined parts of source code.

CORAL 66 can be supported by any valid RSX-11M or IAS operating system configuration which includes: a 9-track magnetic tape system, an RK11 disk cartridge subsystem, or an RK611 disk cartridge subsystem; a 48K-byte main memory partition; and an FP11 Floating Point Processor.

DIBOL (Digital Business Oriented Language) was designed to permit writing business-oriented programs for a mini-computer. It is structured into data definition and procedures sections, similar to COBOL.

Records and numeric integer or alphanumeric fields are defined in the data definition section. Variable names of up to six characters are supported. Files are associated with record/file definition through OPEN statements in the procedures section. Printed output formatting is accomplished ►

DEC PDP-11 Family

BASIC COMPARISON TABLE

Language Version	BASIC/ RT-11	MU BASIC/ RT-11	BASIC- PLUS	BASIC- PLUS II	IAS/ RSX-11M BASIC-11
Number of users	1	8	—	—	20
Minimum memory (bytes):					
With LPS11	32K	32K	—	—	32K*
Without LPS11	16K	16K	—	—	16K*
With String Support	24K	—	—	—	16K*
Maximum memory (bytes)	60K	60K	—	—	56K*
File support:					
Sequential	Yes	Yes	Yes	Yes	Yes
Indexed sequential	No	No	No	Yes	Yes
Direct	Yes	Yes	Yes	Yes	Yes
Debugging aids:					
Breakpoints	—	—	—	Yes	—
Step mode	—	—	—	Yes	—
Change of variables	—	—	—	Yes	—
RMS-11K	No	—	No	Yes	Yes
Character terminals	Yes	Yes	Yes	Yes	Yes
Block-mode terminals	Yes	Yes	No	Yes	Yes
Long variable names	No	No	Yes	Yes	No
Decimal arithmetic	Yes	Yes	Yes	Yes	Yes
Data types:					
Integer	Yes	Yes	Yes	Yes	Yes
String	Yes	Yes	Yes	Yes	Yes
Floating point	Yes	Yes	Yes	Yes	Yes
CHAIN	Yes	Yes	Yes	Yes	Yes
OVERLAY	Yes	Yes	No	No	Yes
CALL	Yes	Yes	No	Yes	Yes
On-GOTO	No	Yes	Yes	Yes	Yes
ON-GOSUB	No	Yes	Yes	Yes	Yes
PRINT-USING	Yes	Yes	Yes	Yes	Yes
COMMON	No	Yes	No	Yes	Yes
Dynamic string handling	Yes	Yes	Yes	Yes	Yes
Virtual arrays	Yes	Yes	Yes	Yes	Yes
Interpreter	Yes	Yes	Yes	No	Yes
Compiler	No	No	No	Yes	No

*Partition; BASIC treated as shared single-user system.

through an edit mask facility much like that of COBOL. In arithmetic operations, a precision of 18 digits is maintained. The language includes complete facilities for handling the display during program execution and for calling external subroutines.

DIBOL programs can be written interactively using the EDIT program. The source module is stored on disk and submitted to the DICOMP language translator when translation is desired. DIBOL programs are executed through a run-time interpreter. A dynamic snapshot facility, called DDT for DIBOL. Debugging Technique, permits stopping a program with display of variable values; the values can be modified and a new checkpoint established.

DIBOL-11 is a compatible extension of the language first used on the PDP-8. It is usable on any system that supports RT-11 or RSTS/E.

FOCAL is a computation language best suited for first-time computer users such as students, scientists, and researchers. FOCAL/RT-11 can be used to interface to real-time devices for experiment control and monitoring under the RT-11 operating system. The FOCAL language is conversational in nature and quite efficient. The RT-11 implementation of

FOCAL is an interpreter that provides both stored-program and immediate-mode operations. FOCAL uses the same floating-point package as does FORTRAN/RT-11, so all arithmetic options are supported. The LIBRARY command allows the user to access any RT-11 file-structured device. Other features include scheduling up to eight asynchronous tasks from the clock; processing interrupts in the FOCAL language; user-controlled error processing; and the facility for one or more user-written assembly-language functions.

FOCAL operates on any system that supports RT-11 and requires a processor with at least 16K bytes of memory (32K bytes recommended). FOCAL supports up to 56K bytes of memory, a line frequency clock, extended arithmetic element, EIS, FIS, floating-point unit, line printer, Unibus programmable real-time clock, Unibus A/D and D/A converters, VT11 Graphics Processor System, and VT55 Video Graphics Terminal.

PDP-11 FORTRAN IV is an optimizing compiler that implements a superset of ANSI standard FORTRAN, X3.9-1966. The same basic language processor is implemented under RT-11, RSTS/E, RSX-11M, RSX-11D, and IAS. Some of the extensions added to make the FORTRAN IV language more efficient are the permitting of general ex-

DEC PDP-11 Family

pressions wherever a variable or a constant is called for; the addition of the .XOR. and .EQV. logical operators; the elimination of redundant subexpressions within blocks of code; and automatic array vectoring to speed of multiply operations required in array subscripting.

Other extensions found in FORTRAN IV and FORTRAN IV-Plus (see below) include up to seven dimensions for arrays, any arithmetic expression as an array subscript, character strings in place of Hollerith constants, mixed mode expressions containing any data type, end of line comments, conditional compilation of debugging statements, negative DO increment parameter values, optional statement label list in an Assigned GO TO, and general expressions in I/O lists. Also provided are list-directed I/O statements, ability to read and write files written in any format, end-of-file or error condition transfer in any READ or WRITE statement, byte data type, implicit declaration, ENTRY statements defining multiple entry points in a single program unit, symbolic names given to constants by PARAMETER statements, function selection by data type, incorporation of FORTRAN source text from a separate file by the INCLUDE statement, and numerous other extension for DO loops, data types, and array dimensions.

As a final polish to each program, the FORTRAN IV compiler does extensive "peephole" organization, examining each sequence of operations and substituting a shorter, faster group if possible.

Under RT-11, a system subroutine library (SYSLIB) is provided. SYSLIB is a collection of FORTRAN-callable routines which allow a FORTRAN programmer to use various features of the RT-11 foreground/background (F/B) and single-job (S/J) monitors. SYSLIB also provides various utility functions and a complete character string manipulation package.

RT-11 also provides a library of FORTRAN-callable graphics routines supporting the VT11 and VS60 graphics hardware systems, plotting support for an electrostatic printer/plotter, and laboratory data acquisition and manipulation routines used in conjunction with the LPS11 and AR11 laboratory peripheral hardware.

FORTRAN IV operates in interactive or batch mode under the RSTS/E monitor and provides assembly language subprogram support, using the macro assembler. Although the assembly language subprogram cannot issue any monitor calls, the macro assembler provides a path to further enhance computational performance.

Under RSX-11, RSX-11D, and IAS, the FORTRAN IV compiler runs in a minimum partition of 16K bytes. If run in a larger partition, it uses the extra space for program and symbol table storage.

An RSX-11/IAS library consists of object modules. Two types of libraries exist: shared and relocatable. Relocatable libraries are stored in files. Object modules from relocatable libraries are built into the task image of each task referencing the module. Shared libraries are located in main memory, and a single copy of each library is used by all referencing tasks.

The RSX-11/IAS system relocatable library provides FORTRAN-callable forms of most executive directives. The FORTRAN programmer can schedule the execution tasks and manipulate system resources through these calls.

The ISA extensions for process I/O control are available in FORTRAN-callable format under RSX-11. Support for laboratory and process control peripherals is also included.

FORTRAN IV-PLUS is an optimizing compiler oriented toward minimizing execution times. FORTRAN IV-PLUS is

a further superset of FORTRAN IV and operates under the RSX-11M, RSX-11D, and IAS operating systems. Features include specialized flow analysis of DO loops; OPEN and CLOSE (for direct file manipulation) language enhancements; and implementation of the ISA real-time extensions.

The key to the speed of FORTRAN IV-PLUS is the way it uses the general registers, asynchronous FPP registers, and instruction set to generate hard in-line code for increased execution speed. The compiler can generate sharable code (for IAS and RSX-11D) as well, and since it is implemented with software virtual memory, large programs can be compiled efficiently in a relatively small user partition.

FORTRAN IV-PLUS includes all the extensions specifically listed under FORTRAN IV above. The compiler requires a floating-point processor and a minimum partition size of 34K bytes, not including the system library under RSX-11D and IAS. Under RSX-11M, a minimum partition size of 36K bytes is required for both the compiler and the system library.

The *Macro Assembler* produces a relocatable object module and optional assembly listing. This language provides global symbols for linking separately assembled object programs, device and file name specifications for input and output files, user-defined macros, a system macro library, program sectioning directives, conditional assembly directives, assembly and listing control functions at program and command string levels, an alphabetized and formatted symbol table listing, and a default error listing on a command output device.

The RT-11 and RSTS/E versions provide a cross-reference symbol table listing. The RSX and IAS versions add global arithmetic, a global assignment operator, a global label operator, a default global declaration, multiple macro libraries, default register definitions, and an indirect command file facility for controlling the assembly process. The macro assembler provides a total of 48 assembly and macro directives of 15 different types.

Under RT-11 and RSTS/E, the macro assembler requires a partition of 24K bytes or more (for additional symbol table use). A system macro library containing the expanded code for all of the RT-11 monitors' programmed requests is provided. RT-11 also provides a smaller version of the assembler called ASEMBL, which does not recognize assembler directives, does not provide floating-point directives, and does not provide a lower case mode.

Under RSX/IAS, the macro assembler requires a minimum of 28K bytes of partition space to execute. The system macro library includes executive directives and file system calls.

Under the RSX-11M system, a 16K-byte version is available for users who have limited memory space. The 16K version differs from the 18K version in the following ways: It does not search the permanent symbol table for symbols appearing in the operand field of a statement; it does not recognize certain ENABL/DSABL directive function control options; it does not recognize or accept the PAL-11R conditional assembly directives and EOT directive; it does not flag in the assembly listing the instructions which are not common among all members of the PDP-11 family; and it does not accept floating point directives or control operators.

DSM-11 (Digital Standard MUMPS) is a procedural language directed toward the processing of variable-length string and array data. Algebraic, Boolean, and assembly-like bit-manipulation operations are available.

DSM-11 is interpreter-based language with two operating modes: program execution mode (indirect mode) and program creation mode (direct mode). Direct mode provides for the creation, modification, debugging, storing, and partial or complete execution of programs.

DEC PDP-11 Family

DSM-11 provides four variables types (simple, subscripted, global, and system) and six types of expression operators (arithmetic, relational, Boolean, string relational, string concatenation, and data mode conversion) for use within the basic unit of expression in MUMPS, the command.

DSM-11 is supported by the MUMPS-11 operating system and requires a console terminal, a disk system and a magnetic tape system in the minimum configuration. The user can add user terminals up to a system total of 64, which can be connected by as many as 16 remote or local lines and as many as 48 multiplexed local lines. The system supports additional disk controllers (up to a maximum of eight drives per controller), up to four magnetic tape drives, and up to four dual DECTape transports. A line printer, card reader, and paper tape reader/punch are also supported. Minimum hardware requirements for DSM-11 are 32K words of memory and a disk subsystem with a minimum 7.5-megabytes capacity.

RPG II is a compatible subset of standard industry versions of the language and offers almost all the functions found in these versions. PDP-11 RPG II provides a set of 31 instructions and support for card readers, magnetic tape units, mass storage devices, printers, and terminals. PDP-11 RPG II accepts sequential, direct, and indexed file organizations and consecutive, sequential by key, sequential within limits, random by key, random by relative record number, and random utilizing ADDRESS ROUTING files.

Some of the features of PDP-11 RPG II are a DSPLY operation code that provides the ability to display messages on a user's terminal during program execution and to accept data in reply; support of console devices as normal files; support of ASCII, binary, packed decimal, overpunched, and zoned decimal numeric data; control of page length and overflow via line counter specifications; repetitive printing of the initial first-page output line to assist in the proper alignment of printer forms, and up to nine matching fields to control multi-file processing.

UTILITIES: The paragraphs following are generalized descriptions of some of the PDP-11 family utility programs.

The *Disk Compression Utility (DCU)* consolidates the area used by files on a disk. If the disk is not full, DCU provides the user with larger contiguous free areas on the disk.

DSKINT (Disk Initializer) is a stand-alone program used to format RK11 disks and to build file structures on RK11, RP04, RP05, RP06 or disks. The structures that DSKINT builds include two file directories, two monitor files, and a dummy bootstrap routine. Format and building operations permit the initialization of private disk and public non-system disks, and enable bad-block checking of all disks.

The *Dump Utility (DMP)* allows users to obtain a printout of any file in ASCII or octal format.

Editor is a symbolic editor program that allows users to create and modify source-code programs from the console keyboard (or via a paper tape or card reader). Modifications are entered into memory as they are typed, thus facilitating checking, correction, and further modification. When the editing process is complete, Editor produces a source program that is suitable for creating a binary object program.

FILCOM (File Compare) traces changes to a file by comparing the two files and providing a list of differences. The files must be ASCII. This utility can be a valuable debugging tool when used following editing changes to a file.

FILDMP (File Dump) examines the contents of a file by reading the entire file or specified blocks of that file and creating a dump copy in octal bytes, words, or ASCII

characters. The file may be formatted or unformatted binary data or formatted ASCII data. FILDMP can also treat each word as a group of three packed Radix-50 characters and print the characters represented. More than one representation of the file can be specified. Output can be sent direct to the keyboard device or line printer or stored in a file.

File Control Services (FCS), available under RSX-11D, provide the user with record-oriented and block-oriented file I/O and additional functions required for file control such as open, close, wait for event flag, and delete operations. The user issues macro calls to specify desired file control operations. FCS supports both sequential and direct-access files. Sequential access is device-independent and can be used for both record-oriented and file-structured devices. Direct access is used for file-structured devices only.

The *File Transfer Program (FLX)* is a utility that converts files between DOS/BATCH and RSX-11D formats and can also convert files using different data types within the DOS/BATCH and RSX-11D formats. Files converted can be of any data type; i.e., task image, binary, or ASCII.

LINK is a DOS/Batch utility that links program segments to one another when they have been successfully compiled or assembled. It also corporates programs that are held in a library and 1) relocates each object module and assigns absolute addresses; 2) links the modules by correlating the global symbols that are defined in one module and referenced in others; 3) when applicable, implements the overlay structure the user has defined; 4) creates an executable load module, writing it as a data set rather than into memory, allowing it to be used more than once; and 5) provides a cross-reference listing of globals.

The *RT-11 Linker* is very similar. It converts object modules produced by the RT-11 Assembler into a format suitable for loading and execution. It allows users to separately assemble a main program and needed subroutines without assigning absolute load addresses at this time. In addition to the functions performed by the DOS/Batch Link program referenced above, the Linker creates an initial core control block for the linked program and produces a load map showing the load module layout.

The Linker requires at least 16K bytes of main memory; any additional memory available is used to extend the symbol table. Input is accepted from any binary device on the system. There must be at least one random-access device (disk or DECTape) for "save image" output.

MONEY is an RSTS-11 system accounting that allows a user to obtain printed data concerning his own account status. The program can be called by any user who is logged into the system.

The *On-Line Debugging Technique (ODT)* aids users in debugging programs that have been assembled/compiled and built into tasks. From the keyboard, the user can 1) print the contents of any location in the task for his examination or alteration; 2) run the entire program or any portion of it, using the breakpoint feature to halt its execution at specified points; 3) search the object program for specific bit patterns, words, or references to a particular address; 4) calculate offsets for relative addresses; and 5) fill a block of words or bytes with a designated value.

A *TRACE* program is also provided for FORTRAN debugging.

ROLLIN is a stand-alone utility program used to transfer data quickly between a disk and either DECTape or magnetic tape or between RK11 disk cartridges. Disks handled by ROLLIN are the RF11, RC11, RP02, and RK11. ROLLIN assumes no file structure, and all data transfers are per-

DEC PDP-11 Family

► formed in image mode. Magnetic tapes are treated as file-structured devices in that each ROLLIN file is preceded by a DOS-compatible file label.

When transferring data onto either type of tape device, ROLLIN automatically writes an initial record containing a tape sequence number called a reel label. For DECTape transfers, the reel label also contains the number of blocks of data transferred. The reel label guards against mounting tapes out of sequence when returning data to a disk device. Preceding all data records on a DECTape or the first file on a magnetic tape, ROLLIN copies a core image of itself. This image permits ROLLIN to be bootstrapped from the tape to load the remainder of the tape.

The SYSTAT program provides current system information in the areas of job, device, disk, and buffer status. SYSTAT can be called by a user logged into the system or from a terminal which is on-line but not logged into the system.

The RSX-11D Task Builder creates actual core images from assembled or compiled tasks. It links relocatable object files together and resolves any references to global symbols, the common area, and the shared libraries. The Task Builder also uses an overlay descriptor language to construct task overlays.

The TTYSET system program is used to establish the terminal characteristic of the user terminals. TTYSET can be run by any user before or after logging into the system.

VERIFY checks the consistency and accuracy of system files on a file-structured device. It also prints the number of available blocks in a volume, locates files that could not otherwise be accessed, and lists the files that have entries in the system-maintained index file for the volume.

QUOLST allows the PDP-11 user to determine what portion of his disk quota is currently in use or occupied and the number of free blocks that remain on the system disk. Output from QUOLST includes the user account number and information printed under the following headings:

- STR—the file structure of the device being reported
- USED—the number of 512-byte blocks used under the user account
- FREE—the number of free blocks remaining in the user account disk quota
- SYSTEM—the number of free blocks remaining to the system on the device indicated.

The Peripheral Interchange Program (PIP) is used to transfer files between devices, merge and delete files, and list, zero, and compress directories. PIP accepts up to nine input files and outputs to one file. Since PIP performs file transfers for all types of files, ASCII, IMAGE or SAVE format, or binary, there are no assumed extensions. All extensions for either input or output must be explicitly specified in the commands to PIP. For the PDP-11 family, PIP is available in two forms. One contains Record I/O copy options and is available only to systems with the Record I/O feature. The other version can perform only formatted ASCII file transfers.

LOGIN and LOGOUT are a pair of PDP-11 family user terminal utilities that operate under RSTS/E.

LOGIN connects a user terminal to RSTS/E, attaches a user to another job already running in the system, or permits the user to run designated system programs from a logged-out terminal. LOGIN can be called either when the user first logs into the system or at a later time.

LOGOUT is called when the user has completed all processing and is ready to leave the terminal. The LOGOUT program is started by a command typed at a user terminal logged into the system. LOGOUT checks the current user's disk quota to ensure that the user does not log out of the system with more than the acceptable disk quota size,

LOGOUT disconnects the terminal from the system, removes the current job number from the list of active jobs, and prints information on the duration of the current job.

SORT-11, VERSION 2 is an independent utility that can be run under the control of the RSX-11M (Version 1), RSTS/E, and IAS operating systems. SORT provides four different efficient sorting procedures, which are selectable by user commands. Any RMS file can be taken as input and will be produced as a reordered output file. Files stored in RMS-11 format may be processed with up to 10 sort keys.

Sorting procedures include record sort; tag sort, where a file is reordered by manipulating only the key position of each record, then randomly reaccessing the input file to write out a newly sequenced output file; ADDRESS ROUTING sort, where one data file may have several addressing files appropriate to alternative sequential processing needs; and index sort, which provides for sequential and direct accessing from a random-data file via an index.

DBMS-11 is DEC's adaptation of Cullinane Corporation's IDMS data base management system. IDMS was originally developed by a Fortune 500 company in 1970 and 1971, and was put into production in early 1972. In 1973 Cullinane was awarded complete responsibility for the system, including all technical developments, enhancements, field support, and marketing. Enhancements have generally followed the CODASYL guidelines, with emphasis on performance and usability, making DEC the first minicomputer vendor to offer a data base management system consistent with the CODASYL recommendations.

DBMS-11 encompasses a data base design methodology; a language to describe the physical and logical data base (DDL); a data manipulation language (DML); compilers for COBOL and FORTRAN; and a data base manager that provides record storage, control, space management, security, and backup and recovery functions. Also included is a data base dictionary subsystem.

The basic unit of physical space under DBMS-11 is the page, a fixed-length block between 512 and 4096 bytes long. Data bases can be divided into physical areas made up of any number of pages and also into logical files. The entire data base can be assigned to one file, and many logical files can be assigned to a physical area.

DBMS-11 uses the concept of sets. Within a set, one record type functions as the "owner" and one or more record types functions as "members." Using the set concept, hierarchical, network, partially inverted, indexed, and bill of material data bases can easily be defined. Set characteristics are defined by the system designer and consist of independent choices of set order, set membership, and set linkage.

The designer can select one of five logical orders for each set:

- SORTED—members are stored under control of a logical sort field.
- FIRST—members are stored LIFO (last-in, first-out).
- LAST—members are stored FIFO (first-in, first-out).
- NEXT—members are stored in a descending sequence under control of the application program.
- PRIOR—members are stored in ascending sequence under control of the application program.

The same member record may be in a different sequence in each set in which it participates.

The designer can select one of four membership specifications for each set. The choices are: ►

DEC PDP-11 Family

- ● **Mandatory Automatic**—members are automatically inserted into a set at the time they are stored and remain in the set until erased from the data base.
- **Mandatory Manual**—members are inserted into a set under program control but remain in the set until erased from the data base.
- **Optional Automatic**—members are automatically inserted into a set when stored but may be disconnected from one set and connected to another under program control.
- **Optional Manual**—members are inserted into sets under program control but must remain in that set until erased from the data base.

A member record may have different linkage specifications in each set in which it participates. Four linkage options are available for each set:

- **NEXT**—the system maintains unidirectional pointers for processing in the forward direction only.
- **NEXT and PRIOR**—the system maintains bidirectional pointers for processing in forward as well as reverse order.
- **NEXT and OWNER**—the system maintains pointers back to the respective owner in each member record as well as pointers in the forward direction.
- **NEXT, PRIOR, and OWNER**—a combination of the second and third options noted above.

Records are stored into the DBMS-11 data base by one of the following three techniques:

- **CALC**—provides for record storage based on a symbolic key within the data record which the data base management system uses to calculate a relative storage address. CALC is used to define entry points into the data base and is often used for "master" type data. Duplicate keys may be accepted or rejected based on design criteria.
- **VIA**—provides for storage of member records physically near the owner record to which they are related within the set. VIA is often used for "transaction" type data and provides for more efficient processing because all the associated data are brought into main memory with a single access.
- **DIRECT**—the application program directs the data base management system to store a record at a given relative location. This technique is useful when the application program desires to establish a custom addressing scheme.

In all cases, actual record storage, space management, buffering, and control are the responsibility of the data base management system.

The subschema provides for a logical subset of the data base and defines the rules by which the individual application system may access the data base. Data independence and data security features are implemented in the subschema, and the user can define additional privacy control through the use of passwords, special keys, or data range analysis. DBMS-11 also provides special routines for data compression and decompression, variable-length records, editing and validation, record substitution, auditing, statistical analysis, and encoding/decoding through the use of special DBA procedures.

Application programs access the data base through use of the DML, which provides the interface to the data base system. DML commands such as STORE, ERASE, CONNECT,

DISCONNECT, MODIFY, and OBTAIN minimize the need for coding CALL statements. The DML commands and the host-language statements, which may be COBOL or FORTRAN, are read into a DML compiler which checks the syntax of the DML command, checks its logical consistency with the data base, and inspects the security and privacy locks associated with the application subschema. In addition, the DML compiler builds the user data work areas, data base communication areas, and data base declarative statements.

Currently, DBMS-11 requires a minimum system consisting of a PDP-11/70 with 256K bytes of main memory, a large disk pack drive (RP04 or equivalent), a 9-track, 1600-bpi magnetic tape subsystem, console for DBMS-11 operator interaction, and the IAS or RSX-11M operating system.

DATATRIEVE-11 is an inquiry and report writing system that allows interactive data retrieval, sorting, and updating; report generation and creation; and maintenance and accessing of data dictionary entries that define RMS-11K records. Like RMS-11K, *DATATRIEVE-11* runs under IAS, RSTS/E, or RSX-11M. The system has capabilities to handle RMS-11K files created by COBOL, BASIC-PLUS II, DIBOL, and macro assembler programs. *DATATRIEVE-11* provides 10 query commands, 6 parameters for report writing, 5 commands for report writing, 5 statistical functions, and a process for storing often-used statements in the data dictionary as procedures.

DATATRIEVE-11 requires an IAS, RSTS/E, or RSX-11M configuration including memory management hardware, 64K bytes of user memory, and hardware multiply/divide.

APPLICATIONS SOFTWARE: DEC PDP-11 applications software packages tend to take the form of advanced tools that can be applied with configured systems that are marketed by groups within the company. DEC issues press releases on new application tools in various applications fields with great regularity, and space limitations preclude complete coverage in this report. Examples of the sophisticated tools DEC can provide are the LA-11 Laboratory Data Processing, COGO-11, ASSIST-11, and WISE packages.

LA-11 is a package of application software modules designed to solve most laboratory automation problems such as data acquisition and instrument control, data display and manipulation, and file storage and retrieval. The library comprises assembly-language routines which are callable at the macro level.

Included in the library is SPARTA, the Signal Processing and Real-Time Analysis program. SPARTA consists of five major components: console interface, data acquisition, interactive graphics, data reduction, and data storage/retrieval. The console interface passes command input from the research user and controls the execution of the other SPARTA components.

SPARTA facilitates interaction through the use of operator-controlled cursors which may either ride along a waveform (fixed) or move freely in two dimensions (free). SPARTA will further display decimal readouts of cursor coordinates and provide display scaling, normalizing, general graphic compressions, and a special zoom-in feature for amplifying regions of interest within a spectrum.

The data reduction functions include both spectrum-to-spectrum and scalar operators for addition, subtraction, multiplication, and division. SPARTA will extract derivatives, both running and absolute integrals, and strip peaks with or without baseline corrections. In addition, the data analysis routines can calculate both forward and inverse

DEC PDP-11 Family

► complex FFT's (Fast Fourier Transforms) on up to 8192 data points and generate a power spectrum or magnitude and phase angle. With the aid of RT-11's file I/O processor, the program can generate under a scientist's direction a permanent library of laboratory data profiles for future access by SPARTA or any other RT-11 software, e.g. BASIC or FORTRAN.

Other modules included in LA-11 are:

- **Interactive Dialog Module**—provides a standard interface to facilitate console question-and-answer dialogue for such activity as initiating or controlling an experiment and providing parameters for manipulation routines.
- **Output Formatter Module**—converts internal data types and prints them in a user-specified format on the console terminal.
- **Analog Data Acquisition Modules**—sample data from up to 64 analog channels simultaneously.
- **Point Plot Display Module**—displays single-precision integer data on an XY point plot scope and displays one or two spectra simultaneously with a moving window display and cursors.
- **Graphics Display Module**—plots byte, single-precision, double-precision, or floating-point data on a CRT under control of an independent asynchronous hardware graphics processor. This processor can also display alphanumeric characters and vectors for axis labeling and decimal readout of XY coordinate pairs.
- **FFT Module (Fast Fourier Transform)**—completes both forward and inverse complex transformations on any number of data points from 8 to 8,192 in powers of two.

Minimum system requirements for running LA-11 include a PDP-11 processor with an ASCII terminal, 16K bytes of main memory, AR11 or LPS-11 analog front-end, and a dual-drive cassette unit.

GOGO-11 is a problem-oriented language that enables an engineer to solve problems in plane coordinate geometry. Using the COGO commands, the user builds a computer file of points, curves, and lines to define a geometry problem. Starting with known points, new points, lines, and curves can be defined, using COGO to describe the known relationships between these elements. Thus, an engineer can work from a sketch, going through the problem as if solving it by hand.

COGO-11 can be employed with PLOT-11 software to produce plotted output from a coordinate table.

The system was designed for persons with little or no computer experience. Existing functions can be modified and new ones added without the use of a macro language.

COGO-11 may be used in the interactive or batch mode by one or several users. Written in FORTRAN, COGO-11 operates under RSX-11D, RSX-11M, or IAS and consists of 131 programs.

ASSIST-11 permits operators to procure telephone directory information on video display terminals. The system provides as few as 2 or as many as 63 operators with simultaneous access to as many as 20 million directory entries stored on magnetic disk. The displayed information is in the same format as the familiar paper telephone directories. Arranged in two columns, upper and lower case, the screen can display 44 entries at once. A full screen of entries can be displayed in seconds. Directory space requirements are reduced, and directory files can be updated. With a variety of hardware

configurations, the system can be adapted to the needs of both large and small operating companies. It can also be used for internal directory assistance in large corporations.

ASSIST-11 operates under RSTS/E on any system from the 11/34A through the 11/70.

WISE is an integrated, expandable data management system designed within an educational time-sharing framework. WISE consists of a data management system with multi-key indexing, on-line file inquiry and updating, and a report generator; a student information system with grade reports and on-line file maintenance, course registration (including class lists and student schedules), and grade entry; an admissions information system with on-line file maintenance; and an alumni information system with on-line alumni data file maintenance, mailing labels, and donor analysis.

WISE operates under RSTS/E on any system from the 11/34A through the 11/70.

PRICING

POLICY: DEC generally provides the PDP-11 minicomputers on a purchase basis, with separately priced maintenance agreements. Leasing arrangements are available through DEC's joint venture with U.S. Leasing Corp. or through TEC Leasing Corp. of New York. Lease rates vary with the prime interest rate, the customer's volume of business with DEC, and the value of the equipment being leased.

Software maintenance is offered through several levels of optional service, ranging from a periodic software newsletter to automatic updates of software and manuals (software subscription service). In addition, software components, including documents and updates, can be purchased separately from Digital's Software Distribution Center.

The Digital Equipment Computer Users Society (DECUS) is a voluntary, non-profit users' group supported by DEC. DECUS provides an extensive program library, users' groups, special interest groups, and workshops/symposia. Technical symposia are sponsored twice a year in the United States and once a year in Europe, Canada, and Australia. In terms of documentation, the society has the responsibility of maintaining the DECUS program library and publishing a library catalog, the proceedings of symposia, and a periodic newsletter, *DECUSCOPE*.

Training credits are issued with many of the PDP-11 systems, allowing the customer to obtain free training in programming techniques and systems operation and applications. Each individual student week of instruction or fraction thereof requires one training credit. Training is offered in 17 DEC facilities found in Japan, Australia, Great Britain, Germany, France, The Netherlands, Sweden, Italy, Canada, and throughout the United States. At present, over 100 courses are offered. Digital also offers on-site instruction in both standard and customized courses and self-paced audio/visual (A/V) courses. A/V courses are presented through mixed media of audio/film-strip cartridges, video cassettes, and workbooks. A/V courses include Introduction to the PDP-11, Introduction to Minicomputers, and Introduction to Data Communications Concepts. DEC's Special Systems group offers training in both hardware and software areas on-site and in DEC training centers.

Field service is offered on several levels to meet varying customer needs. For customers with in-house troubleshooting and self-maintenance capabilities, DEC offers the off-site facilities of its Product Repair Center (PRC), with 17 locations throughout the world. Services provided by PRC include return-to-PRC agreements which cover all repairs (user performs troubleshooting) on a specific CPU, peripheral, or system for one year; exchange service providing

DEC PDP-11 Family

► teletypewriters, punches, and selected disk drive exchange at a flat rate; a fixed quote service, which provides a quote on equipment repair before any work is performed; and a loose piece module repair plan for modules and subassemblies. Under the repair plan, DEC estimates a typical turn-around repair time of 20 working days after receipt at the customer returns area (CRA). PRC also offers a module exchange service on a yearly contract basis, allowing a customer to replace a defective module within seven working days from the time it is received at the CRA. DEC supplies special mailers for both the loose piece module repair plan and the module exchange service. Also available for this class of customer is a customer spares program, which includes component and subassembly spares, engineer-designed spares kits, memory stack spares, maintenance test equipment, maintenance documentation service, and emergency parts service.

On-site field service is offered worldwide through a network of 300 offices, 190 of which are located in North America. These offices provide both field service and spare parts inventory. Over 4000 service representatives are assigned to these offices.

Per Call On Site Service is offered to customers for whom downtime may not be critical and who have sufficient expertise to perform first-line maintenance, or as a supplementary program for standard service agreement customers if remedial maintenance is required outside their normal hours of coverage. Labor rate charges are portal-to-portal; parts and travel expenses are rated separately. Labor rates from 8 a.m. to 5 p.m. Monday through Friday are \$42 per hour; all other times, including Digital holidays, are priced at \$48 per hour. A two-hour minimum is in effect for per call service. Travel charges are based on a portal-to-portal rate of 16 cents

per mile plus any commercial travel expenses incurred. Normal response for per call service is one to two days. If unanswered in three working days, per call requests are placed in the same category as standard service agreement or warranty customers.

The basic field service agreement includes remedial maintenance; preventive maintenance; an assigned service representative; all parts, material, and labor; engineering modifications; and documentation. Hours of coverage are 8 a.m. to 5 p.m. Monday through Friday. (Preventive maintenance time is extended by 3 hours to 8 p.m. on weekdays.) Extensions are available to allow coverage up to 24 hours a day, 7 days a week.

The DECservice agreement is the same as the basic field service agreement except for these additions: response time of four hours or less if a call is made during coverage hours; continuous service until system level repairs are complete; and no extra charge for service continued after coverage hours.

The newest field engineering service is Remote Diagnosis for the PDP-11/70. This process consists of an electronic console, the Digital Diagnosis Center (DDC) with its host computer, and the Service Response Hot-Line/Remote Diagnosis. The electronic console replaces the regular PDP-11/70 front panel and permits initiation of operating commands through the system terminal. Both the DDC and the response group operate 24 hours per day and 7 days a week, and are responsible for decisions on the use of remote diagnosis and analysis of results.

EQUIPMENT: A large number of packaged PDP-11 systems appear in the Equipment Price List which follows. ■

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
LSI-11 AND LSI-11/2 PROCESSORS*			
KD11-HA	LSI-11/2 CPU with power fail/auto restart, 16-bit I/O DMA port, real-time clock input, and vector interrupt handling	\$ 459	NA
KD11-HF	With 8K bytes of MOS on a separate board	990	NA
KD11-HB	With 16K bytes of MOS on a separate board	1,290	NA
KD11-HC	With 32K bytes of MOS on a separate board	1,690	NA
KD11-HD	With 64K bytes of MOS on a separate board	2,490	NA
KD11-HU	With UV PROM/RAM memory board including 512 bytes of RAM and sockets for up to 4K x 16-bit UV PROM chips		
KD11-F	LSI-11 CPU with power fail/auto restart, 16-bit I/O DMA port, real-time clock input, vector interrupt handling, and 8K bytes of MOS	990	NA
KD11-FA	With 8K bytes of additional MOS on a separate board	1,240	NA
KD11-FB	With 16K bytes of additional MOS on a separate board	1,490	NA
KD11-FC	With 32K bytes of additional MOS on a separate board	1,990	NA
KD11-J	Same as KD11-F but all 8K bytes of memory (core) is on a separate board	1,536	NA
KD11-R	Same as KD11-F but all 32K bytes of memory (MOS) is on a separate board	2,490	NA
KD11-U	Same as KD11-F without on-board memory; includes UV PROM/RAM memory board with 512 bytes of RAM and sockets for up to 4K x 16-bit UV PROM chips	990	NA
KD11-WA	Same as KD11-F but all 32K bytes of memory (MOS) is on a separate board; includes writable control store board with 1K x 24 RAM	3,490	NA

*Available from DEC components group.

PDP-11/03 THROUGH PDP-11/70 PROCESSORS

PDP-11/03 processors include 8 general-purpose registers, power fail/auto restart, stack architecture, ASCII console emulator, bootstrap loader, single-level vectored priority interrupts, DMA, line frequency clock, cabinet-mountable 3.5-inch-high chassis for up to 56K bytes of user memory, operator's console, vans, and power supply.

11/03-EA	LS11 CPU with 8K bytes of MOS memory and 6 Sub-Unibus slots	1,995	37
11/03-KA	LS11 CPU with 32K bytes of MOS memory and 4 Sub-Unibus slots	3,495	50
11/03-FA	LS11 CPU with 8K bytes of core memory and 4 Sub-Unibus slots	2,425	37
11/03-LC	LS11 CPU with 32K bytes of core memory and 7 Sub-Unibus slots	3,995	40
11/03-WC	11/03-LC plus writable control store (WCS) module with 1K x 24 RAM	5,495	NA

DEC PDP-11 Family

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
--	--	-----------------------	-----------------------

PDP-11/03 THROUGH PDP-11/70 PROCESSORS (Continued)

PDP-11/04 processors include 8 general-purpose registers, power fail/auto restart, stack architecture, a multifunction ROM module with bootstrap loader, automatic self test feature, AS11 console emulator, 4-level vectored priority interrupts, direct memory access, and choice of chassis with fans, power-supply, and operator's console. Chassis holds up to 56K bytes of user memory.

Cabinet-mountable, 5.25-inch, 9-slot chassis:

11/04-BC	CPU with 16K bytes of MOS memory and 5 hex, 2 quad small peripheral controller (SPC) slots	3,995	54
11/04-DC	CPU with 32K bytes of MOS memory and 5 hex, 2 quad SPC slots	5,065	57
11/04-LC	CPU with 56K bytes of MOS memory and 4 hex, 2 quad SPC slots	7,510	82
11/04-FC	CPU with 16K bytes of core memory and 4 hex, 2 quad SPC slots	4,695	54
11/04-HC	CPU with 32K bytes of core memory and 4 hex, 2 quad SPC slots	6,045	57
11/04-MC	CPU with 56K bytes of core memory and 2 hex, 2 quad SPC slots	9,270	82

Cabinet-mountable, 10.5-inch, 22-slot chassis:

11/04-D4	CPU with 32K bytes of MOS memory; 3 Sub-Unibus (SU), 5 hex SPC, and 2 quad SPC slots	6,320	61
11/04-LA	CPU with 56K bytes of MOS memory; 3 SU, 4 hex SPC, and 2 quad SPC slots	8,770	86
11/04-HH	CPU with 32K bytes of core memory; 3 SU, 4 hex SPC, and 2 quad SPC slots	7,300	61
11/04-MH	CPU with 56K bytes of core memory; 3 SU, 2 hex SPC, and 2 quad SPC slots	10,530	86

PDP-11/34A processors include 8 general-purpose registers, power fail/auto restart, stack architecture, multifunction ROM module with ROM bootstrap loader, automatic self test feature, ASCII console emulator, 4-level vectored priority interrupts, direct memory access, hardware memory management, hardware multiply/divide, extended instruction set (EIS), and choice of chassis with fans, power supply and operator's console. Chassis holds up to 128K bytes of user memory.

Cabinet-mountable, 5.25-inch, 9-slot chassis:

11/34A-DC	CPU with 32K bytes of MOS memory and 3 hex, 3 quad SPC slots	9,050	87
11/34A-LC	CPU with 64K bytes of MOS memory and 2 hex, 3 quad SPC slots	10,970	112
11/34A-HC	CPU with 32K bytes of core memory and 2 hex, 3 quad SPC slots	10,030	87
11/34A-MC	CPU with 64K bytes of core memory and 3 quad SPC slots	12,930	112

Cabinet-mountable, 10.5-inch, 22-slot chassis:

11/34A-DH	CPU with 32K bytes of MOS memory; 3 SU, 3 hex SPC, and 3 quad SPC slots	10,310	91
11/34A-DE	CPU with 32K bytes of MOS memory; 3 SU, 3 hex SPC, and 1 quad SPC slot	11,520	71
11/34A-LH	CPU with 64K bytes of MOS memory; 3 SU, 2 hex SPC, and 3 quad SPC slots	12,230	116
11/34A-LE	CPU with 64K bytes of MOS memory; 3 SU, 2 hex SPC, and 1 quad SPC slot	13,440	96
11/34A-HH	CPU with 32K bytes of core memory; 3 SU, 2 hex SPC, and 2 quad SPC slots	11,290	91
11/34A-HE	CPU with 32K bytes of core memory; 3 SU, 2 hex SPC, and 2 quad SPC slots	12,500	71
11/34A-MH	CPU with 64K bytes of core memory; 3 SU and 3 quad SPC slots	14,190	116
11/34A-ME	CPU with 64K bytes of core memory; 3 SU and 1 quad SPC slot	15,400	96

11/35-FC	PDP-11/35 with 8 general-purpose registers, fixed stack overflow, power fail/auto restart, direct memory access, 4-level vectored priority interrupts, and 21-inch cabinet-mountable chassis with fans, power supply, chassis slide assembly, and programmer's console. Chassis holds up to 128K bytes of memory.	19,800	117
----------	---	--------	-----

PDP-11/45 and 11/55 processors include 16 general-purpose registers, power fail/auto restart, variable stack overflow, 4-level vectored priority interrupts, KW11-L Line Frequency Clock, hardware memory management, EIS, direct memory access, M9301-YA ROM Multidevice Bootstrap Loader, and H960-CA Equipment Cabinet with fans and power supply. Chassis limit is 64K bytes of memory.

11/45-BW	CPU with 32K bytes of parity core memory, 1 SU slot, and 2 SPC slots	43,300	237
11/45-DW	CPU with 64K bytes of parity core memory, 1 SU slot, and 2 SPC slots	41,800	238
11/55-BA	CPU with 64K bytes of parity bipolar memory, 3 SU slots and 2 SPC slots	50,400	354
11/55-BD	CPU with 32K bytes of parity core and 32K bytes of parity bipolar memory, 1 SU slot and 2 SPC slots	44,100	296

PDP-11/70 processors include 16 general-purpose registers, power fail/auto restart, variable stack overflow, 4-level vectored priority interrupts, KW11-L Line Frequency Clock, hardware memory management, EIS, direct memory access, M9301-YC ROM Multidevice Bootstrap Loader, operator's console, prewired slots for up to four high-speed mass storage control units, floating-point processor, 2K-byte cache memory, LA36 DECwriter II console, and two H960-CA Equipment Cabinets with fans and power supplies. Cabinet limit is 2048K bytes of memory.

11/70-NA	CPU with 128K bytes of memory	63,000	281
11/70-VA	CPU with 128K bytes of parity core memory and 4 SPC slots	63,000	241
11/70-VE	CPU with 256K bytes of interleaved parity core memory and 4 SPC slots	81,590	311

PDP-11/03 PACKAGED SYSTEMS

PDP-11/03 packaged systems include a processor with 32K bytes of MOS memory, RT-11 software license, DLV11 Serial Line Interface, power control, LA36 DECwriter II Console Terminal, bootstrap loader, and extended arithmetic chip.

SR-VXRRRA-LA	Real-Time Package; includes RXV11 Dual Floppy Disk System and 25-inch-high cabinet; 1 double 11/03 slot	10,000	108
SR-VXFJA-LA	RK05J Disk-Based Package; includes a 2.5-megabyte RKV11 Cartridge Disk Subsystem for backup and loading, a 5-megabyte RK05F Cartridge Disk Drive for the systems device. A REV11-A Utility Interface, and a H967 Cabinet; 1 double 11/03 slot	19,000	203
SR-VXFJA-VA	Same as SR-VXFJA-LA but VT52 Alphanumeric CRT Terminal replaces LA36 DECwriter II	19,900	203
SR-VXRRRA-VA	Same as SR-VXRRRA-LA but VT52 Alphanumeric CRT Terminal replaces LA36 DECwriter II	10,000	109

PDP-11/04 PACKAGED SYSTEMS

PDP-11/04 packaged systems include a processor with 32K bytes of memory, bootstrap loader, serial line interface, real-time clock, CPU self-diagnostic module, LA36 DECwriter II Console Terminal, and H960 Equipment Cabinet.

DEC PDP-11 Family

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
PDP-11/04 PACKAGED SYSTEMS (Continued)			
MOS Parity Memory:			
SR-20RRA-LA	Real-Time Package; includes RT-11 software license and RX11 Dual Floppy Disk Subsystem; SU 1 & 2 provide 4 hex slots, 1 quad slot; SU3 to 5 provide 3 SU slots	17,330	118
SR-20FJA-LA	Real-Time Package; include RT-11 software license, 2.5-megabyte RK11J Cartridge Disk Subsystem for backup and loading, and 5-megabyte RK05F Cartridge Disk Drive for the systems device; SU 1 & 2 provide 4 hex slots and 2 quad slots; SU 3 to 5 provide 2 SU slots	23,500	220
SR-20JJA-LA	Real-Time Package; as described under SR-20FJA-LA but RK05J substituted for RK05F	23,500	205
SR-20LLA-LA	Real-Time Package; includes 64K bytes of memory, RT-11 software license, RL11-AK Cartridge Disk Subsystem with two 5-megabyte disk drives, and H967 cabinet; SU 1 & 2 provide 2 hex slots and 2 quad slots	21,000	214
SM-20FJA-LA	Real-Time Package; as described under SR-20FJA-LA but software license is for RSX-11M	24,900	220
SM-20JJA-LA	Real-Time Package; as described under SR-20FJA-LA but software license is for RSX-11M and RK05J is substituted for RK05F	24,900	205
SM-20LLA-LA	Real-Time Package; as described under SR-20LLA-LA but software license is for RSX-11M	22,400	214
Core Memory:			
CR-20RRA-LA	Real-Time Package; as described under SR-20RRA-LA but SU 1 & 2 provide 3 hex slots and 1 quad slot	18,310	118
CR-20FJA-LA	Real-Time Package; as described under SR-20FJA-LA but SU 1 & 2 provide 3 hex slots and 2 quad slots	24,480	220
CR-20JJA-LA	Real-Time Package; as described under SR-20FJA-LA but RK05J is substituted for RK05F and SU 1 & 2 provide 3 hex slots and 2 quad slots	24,480	205
CR-20LLA-LA	Real-Time Package; as described under SR-20LLA-LA	21,790	206
CM-20FJA-LA	Real-Time Package; as described under SR-20FJA-LA but software license is for RSX-11M and SU 1 & 2 provide 3 hex slots and 2 quad slots	25,880	220
CM-20JJA-LA	Real-Time Package; as described under SR-20FJA-LA, but software license is for RSX-11M and RK05J is substituted for RK05F; SU 1 & 2 provide 3 hex slots, 2 quad slots; SU 3 to 5, 2 SU slots	25,880	205
CM-20LLA-LA	Real-Time Package; as described under SR-20LLA-LA but software license is for RSX-11M	23,190	206
PDP-11/34A PACKAGED SYSTEMS			
PDP-11/34A packaged systems include a processor with memory management, parity control, EIS, and automatic bootstrap loader; serial line interface; real-time clock; programmer's console; LA36 DECwriter II Console Terminal; and H960 Equipment Cabinet.			
MOS Parity Memory:			
SR-30RRA-LA	Real-Time Package; includes 32K bytes of memory, RT-11 software license, and RX11 Dual Floppy Disk Subsystem; SU 1 & 2 provides 3 hex slots; SU 3 to 5, 3 SU slots	20,880	123
SR-30FJA-LA	Real-Time Package; includes 64K bytes of memory, RT-11 software license, 2.5-megabyte RK11J Cartridge Disk Subsystem for backup and loading, and 5-megabyte RK05F Cartridge Disk Drive for the systems device; SU 1 & 2 provide 2 hex slots and 1 quad slot; SU 3 to 5, 2 SU slots	27,500	250
SR-30JJA-LA	Real-Time Package; as described under SR-30FJA-LA but RK05J substituted for RK05F	27,500	235
SR-30KKA-LA	Real-Time Package; includes 64K bytes of memory, RT-11 software license, RK611 Disk Subsystem with two 14-megabyte RK06 Cartridge Disk Drives in dedicated cabinets; SU 1 & 2 provide 2 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 2 quad slots, and 1 SU slot	40,800	301
SR-30LLA-LA	Real-Time Package; includes 64K bytes of memory, RT-11 software license, and RL11-AK Cartridge Disk Subsystem with two 5-megabyte disk drives; SU 1 & 2 provide 3 hex slots and 1 quad slot; SU 3 to 5, 3 hex slots, 2 quad slots, and 1 SU	25,500	223
SM-30FJA-LA	Real-Time Package; as described under SR-3 of JA-LA but software license is for RSX-11M	28,900	250
SM-30HHA-LA	Real-Time Package; includes 128K bytes of memory, RSX-11M software license, RK711-EA Cartridge Disk Drive Subsystem with two 28-megabyte drives, and a BA11-K Expansion Box; SU 1 & 2 provide 3 hex slots, 2 quad slots, and 1 SU; SU 3 to 5, 2 hex slots, 2 quad slots, and 1 SU; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 5, 3 SU's	50,900	551
SM-30JJA-LA	Real-Time Package; as described under SR-30FJA-LA but software license is for RSX-11M and RK05J is substituted for RK05F	28,900	235
SM-30KKA-LA	Real-Time Package; as described under SR-30KKA-LA but software license is for RSX-11M and 5.25-inch BA11 Expander Box is added; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 3 hex slots, 3 quad slots, and 1 SU; BA11-L SU 1 & 2, 2 hex slots and 1 quad slot	47,000	336
SM-30LLA-LA	Real-Time Package; as described under SR-30LLA-LA but software license is for RSX-11M	26,900	223
SM-30UVA-LA	Real-Time Package; includes 128K bytes of memory, RSX-11M software license, 67-megabyte RJM02 Removable Disk Pack Drive Subsystem for the system device, one-drive TJE16 Magnetic Tape Subsystem, and a BA11-K Expansion Box; SU 1 & 2 provide 3 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 2 quad slots, 1 SU; BA11-K, 1 SU	66,300	471
SE-30FJA-LA	Timesharing Package; as described under SR-30FJA-LA but software license is for RSTS/E, and memory is increased to 96K bytes; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 3 hex slots and 3 quad slots	35,400	275
SE-30JJA-LA	Timesharing Package; includes 96K bytes of memory, RSTS/E software license, 2.5-megabyte RK11J Cartridge Disk Subsystem for backup and loading, and 2.5-megabyte RK05J Cartridge Disk Drive for the systems device; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 3 hex slots and 3 quad slots	35,400	260
SE-30HHA-LA	Timesharing Package; includes 192K bytes of memory, RSTS/E software license, RK711-EA Cartridge Disk Drive Subsystem with two 28-megabyte drives, and a BA11-K Expansion Box; SU 1 & 2 provide 3 hex slots and 1 quad slot; SU 3 to 5, 2 quad slots and 1 SU; BA11-K SU 1 & 2, 2 hex and 1 quad slot; SU 3 to 5, 3 SU's	57,500	491
SE-30KKA-LA	Timesharing Package; includes 128K bytes of memory, RSTS/E software license, RK611 Disk Subsystem with two 14-megabyte RK06 Cartridge Disk Drives in dedicated cabinets, and 10.5-inch BA11-K Expander Box; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 3 quad slots, and 1 SU slot; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 5 provide 3 SU slots	53,700	367
SE-30AVA-LA	Timesharing Package; includes 192K bytes of memory, RSTS/E software license, RJP04 Disk Subsystem with 88-megabyte single-access disk drive as the systems device, one-drive TJE16 Magnetic Tape Subsystem as the primary backup and load device, and 10.5-inch BA11-K Expander Box; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 3 quad slots and 1 SU; BA11-K SU 3 to 5, 1 SU	90,290	511
SE-30UVA-LA	Timesharing Package; includes 192K bytes of memory, RSTS/E software license, 67-megabyte RJM02 Removable Disk Pack Drive Subsystem for the system device, one-drive TJE16 Magnetic Tape Subsystem, and a BA11-K Expansion Box; SU 1 & 2 provide 3 hex slots and 1 quad slot; SU 3 to 5, 2 quad slots and 1 SU; BA11-K, 1 SU	72,900	521

DEC PDP-11 Family

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
PDP-11/34A PACKAGED SYSTEMS (Continued)			
SP-30FJA-LA	Multi-User Data Base Management Package; same as SR-30FJA-LA but software license is for MUMPS-11	34,400	250
SP-30HTA-LA	Multi-User Data Base Management Package; includes 128K bytes of memory, MUMPS-11 software license, 28-megabyte RK711-EA Cartridge Disk Drive Subsystem for system device TME11-MA Magnetic Tape Subsystem for primary backup and load device, and a BA11-K Expansion Box; SU 1 & 2 provide 3 hex slots and 1 quad slot; SU 3 to 5 provide 2 hex slots, 2 quad slots, and 1 SU; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 5, 2 SU's	67,500	516
SP-30JJA-LA	Multi-User Data Base Management Package; same as SR-30FJA-LA but RK05J is substituted for RK05F and software license is for MUMPS-11	34,400	235
SP-30KKA-LA	Multi-User Data Base Management Package; same as SR-30KKA-LA but software license is for MUMPS-11	44,700	301
SP-30AVA-LA	Multi-User Data Base Management Package; same as SE-30AVA-LA but memory is 64K bytes and software license is for MUMPS-11; SU 1 & 2 provide 2 hex slots and 1 quad slot; SU 3 to 5, 1 SU slot; BA11-K SU 3 to 5, 3 SU slots	81,630	471
SP-30UVA-LA	Multi-User Data Base Management Package; includes 128K bytes of memory, MUMPS-11 software license, 67-megabyte RJM02 Removable Disk Pack Drive Subsystem for the system device, one-drive TJE16 Magnetic Tape Subsystem, and a BA11-K Expansion Box; SU 1 & 2 provides 3 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 2 quad slots, 1 SU; BA11-K, 1 SU	73,900	471
Parity Core Memory:			
CR-30RRA-LA	Real-Time Package; as described under SR-30RRA-LA but SU 1 & 2 provide 2 hex slots	21,860	123
CR-30FJA-LA	Real-Time Package; as described under SR-30-FJA-LA but SU 1 & 2 provide 4 hex slots, 1 quad slot; SU 3 to 5 provide 2 hex slots and 3 quad slots	30,120	250
CR-30JJA-LA	Real-Time Package; as described under SR-30FJA-LA but RK05J is substituted for RK05F; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots and 3 quad slots	30,120	235
CR-30KKA-LA	Real-Time Package; as described under SR-30KKA-LA but 10.5-inch BA11-L Expander Box added; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 3 quad slots and 1 SU; BA11-L SU 1 & 2, 2 hex slots and 1 quad slot	45,020	311
CR-30LLA-LA	Real-Time Package; as described under SR-30LLA-LA	26,360	215
CM-30FJA-LA	Real-Time Package; as described under SR-30FJA-LA but software license is for RSX-11M; SU 1 & 2 provide 4 hex slots, 1 quad slot; SU 3 to 5 provide 2 hex slots and 3 quad slots	31,520	250
CM-30HHA-LA	Real-Time Package; as described under SM-30HHA-LA, but SU 1 & 2 provide 3 hex slots and 1 quad slot	51,900	425
CM-30JJA-LA	Real-Time Package; as described under SR-30FJA-LA but RK05J is substituted for RK05F and software license is for RSX-11M; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots and 3 quad slots	31,520	235
CM-30KKA-LA	Real-Time Package; as described under SR-30KKA-LA but software license is for RSX-11M and 5.25-inch BA11-L Expander Box is added; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 3 quad slots and 1 SU slot; BA11-L SU 1 & 2, 2 hex slots and 1 quad slot	49,940	336
CM-30LLA-LA	Real-Time Package; as described under SR-30LLA-LA	27,760	215
CE-30FJA-LA	Timesharing Package; as described under SR-30FJA-LA but software license is for RSTS/E and memory is increased to 96K bytes; SU 1 & 2 provide 4 hex slots, 1 quad slot; SU 3 to 5 provide 3 quad slots	38,340	275
CE-30JJA-LA	Timesharing Package; as described under SE-30JJA-LA	38,340	260
CE-30KKA-LA	Timesharing Package; as described under SE-30KKA-LA but SU 1 & 2 provide 2 hex slots, 1 quad slot; SU 3 to 5, 3 quad slots, 1 SU; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 5, 3 SU slots	58,500	367
CE-30AVA-LA	Timesharing Package; as described under SE-30AVA-LA but adds a second BA11-K Expander Box; SU 1 & 2 provide 4 hex slots, 1 quad slot; SU 3 to 5, 3 quad slots and 1 SU; BA11-K #1, SU 1 & 2, 3 quad slots, SU 3 to 5, 1 SU; BA11-K #2, SU 3 to 5, 3 SU slots	101,340	587
CP-30FJA-LA	Multi-User Data Base Management Package; as described under SR-30FJA-LA, but software license is for MUMPS-11; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots and 3 quad slots	37,020	250
CP-30JJA-LA	Multi-User Data Base Management Package; as described under SR-30FJA-LA, but RK05J is substituted for RK05F and software license is for MUMPS-11	37,020	235
CP-30KKA-LA	Multi-User Data Base Management Package; as described under SR-30KKA-LA but software license is for MUMPS-11 and 10.5-inch BA11-K Expander Box is added; SU 1 & 2 provide 4 hex slots and 1 quad slot; SU 3 to 5, 2 hex slots, 3 quad slots, and 1 SU; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 5, 3 SU slots	49,740	317
CP-30AVA-LA	Multi-User Data Base Management Package; as described under SE-30AVA-LA but memory is 64K bytes and software license is for MUMPS-11; SU 1 & 2 provide 4 hex slots, 1 quad slot; SU 3 to 5, 2 hex slots, 3 quad slots, and 1 SU; BA11-K SU 3 to 5, 1 SU slot	84,250	471
PDP-11/55 PACKAGED SYSTEMS			
PDP-11/55 packaged systems include a processor with hardware memory management, serial line interface, floating-point processor, real-time clock, LA36 DECwriter II Console Terminal, bootstrap loader, two H960 Equipment Cabinets, and software license for RSX-11M.			
CM-50JJA-LA	Real-Time Package; includes 32K bytes each of parity bipolar memory and parity core memory, RK11J Disk Subsystem with two 2.5-megabyte RK05J Cartridge Disk Drives and 10.5-inch BA11-K Expander Box; 2 quad slots and 1 SU slot; BA11-K SU 1 & 2 provides 1 SU slot; SU 3 to 5, 3 SU slots	66,170	462
CM-50FJA-LA	Real-Time Package; same as CM-50JJA-LA but RK05F replaces one of the RK05J drives as a systems device	70,405	477
SM-50JJA-LA	Real-Time Package; includes 64K bytes of bipolar memory and RK11J Disk Subsystem with two 2.5-megabyte RK05J Cartridge Disk Drives; 2 quad slots and 2 SU slots	75,850	504
SM-50FJA-LA	Real-Time Package; same as SM-50JJA-LA but RK05F replaces one of the RK05J drives as a systems device	74,960	519
11T55-BA	PDP-11/55 Package; as described under SM-50JJA-LA but without software license, and parity core memory is employed; 2 SPC slots and 2 SU slots	73,100	504
11T55-BC	PDP-11/55 Package; as described under CM-50JJA-LA but without expander box and software license; 2 SPC slots	61,000	446
11T55-B4	PDP-11/55 Package	65,235	461

DEC PDP-11 Family

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
PDP-11/60 PACKAGED SYSTEMS			
PDP-11/60 packaged systems include a processor with hardware memory management, integral cache memory, error-correcting MOS memory, integral floating point, EIS, serial line interface, real-time clock, multi-device bootstrap loader, programmer's console, LA36 DECwriter Console Terminal, and dual-width high-boy cabinet.			
SR-60FJB-LA	Real-Time Package; as described under SR-30FJA-LA; but SU 1 to 3 provide 1 hex slot and 1 quad slot; SU 4 to 6, memory space	40,000	328
SR-60KKA-LA	Real-Time Package; same as SR-30KKA-LA but memory is increased to 128K bytes and BA11-P Expander Box added; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU slot and memory space; BA11-P SU 1 & 2, 2 hex slots; SU 3 to 6, 4 SU slots	57,630	409
SR-60LLA-LA	Real-Time Package; includes 64K bytes of memory, RT-11 software license, RL11-AK Cartridge Disk Subsystem with two 5-megabyte disk drives and a BA11-P Expansion Box; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 hex and 2 quad slots; BA11-P, 6 SU's	39,500	316
SM-60FJB-LA	Real-Time Package; as described under SR-30FJA-LA, but software license is for RSX-11M; SU 1 to 3 provide 1 hex slot and 1 quad slot; SU 4 to 6, memory space	41,400	328
SM-60HHA-LA	Real-Time Package; as described under SM-30HHA-LA but expansion box is BA11-P; SU 1 to 3 and 4 to 6 both provide 1 hex slot, 1 quad slot, and 1 SU; BA11-P SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 6, 4 SU's	60,900	483
SM-60HHB-LA	With one double-width low-boy cabinet	60,900	483
SM-60KKA-LA	Real-time package; includes 128K bytes of memory, RSX-11M software license, RK611 Disk Subsystem with two 14-megabyte RK06 cartridge Disk Drives and BA11-P Expansion Box; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU, and memory space; BA11-P SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 6, 4 SU slots	59,000	409
SM-60LLA-J A	Real-Time Package; as described under SR-60LLA-LA but software license is for RSX-11M and memory is increased to 128K bytes	42,900	331
SM-60CVB-LA	Real-Time Package; includes 128K bytes of memory, RSX-11M software license, RJP06 Disk Subsystem with 176-megabyte single-access disk drive as the systems device, one-drive TJE16 Magnetic Tape Subsystem as the primary backup and load device, and BA11-P Expansion Box; SU 1 to 3 provide 1 hex and 1 quad slot, SU 4 to 6, 1 SU and memory space; BA11-P SU 5 & 6, 2 SU slots	101,400	563
SM-60UVA-LA	Real-Time Package; as described under SM-30UVA-LA but expansion box is BA11-P; SU 1 to 3 provide 1 hex and 1 quad slot; BA11-P SU 5 & 6, 2 SU's	78,900	513
SE-60FJB-LA	Timesharing Package; includes 128K bytes of memory, RSTS/E software license, 2.5-megabyte RK11J Cartridge Disk Subsystem for backup and loading, and 5-megabyte RK05F Cartridge Disk Drive for the systems device; SU 1 to 3 provide 1 hex slot and 1 quad slot; SU 4 to 6, memory space	49,700	343
SE-60HHA-LA	Timesharing Package; as described under SE-30HHA-LA but expansion box is BA11-P; SU 1 & 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU; BA11-P SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 6, 4 SU's	67,900	498
SE-60KKA-LA	Timesharing Package; as described under SM-60KKA-LA but software license is for RSTS/E	62,300	409
SE-60CVB-LA	Timesharing Package; as described under SM-60CVB-LA but software license is for RSTS/E	104,700	563
SE-60UVA-LA	Timesharing Package; as described under SE-30UVA-LA; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU, BA11-K, SU 5 & 6, 2 SU's	85,900	528
SP-60FJB-LA	Multi-User Data Base Management Package; as described under SE-60FJB-LA but software license is for MUMPS-11	51,900	343
SP-60HTA-LA	Multi-User Data Base Management Package; as described under SP-30HTA-LA; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU; BA11-K SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 6, 3 SU's	77,900	558
SP-60KKA-LA	Multi-User Data Base Management Package; as described under SM-60KKA-LA but software license is for MUMPS-11	64,500	409
SP-60CVB-LA	Multi-User Data Base Management Package; as described under SM-60CVB-LA but software license is for MUMPS-11	106,900	563
SP-60UVA-LA	Multi-User Data Base Management Package; as described under SP-30UVA-LA but expansion box is BA11-P; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 SU; BA11-P, 2 SU's	86,900	513
SA-60KKA-LA	Interactive Application System Package; includes 192K bytes of memory, IAS software license, EK611 Disk Subsystem with two 14-megabyte RK06 Cartridge Disk Drives, BA11-P Expander Box, and VT52 Alphanumeric Display Terminal; SU 1 to 3 provide 1 hex slot and 1 SU; SU 4 to 6, memory space; BA11-P SU 1 & 2, 2 hex slots and 1 quad slot; SU 3 to 6, 4 SU slots	72,500	449
SA-60CVB-LA	Interactive Application System Package; includes 192K bytes of memory, IAS software license, RJP06 Disk Subsystem with 176-megabyte single-access disk drive as the system device, one-drive TJE16 Magnetic Tape Subsystem as the primary backup and load device, BA11-D Expander Box, and VT52 Alphanumeric Display Terminal; SU 1 to 3 provide 1 hex slot and 1 SU slot; SU 4 to 6, memory space; BA11-P SU 5 & 6, 2 SU slots	114,900	603
SA-60UVA-LA	Interactive Application System Package; includes 192K bytes of memory, IAS software license, 67-megabyte RJM02 Removable Disk Pack Drive Subsystem for the system device, one-drive TJE16 Magnetic Tape Subsystem, and BA11-P Expansion Box; SU 1 to 3 provide 1 hex and 1 quad slot; SU 4 to 6, 1 hex slot and 2 quad slots; BA11-P, 2 SU's	92,900	573
11X60-BA	PDP-11/60 Package; includes 64K bytes of parity core memory; without LA36 DECwriter Console, Serial Line Interface and H961 Cabinet; 7 SU slots and 2 quad SPC slots	31,700	184
11X60-CA	PDP-11/60 Package; as described under 11X60-BA but MOS parity memory; 1 SU slot and 2 quad SPC slots	25,700	174
11T60-BA	PDP-11/60 Package; includes 64K bytes of parity core memory LA36 DECwriter II Console Terminal, DL11-WA Serial Line Interface/Line Frequency Clock, 2.5-megabyte RK11J Cartridge Disk Subsystem for backup and loading, 5-megabyte RK05F Cartridge Disk Drive for the systems device, and H961 Cabinet; 2 quad SPC slots and 6 SU slots	NA	NA
11T60-CA	PDP-11/60 Package; as described under 11T60-BA but MOS parity memory; 2 quad SPC slots	NA	NA
11S60-BA	PDP-11/60 Package; includes 128K bytes of parity core memory, LA36 DECwriter II Console Terminal, DL11-W Serial Line Interface, KW11-L Line Frequency Clock, RK611 Disk Subsystem with two 14-megabyte RK06 Cartridge Disk Drives, and H961 Cabinet; 5 SU slots and 2 SPC slots	67,300	419
11S60-CA	PDP-11/60 Package; as described under 11S60-BA but MOS parity memory	62,700	409

PDP-11/70 PACKAGED SYSTEMS

PDP-11/70 packaged systems include a processor with 256K bytes of interleaved parity memory, bootstrap/diagnostic loader, serial line interface, real-time clock, battery backup (MOS only), two H960 Equipment Cabinets and dedicated mass storage cabinets; MK11-BA frame (MOS) or two MJ11-BA frames (core).

DEC PDP-11 Family

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
PDP-11/70 PACKAGED SYSTEMS (Continued)			
Error-Correcting MOS:			
SM-70CVA-LA	Real-Time Package; includes RSX-11M software license, RWPO6 Disk Subsystem with 176-megabyte single-access disk drive as the system device, and one-drive TWE16 Magnetic Tape Subsystem as the primary backup and load device; 3 hex slots and 1 quad slot	130,000	611
SM-70TVA-LA	Real-Time Package; includes RSX-11M software license, RWM03 Disk Subsystem with 67-megabyte single-access disk drive as the systems device and one-drive TWE16 Magnetic Tape Subsystem as the primary backup and load device; 3 hex slots and 1 quad slot	100,000	561
SM-70CWA-LA	Real-Time Package; as described under SM-70CVA-LA, but TWE16 is replaced by TWU45	130,000	611
SE-70CVA-LA	Timesharing Package; as described under SM-70CVA-LA but software license is for RSTS/E	133,300	611
SE-70CVA-LA	Timesharing Package; as described under SM-70TVA-LA but software license is for RSTS/E	103,300	561
SE-70CWA-LA	Timesharing Package; as described under SM-70CVA-LA but software license is for RSTS/E and TWE16 is replaced by TWU45	139,210	671
SP-70CVA-LA	Multi-User Data Base Management Package; as described under SM-70CVA-LA but software license is for MUMPS-11	135,500	611
SP-70TVA-LA	Multi-User Data Base Management Package; as described under SM-70TVA-LA but software license is for MUMPS-11	105,500	561
SP-70CWA-LA	Multi-User Data Base Management Package; as described under SM-70CVA-LA but software license is for MUMPS-11 and TWE16 is replaced by TWU45	141,410	671
SA-70CVA-LA	Interactive Application System Package; as described under SM-70CVA-LA but software license is for IAS and VT52 Alphanumeric CRT Terminal is added; 3 hex slots	138,500	636
SA-70TVA-LA	Interactive Application System Package; as described under SM-70TVA-LA but software license is for IAS and VT52 Alphanumeric CRT Terminal is added; 3 hex slots	108,500	586
SA-70CWA-LA	Interactive Application System Package; includes IAS software license, RWPO6 Disk Subsystem with 176-megabyte single-access disk drive as the system device, one-drive TWU45 Magnetic Tape Subsystem as the primary backup and load device, and VT52 Alphanumeric CRT Terminal; 3 hex slots	144,410	696
Core Memory:			
CM-70CVA-LA	Real-Time Package; as described under SM-70CVA-LA	130,000	651
CM-70TVA-LA	Real-Time Package; as described under SM-70TVA-LA	100,000	601
CM-70CWA-LA	Real-Time Package; as described under SM-70CVA-LA but TWE16 is replaced by TWU45	135,900	711
CE-70CVA-LA	Timesharing Package; as described under SM-70CVA-LA but software license is for RSTS/E	133,300	651
CE-70TVA-LA	Timesharing Package; as described under SM-70TVA-LA but software license is for RSTS/E	103,300	601
CE-70CWA-LA	Timesharing Package; as described under SM-70CVA-LA but software license is for RSTS/E and TWE16 is replaced by TWU45	139,210	711
CP-70CVA-LA	Multi-User Data Base Management Package; as described under SM-70CVA-LA but software license is for MUMPS-11	135,500	651
CP-70TVA-LA	Multi-User Data Base Management Package; as described under SM-70TVA-LA but software license is for MUMPS-11	105,500	601
CP-70CWA-LA	Multi-User Data Base Management Package; as described under SM-70DVA-LA but software license is for MUMPS-11 and TWE16 is replaced by TWU45	144,410	696
CA-70CVA-LA	Interactive Application System Package; as described under SM-70CVA-LA but software license is for IAS and VT52 Alphanumeric CRT Terminal is added; 3 hex slots	138,500	676
CA-70TVA-LA	Interactive Application System Package; as described under SM-70TVA-LA but software license is for IAS and VT52 Alphanumeric CRT Terminal is added; 3 hex slots	108,500	626
CA-70CWA-LA	Interactive Application System Package; as described under SA-70CWA-LA	144,410	736
TRAX PACKAGED SYSTEMS (see notes)			
—	VT62 Terminal; 1920 characters, 24 lines x 80 characters, typewriter-like keyboard	3,150	NA
—	PDP-11/34-based TRAX system with RK07 disk drives	114,990	NA
—	PDP-11/34-based TRAX system with RMO2 disk drives	114,990	NA
—	PDP-11/60-based TRAX system with RK07 disk drives	123,860	NA
—	PDP-11/60-based TRAX system with RMO2 disk drives	123,860	NA
—	PDP-11/70-based TRAX system with RMO3 disk drives	141,620	NA
—	PDP-11/70-based TRAX system with RPO6 disk drives	199,570	NA
Note 1:	The price given for the VT62 Terminal is quantity one. In quantities of 3 to 9 the price is \$3,000 each; in quantities of 10 or more the price is \$2,500.		
Note 2:	The system prices provided include license, 90-day warranty, distribution, and training. Multiple system purchases require that only one system be purchased at this price. All additional systems are purchase priced at \$18,710 less.		
PROCESSOR OPTIONS			
KEV11	Extended Arithmetic Option; includes extended and floating-point instruction sets (EIS/FIS) for the 11/03	190	—
KE11-B	Extended Arithmetic Element for the 11/04; provides extended manipulation of signed integer multiply and divide, multiple shifts, and normalization	1,820	18
KE11-E	For the 11/35	1,760	11
KE11-F	Floating-Point Instruction Set for 11/35; includes add, subtract, multiply, and divide	1,760	11
FP11-A	Floating-Point Processor for the 11/34; offers single and double precision operands	2,900	21
FP11-C	Floating-Point Processor for the 11/45, 11/55, and 11/70; offers single and double precision operands and integer to floating-point conversions	5,600	30
FP11-EA	High-Speed Floating-Point Processor for the 11/60; offers single and double precision operands and 17 digits of accuracy	5,600	42
KW11-L	Line Frequency Real-Time Clock for the 11/35, 11/45, 11/55, and 11/70; divides time into intervals of 16.67 milliseconds at 60 Hertz	NA	NA
KW11-K	Dual Programmable Real-Time Clock for any RT-11 or RSX-11M system	990	16
KW11-P	Programmable Real-Time Clock; program-selectable interrupts of 100K Hertz, 10K Hertz, line frequency, or external signal	NA	NA
KWW11-A	Programmable Real-Time Clock for 11/03 under RT-11; 16-bit, one of four programmable modes, user selectable; one of five crystal-controlled frequencies, 100 Hz to 1 MHz plus 60 Hz and external input	600	5

DEC PDP-11 Family

EQUIPMENT PRICES

PROCESSOR OPTIONS (Continued)		Purchase Price	Monthly Maint.
KU116-AB	Extended Control Store for 11/60; includes control circuitry and sockets for up to 1.5K x 48 bits for PROM or ROM	1,200	—
KU116-AE	User Control Store for 11/60; includes 1K x 48 bits plus parity of RAM; microassembler, microloader, manual, and microdebugger for use with RSX-11M on RK05 media	5,000	—
KU116-AT	On RK06 media	5,000	—
KU116-BB	Diagnostic Control Store Fault Isolator	3,800	—
KU11-UH	WCS Field Upgrade Kit; includes WCS module cable and KD11-HA at the required revisions level to support the WCS	2,195	NA
MRV11-AA	PROM/ROM Memory Unit; 32 1C sockets, accepts 256 x 4 or 512 x 4 fusible link memory devices and mask ROM devices up to 4K x 16	175	—
MRV11-AC	Unprogrammed Fusible Link, PROM chip (512 x 4 array size)	40	—
MRV11-BA	UV PROM/RAM Memory Unit; up to 4K x 16-bit PROM memory in 1K increments with 512 bytes of RAM	325	NA
MRV11-BC	UV PROM Chip; 1K x 8 bit storage	100	NA
M7850	Parity Control for memory on the 11/04 and 11/34A; one per DD11 required	880	—
M9301-YA	ROM Bootstrap Loader; includes loaders for paper tape, disk, floppy disk, cassette tape, DECtape, and standard magnetic tapd and go/ no go diagnostics	880	3
M9301-YB	ROOM Bootstrap Loader; same as M9301-YA but adds capability for larger disks	880	3
M9301-YC	ROM Bootstrap Loader for 11/70; includes loaders for magnetic tape, DECtape, and disk and go/no go diagnostics	NA	NA
M9301-YE	ROM Bootstrap Loader; includes loaders for disk, DECnet, DU, DUP and DL interfacing options	NA	NA
M9301-YF	ROM Bootstrap Loader; includes loaders for disk, magnetic tape, and paper tape and go/no go diagnostics	880	3
REV11-A	Refresh/Bootstrap/Diagnostic/Terminator option; external refresh module which is used when the dynamic RAM memory refresh implemented in the LSI-11 or PDP-11/03 CPU microcode is disabled; reduces the interrupt latency which exists when operating with the CPU microcode refresh functions; includes bootstraps for the RXV11 floppy disk, resident paper tape absolute loader, CPU and memory diagnostics, and 120-ohm bus termination	320	NA
BDV11-AA	Bootstrap/Diagnostics/PROM Option Module; includes a bootstrap for the RXV11, RKV11, and DECNET; diagnostics for the CPU memory, console device, bus hardware, RXF11, DECNET load device; sockets for 16K x 16 ROM chips and 2K x 16 EPROM chips (2708-type chips)	750	NA
CORE MEMORY			
MMV11-A	8K-byte Module; for the 11/03	990	13
MM11-CP	16K-byte Module; with parity and control; for the 11/04	2,280	22
MM11-DP	32K-byte Module; with parity and control; for the 11/04 and 11/34A	3,200	25
MM11-DR	64K-byte Module; with parity and control; for the 11/34A	6,000	50
MM11-DS	128K-byte Module; with parity and control; for the 11/04 and 11/34A	10,400	100
MM11-YP	64K-byte Module; with parity and control; for the 11/04 and 11/34	5,500	42
MM11-YR	128K-byte Module; with parity and control; for the 11/04 and 11/34A	9,400	84
MF11-UP	32K-byte Module; with parity and control for up to 64K bytes; for the 11/35, 11/45, and 11/55	3,000	27
MM11-UP	32K-byte Module with parity; mounts in MF11-UP	2,200	27
MF11-UR	64K-byte Module with parity and control; for the 11/35, 11/45, and 11/55	5,200	54
MF11-US	128K-byte Module Package with parity and control; for the 11/35, 11/45 and 11/55	10,400	108
MF11-WP	128K-byte Memory Expansion System with parity, chassis, 64K byte module, and control for up to 128K bytes; for the 11/55 and 11/60	6,650	30
MF11-WS	128K-byte Module with MF11-WP and MM11-WP	10,000	60
MF11-WT	256K-byte Memory Expansion System; with parity, chassis, 192K bytes of memory, and control for up to 256K bytes	13,000	90
MM11-WP	64K-byte Module; with parity and control; mounts in MF11-WP	5,500	30
MJ11-BA	128K-byte Module; with parity, control, frame and power supplies for up to 512K bytes; for the 11/70	18,590	70
MJ11-BE	128K-byte Module; with parity; mounts in MJ11-BA	11,550	60
MJ11-BC	512K-byte Memory Expansion System; with 512K-byte module, parity, control, power supplies and cabinet	55,500	250
MJ11-BG	512K-byte Memory Expansion Unit; with power supplies, control, and frame; mounts in MJ11-BC	53,240	250
SEMICONDUCTOR MEMORY			
MOS:			
MSV11-B	8K-byte Module; for the 11/03	625	13
MSV11-CD	32K-byte Module; for the 11/03	1,375	19
MSV11-DB	16K-byte Module; includes on-board refresh	850	NA
MSV11-DC	32K-byte Module; includes on-board refresh	1,375	NA
MSV11-DD	64K-byte Module; includes on-board refresh	2,400	NA
MSV11-EB	16K-byte Module; includes byte parity and on-board refresh	925	NA
MSV11-EC	32K-byte Module; includes byte parity and on-board refresh	1,475	NA
MSV11-ED	64K-byte Module; includes byte parity and on-board refresh	2,525	NA
MS11-FP	16K-byte Module; with parity and control; for the 11/04	1,700	22
MS11-JP	32K-byte Module; with parity and control; for the 11/04 and 11/34A	2,200	25
MS11-JR	64K-byte Module; with parity and control; for the 11/04 and 11/34A	4,000	50
MS11-JS	128K-byte Module; with parity and control; for 11/04 and 11/34A	6,400	100
MS11-KE	64K-byte Module; with error checking and correction (ECC); for the 11/60	4,500	15
MS11-KF	128K-byte Module; with error checking and correction (ECC); for 11/60	7,400	30
MS11-KG	192K-byte Module; with error checking and correction (ECC); for 11/60	10,000	45
MK11-BA	1024K-byte Memory Expansion System; includes frame, power supplies, control, battery backup and 128K-byte module	22,500	70

DEC PDP-11 Family

EQUIPMENT PRICES

SEMICONDUCTOR MEMORY (Continued)		Purchase Price	Monthly Maint.
MK11-BE	128K-byte Module; mounts in MK11-BA	10,800	30
MK11-BF	512K-byte Memory Unit; mounts in MK11-BA	40,000	120
MK11-BG	1024K-byte Memory Unit; includes memory, frame, power supply, and control	93,000	280
Bipolar:			
MS11-AP	8K-byte Module; with parity; for the 11/45 and 11/55	4,620	25
MS11-CC	Bipolar Memory Control; capabilities up to 32K bytes	2,310	13
KK11-A	2K-byte RAM Cache Memory; for the 11/34A	3,900	—
H775-CA	Battery Backup for the MS11-JP Memory Module	1,000	7
DWR70	High-Speed User Interface to 11/70 Main Memory; includes MASSBUS controller for up to eight interface units	13,200	55
DR70	High-Speed User Interface to 11/70 Main Memory; plug-compatible with DR11-B	5,760	25
MASS STORAGE			
All DEC drives include one cartridge or pack.			
TA11-AA	Dual DEctape transport plus controller; 90K characters per reel	4,200	38
TC11-GA	Dual DEctape transport plus controller; expandable to 4 dual transports, 288K characters per reel; includes cabinet	14,490	48
TU56	Dual DEctape transport for TA11-AA and TC11-GA	7,590	40
RX11-AA	Floppy Disk Subsystem; includes 256K-byte drive and control	3,350	25
RXV11-AA	For 11/03 only	3,350	25
RX11-BA	Floppy Disk Subsystem; includes two 256K-byte drives and control; not for MUMPS-11 systems	4,300	33
RXV11-BA	For 11/03 only		
RX01K-5	Package of five diskettes	40	—
RX01K-IU	Package of ten diskettes	75	—
RK11J-AA	Cabinet-Mountable Cartridge Disk Subsystem; includes 2.5-megabyte RK05J Removable Cartridge Disk Drive and controller for up to 8 RK05J/RK05F Disk Drives; not for 11/03	9,900	81
RKV11-AA	For 11/03 only	9,900	75
RK11J-DE	With H960 Equipment Cabinet and power control; not for 11/03	11,050	81
RKV11-DE	For 11/03 only; with H960 Equipment Cabinet and power control	11,050	75
RK05J-AA	Cabinet-Mountable Add-on 2.4-megabyte Removable Cartridge Disk Drive	5,100	54
RK05F-FA	Cabinet-Mountable Add-on 5-megabyte Nonremovable Cartridge Disk Drive	5,100	54
RK05K-11	2.4-megabyte Disk Cartridge for RK05J drives	99	—
RL11-AK	Cabinet-Mountable Cartridge Disk Subsystem; includes 5.0-megabyte RL01 Removable Cartridge Disk Drive and controller for up to four RL01 Disk Drives; not for 11/03	5,100	58
RLV11-AK	For 11/03	5,100	58
RL01-AK	Cabinet-Mountable Add-on 5.0-megabyte Removable Cartridge Disk Drive	3,800	50
RL01K-DC	5.0-megabyte Disk Cartridge for RL01 drives	149	—
RK611-EA	Free-Standing, Single-Access Cartridge Disk Subsystem; includes 14-megabyte RK06 Removable Cartridge Disk Drive and controller for up to eight RK06 drives; not for 11/03	11,500	108
RK611-FA	Dual-Access Version with two controllers	19,000	148
RK611-C	Dual Access Kit; contains drive logic and a controller to convert RK611-EA to RK611-FA	10,450	40
RK06-EA	Free-Standing, Add-on, Single-Access, 14-Megabyte Cartridge Disk Drive; not for 11/03	7,500	78
RK06-FA	Dual-Access Version	11,000	88
RK06-C	Dual-Access Kit; contains drive logic to convert RK06-EA to RK06-FA	3,850	10
RK06K-DC	14-megabyte Disk Cartridge for RK06 drives	249	—
RK06K-AC	14-megabyte Alignment Disk Cartridge for RK06	995	—
RK711-EA	Free-Standing, Single-Access Cartridge Disk Subsystem; includes 28-megabyte RK07 Removable Cartridge Disk Drive and controller for up to eight RK07 drives; not for 11/03	14,500	145
RK711-FA	Dual-Access Version with two controllers	22,000	190
RK711-C	Dual-Access Kit; contains drive logic and a controller to convert RK07-E to RK07-F	10,450	45
RK07-EA	Free-Standing, Add-on, Single-Access, 28-megabyte Cartridge Disk Drive; not for 11/03	10,500	115
RK07-FA	Dual-Access Version	14,000	130
RK07-C	Dual Access Kit; contains drive logic to convert RK07-EA to RK07-FA	14,000	130
RK07K-EF	28-megabyte Disk Cartridge for RK07 drives (error free)	425	—
RK07K-AC	28-megabyte Alignment Disk Cartridge for RK07	1,295	—
RK07K-DC	28-megabyte Disk Cartridge for RK07 drives	325	—
RJM02-AA	Free-Standing, Single-Access Disk Pack Subsystem; includes 67-megabyte Disk Pack Drive and controller for up to eight RM02 drives; for PDP-11/34 through PDP-11/60	23,000	170
RJM02-BA	Dual-Access Version	30,000	215
RJM02-C	Dual-Access Kit; contains drive logic and controller to convert RJM02-A to RJM02-B	7,000	45
RM02-AA	Free-Standing, Add-on, Single-Access, 67-megabyte Disk Pack Drive	18,000	140
RM02-BA	Dual-Access Version	20,000	155
RM02-C	Dual-Access Kit; contains drive logic to convert RM02-A to RM02-B	2,000	15
RWM03-AA	Free-Standing, Single-Access Disk Pack Subsystem; includes 67-megabyte Disk Pack Drive and controller for up to eight RM03 drives; for 11/70	25,000	170
RWM03-BA	Dual-Access Version with two controllers	33,000	215
RWM03-C	Dual-Access Kit; contains drive logic and controller to convert RWM03-AA to RWM03-BA	8,000	45
RM03-AA	Free-Standing, Add-on, Single-Access, 67-megabyte Disk Pack Drive	19,000	140
RM03-BA	Dual-Access Version	21,000	155
RM03-C	Dual-Access Kit; contains drive logic to convert RM03-AA to RM03-BA	2,000	15
RM03-P	67-megabyte Disk Pack for RM03 and RM02	595	—
RJP04-AA	Free-Standing, Single-Access Disk Pack Subsystem; includes 88-megabyte Disk Pack Drive and controller for up to eight RP04, RP05, or RP06 drives; not for 11/70	36,750	220
RWP04-AA	Same as RJP04-AA but for the 11/70 only	36,750	220
RJPO4-BA	Dual-Access Version of RJP04-AA with two controllers	49,350	270

DEC PDP-11 Family

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
MASS STORAGE (Continued)			
RWP04-BA	Same as RJP04-BA but for the 11/70 only	49,350	270
RWP04-CA	Same as RJP04-BA but one controller is for 11/70 and the other controller is for a PDP-11 other than the 11/70	49,350	270
RJP04-C	Dual-Access Kit; contains drive logic and controller to convert RJP04-AA to RJP04-BA	14,700	50
RWP04-C	Dual-Access Kit; contains drive logic and controller to convert RWP04-AA to RWP04-BA	14,700	50
RP04-AA	Free-Standing, Add-on, Single-Access, 88-megabyte Disk Pack Drive; for both RWP04 and RJP04 systems	22,000	190
RP04-BA	Dual-Access Version	27,000	210
PR04-C	Dual-Access Kit; contains drive logic to convert RP04-AA to RP04-BA	5,150	20
RP04-P	88-megabyte Disk Pack for RP04 drives	600	—
RJP05-AA	Same as RJP04-AA but field-upgradeable to RP06; not for 11/70	40,950	220
RWP05-AA	Same as RJP04-AA but field-upgradeable to RP06; for 11/70 only	40,950	220
RJP05-C	Dual-Access Kit; contains drive logic and controller to convert RJP05-AA to RJP05-BA	14,700	50
RWP05-C	Dual-Access Kit; contains drive logic and controller to convert RWP05-AA to RWP05-BA	14,700	50
RJP05-BA	Same as RJP04-BA but field-upgradeable to RP06 dual-access version	53,550	270
RWP05-BA	Same as RJP04-BA but field-upgradeable to RP06 dual-access version; 11/70 only	53,550	270
RWP05-CA	Same as RJP04-BA but field-upgradeable to RP06 dual-access version with one controller for 11/70 and the other controller for a PDP-11 other than the 11/70	53,550	270
RP05-AA	Same as RP04-AA but field-upgradeable to RP06	31,400	190
RP05-BA	Same as RP04-BA but field-upgradeable to RP06	36,540	210
RP05-C	Dual-Access Kit; contains drive logic to convert RP05-AA to RP05-BA	5,150	20
RJP06-AA	Free-Standing Single-Access Disk Drive Subsystem; includes 176-megabyte Disk Pack Drive and controller for up to eight RP04, RP05, or RP06 drives; not for 11/70	44,000	220
RWP06-AA	Same as RJP06-AA but for 11/70 only	44,000	220
RJP06-BA	Dual-Access Version of RJP06-AA with two controllers	56,600	270
RJP06-C	Dual-Access Kit; contains drive logic and controller to convert RJP06-AA to RJP06-BA	14,700	50
RWP06-BA	Same as RJP06-BA but for 11/70 only	56,600	270
RWP06-CA	Same as RJP06-BA but one controller is for the 11/70 and the other controller is for a PDP-11 other than the 11/70	56,600	270
RP06-AA	Free-Standing, Add-on, Single-Access, 176-megabyte Disk Pack Drive	34,000	190
RP06-BA	Dual-Access Version	39,140	210
RP06-C	Dual-Access Kit; contains drive logic to convert RP06-AA to RP06-BA	5,150	20
RP06-U	RP05 to RP06 Field Upgrade Kit; includes drive upgrade parts and RP06-P disk pack	10,500	—
PR06-P	176-megabyte Disk Pack for RP06 drives	850	—
RJS03-BA	Cabinet-Mounted Fixed-Head Disk Drive Subsystem; includes 512K-byte RS03 Fixed-Head Disk Drive and controller for up to eight RS03 or RS04 drives; not for 11/70	16,900	75
RWS03-BA	Same as RJS03-BA but for 11/70 only	16,900	75
RJS04-BA	Cabinet-Mounted Fixed-Head Disk Drive Subsystem; includes 1024K byte RS04 Fixed-Head Disk Drive and controller for up to eight RS03 or RS04 drives; not for 11/70	21,120	85
RWS04-BA	Same as RJS04-BA but for 11/70 only	23,320	85
RS03-AA	Cabinet-Mountable, Add-on, 512K-byte Fixed-Head Disk Drive	10,450	45
RS04-AA	Cabinet-Mountable, Add-on, 1024K-byte Fixed-Head Disk Drive	15,200	55
MAGNETIC TAPE EQUIPMENT			
TA11-AA	Cabinet-Mountable Dual DEC Cassette Subsystem; includes two 90K-character tape cassette drives and control	4,200	38
TME11-AA	Magnetic Tape Subsystem; includes a TE10W-AE drive in a dedicated cabinet and control; for the 11/60	14,230	101
TME11-BA	Magnetic Tape Subsystem; includes a TE10W-BE drive in a dedicated cabinet and control; for the 11/50	16,225	101
TME11-EA	Magnetic Tape Subsystem; includes a TW10W-EE drive in a dedicated cabinet and control for up to eight drives; not for 11/60	13,280	101
TME11-FA	Magnetic Tape Subsystem; includes a TE10W-BE drive in a dedicated cabinet and control for up to eight drives; not for 11/60	NA	NA
TE10W-AE	Magnetic Tape Transport; 9-track, 800 bpi, 45 ips, cabinet-mounted; for 11/60	11,555	74
TE10W-BE	Magnetic Tape Transport; 7-track, 200/556/800 bpi, 45 ips cabinet-mounted; for 11/60	12,180	74
TE10W-EE	Magnetic Tape Transport; 9-track, 800 bpi, 45 ips, cabinet-mounted; not for 11/60	10,300	74
TME11-MA	Magnetic Tape Subsystem; includes a TS03-SA drive in a dedicated cabinet and control for up to two drives	NA	NA
TS03-SA	Magnetic Tape Transport; 9-track, 800 bpi, 12.5 ips, cabinet-mounted	3,850	50
TJE16-AA	Magnetic Tape Subsystem; includes a TE16-AE drive in a dedicated cabinet and control for up to eight drives; for the 11/60	18,850	120
TJE16-EA	Same as TJE16-AA but employs TE16-EE drive; not for 11/60	17,090	120
TWE16-EA	Same as TJE16-AA but employs TE16-EE drive; for 11/70 only	17,000	120
TJE16-EK	Same as TJE16-AA but 800 bpi only; not for 11/70	15,930	110
TWE16-EK	Same as TJE16-AA but 800 bpi only; for 11/70	15,930	110
TE16-AE	Magnetic Tape transport; 9-track, 800/1600 bpi, 45 ips cabinet-mounted	11,290	60
TE16-EE	Magnetic Tape Transport; 9-track, 800/1600 bpi, 45 ips, cabinet-mounted; not for 11/60	10,300	60
TJU45-EA	Magnetic Tape Subsystem; includes TU45-EE drive in a dedicated cabinet and control for up to eight drives; not for 11/70	23,000	180
TWU45-EA	Same as TJU45-EA but for the 11/70	23,000	180
TU45-EE	Magnetic Tape Transport; 9-track, 800/1600 bpi, 75 ips, cabinet-mounted	14,000	120
PRINTERS			
All printers except LV11-BA are free-standing.			
LA11-PA	Serial Printer Subsystem; includes 132-position, 128-character set, 180-cps dot matrix printer and control unit	3,770	55
LPV11-PA	With parallel line interface for LSI-11 and LSI-11/2	3,770	NA

DEC PDP-11 Family

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
PRINTERS (Continued)			
LP11-CA	Line Printer Subsystem; includes 132-position, 64-character set, 900-lpm printer and control unit	24,000	185
LP11-DA	Line Printer Subsystem; includes 132-position, 96-character set, 660-lpm printer and control unit	25,700	185
LP11-FA	Line Printer Subsystem; includes 80-position, 64-character set, 356-lpm printer and control unit	NA	NA
LP11-JA	Line Printer Subsystem; includes 132-position, 64-character set, 245-lpm printer and control unit	NA	NA
LP11-KA	Line Printer Subsystem; includes 132-position, 96-character set, 173-lpm printer and control unit	NA	NA
LP11-RA	Line Printer Subsystem; includes 132-position, 64-character set, 1250-lpm printer and control unit	38,470	185
LP11-SA	Line Printer Subsystem; includes 132-position, 96-character set, 925-lpm printer and control unit	42,900	185
LP11-VA	Line Printer Subsystem; includes 132-position, 64-character set, 300-lpm printer and control unit	11,800	95
LP11-WA	Line Printer Subsystem; includes 132-position, 96-character set, 230-lpm printer and control unit	14,050	95
LP11-YA	Line Printer Subsystem; includes 132-position, 64-character set, 600-lpm printer and control unit	22,000	108
LP11-ZA	Line Printer Subsystem; includes 132-position, 96-character set, 436-lpm printer and control unit	23,500	108
LV11-BA	Electrostatic Printer/Plotter Subsystem; includes 132-position, 96-character set, 500-lpm printer/plotter and control unit	NA	NA
LXY11	Printer/Plotter Subsystem; includes 96-character set, 300-lpm (print)/170-lpm (plot) printer and control unit	NA	NA
LP05K-LL	Long Line Interface for up to 2,000 feet; applies to LP11-VA, LP11-WA, LP17-YA, and LP11-ZA	1,540	12
PUNCHED CARD EQUIPMENT			
CD11-A	Reader Subsystem; includes 80-column, 100-cpm card reader and control unit; table-top mounted	13,920	74
CD11-EA	Reader Subsystem; includes 80-column, 1200-cpm card reader and control unit; table-top mounted	19,250	95
CM11-FA	Reader Subsystem; includes 80-column, 285-cpm optical mark or punched card reader and control unit	6,900	53
CR11	Reader Subsystem; includes 80-column, 285-cpm card reader and control unit; table-top mounted	6,170	53
PAPER TAPE EQUIPMENT			
PC11	Paper Tape Subsystem; includes cabinet-mounted 300-cps (read)/50-cps (punch) tape drive and control unit	5,060	41
H722	Transformer; required for 230 VAC, 50 Hz operation; mounts on rear door of cabinet	110	—
PRS01-AA	Portable Reader; 2400 bps (120 cps); requires DLV11 interface; for LSI-11 and LSI-11/2	750	NA
PRS01-BA	Same as PRS01-AA but 300 bps (22 cps)	750	NA
TERMINALS			
LA37-CE	DECwriter II Hardcopy Terminal; includes APL-11 character set and 20-ma interface	2,950	22
LA37-PE	With EIA interface	3,050	22
LA36-CE	DECwriter II Hardcopy Terminal with 20-ma interface	2,100	19
LA36-HE	With EIA interface	2,200	19
LA35-CE	DECwriter II Hardcopy Terminal; without keyboard; includes 20-ma interface	1,900	19
LA35-HE	With EIA interface	NA	NA
LAXX-KG	EIA/CCITT Adapter for the DECwriter II	65	—
LA180-CA	DECwriter III Hardcopy Terminal; without keyboard; includes 20-ma interface	3,770	55
LA180-EA	With EIA interface	3,770	55
LS120-HE	With EIA interface for 1200 bps communications; for LSI-11 and LSI-11/2	3,990	NA
VT50-AA	DECscope CRT; 12 lines by 80 characters, 64-character keyboard, numeric pad, switch selectable parity; 20-ma interface, 75 to 9600 bps	1,450	22
BN50A-7F	EIA/CCITT Adapter for the VT50-AA	72	—
VT52-AA	DECscope CRT; 24 lines by 80 characters, cursor control, 96-character keyboard, numeric pad, switch-selectable parity, 20-ma interface, 75 to 9600 bps	1,900	20
VT52-AE	With EIA/CCITT interface	1,900	20
VT52F-AA	Package for four VT52-AA DECscope CRT's	6,000	80
VT52F-AE	Package of four VT52-AE DECscope CRT's	6,000	80
VT55-EA	Graphic Display CRT; provides both graphics and alphanumeric capability; 20-ma current loop	2,750	25
VT55-EE	With EIA interface	2,750	25
VT55-FA	Same as VT55-EA but with hard-copy device	3,995	60
VT55-FE	Same as VT55-EA but with hard-copy device and EIA interface	3,995	60
VT61-AA	Alphanumeric Display; 24 lines by 80 characters, blinking cursor, 128-character set, LSI-11 controlled, 20-ma interface, 75 to 9600 bps	3,100	33
VT61-AC	With full modem control	3,260	33
VT61-AE	With limited modem control	3,100	33
COMMUNICATIONS EQUIPMENT			
KMC11-A	High-Speed General-Purpose MSI Microprocessor for interface to PDP-11 Unibus	2,200	21
Single-Line Asynchronous Interfaces:			
DL11-A	20-ma Current Loop Serial Line Interface; 8-bit character size	770	6
DL11-B	EIA/CCITT Serial Line Interface; 8-bit character size	770	6
DL11-C	20ma Current Loop Serial Line Interface; jumper-selectable character size	770	6
DL11-D	EIA/CCITT Serial Line Interface; jumper-selectable character size	770	6
DL11-E	Modem-Controlling EIA/CCITT Interface; includes 25 feet of cable, customer specifications	770	6
DL11-WA	Serial Line Interface and Real-Time Clock; 20-ma interface	770	5
DL11-WB	Serial Line Interface and Real-Time Clock; EIA/CCITT interface	770	5
DLV11	Serial Interface Unit; optically isolated 20-ma or EIA/CCITT interface levels	250	5
DLV11-E	Modem-Controlling EIA/CCITT Serial Line Unit; with programmable speed, character size, parity, and stop bit	300	NA
DLV11-EB	With BC01-25 25-foot cable	400	NA
DLV11-J	Four independently programmable serial line units; supports RS-422 and RS-423 (compatible with RS-232C); selectable parity data and stop bits; rates from 150 to 38400 bps	465	NA
DLV11-KA	EIA to 20-ma In-Line Converter; support for 110 bps; for use with the DLV11-J	110	NA

DEC PDP-11 Family

EQUIPMENT PRICES

COMMUNICATIONS EQUIPMENT (Continued)		Purchase Price	Monthly Maint.
Asynchronous Multiplexers (Programmed I/O):			
DJ11-AA	EIA/CCITT Asynchronous 16-Line Multiplexer; includes panel	4,360	32
DJ11-AC	20-ma Asynchronous 16-Line Multiplexer; includes panel with 16 terminal strips, customer specifications	4,130	32
DZ11-A	EIA/CCITT Asynchronous 8-Line Multiplexer; speeds and formats are programmable on a per-line basis; expandable to 16 lines	2,310	25
DZ11-B	EIA/CCITT 8-Line Multiplexer Expansion Unit for DZ11-A	1,710	21
DZ11-C	20-ma Asynchronous 8-Line Multiplexer; speeds and formats are programmable on a per-line basis; expandable to 16 lines	2,310	25
DZ11-D	20-ma 8-Line Multiplexer Expansion Unit for DZ11-C	1,710	21
DZ11-E	EIA/CCITT Asynchronous 16-Line Multiplexer; speeds and formats are programmable on a per-line basis	3,740	46
DZ11-F	20-ma Asynchronous 16-Line Multiplexer; speeds and formats are programmable on a per-line basis	3,740	46
DZV11-B	EIA/CCITT Asynchronous 4-Line Multiplexer; speeds and formats are programmable on a per-line basis	850	9
Asynchronous Multiplexers (NPR Output):			
DH11-AA	EIA/CCITT or 20-ma Asynchronous 16-Line Multiplexer and mounting panel; speed to 9600 bps, characteristics established by DM11 interfaces; EIA/CCITT or 20-ma lines may be mixed in 4-line groups	5,170	32
DM11-BB	16-Modem Multiplexer for Bell 103, 202, or equivalent; for DH11-AA	1,650	19
DM11-DA	20-ma 4-Line Adapter for DH11-AA	250	5
DM11-DB	EIA 4-Line Adapter for DH11-AA; includes 4 cables	650	5
DM11-DC	EIA/CCITT 4-Line Adapter with modem controls for DM11-BB	1,120	11
DH11-AD	Programmable Asynchronous 16-Line Multiplexer; EIA/CCITT interface and modem controls; cables not included	6,600	56
DH11-AE	Same as DH11-AD above without modem controls	5,720	46
Single-Line Synchronous Interfaces:			
DU11-DA	Full/Half Duplex Synchronous Interface, programmable characteristics; speed to 9600 bps; interfaces Bell 200 or equivalent modem; data set controls included	1,500	5
DUP11-DA	Synchronous Line Interface; programmable characteristics; speed to 9600 bps; double-buffered	1,380	9
DUV11-DA	Synchronous Line Interface; full-duplex transmission at speeds up to 9600 bps; interfaces to Bell Series 200 modems	750	NA
DFC11-A	Clock option for DU11-DA; used in local PDP-11 to PDP-11 connections without modems	310	4
DMC11-AL	Network Link Microprocessor Module for local applications; data rates to 1 million bps, full- or half-duplex; includes firmware for unattended operation; requires DMC11-MA or DMC11-MD line unit module; requires one hex SPC slot	1,520	13
DMC11-AR	Network Line Microprocessor Module for remote applications; data rates to 19,200 bps, full- or half-duplex; includes full data set controls, and firmware for unattended operation; requires DMC11-AD line unit module; requires one hex SPC slot	1,520	13
DMC11-DA	Network Link Remote Line Unit Module; interfaces to EIA/CCITT	850	6
DMC11-FA	Network Link Remote Line Unit Module; interfaces to CCITT V.35/DDS synchronous modems (Bell 500A L 1/5 or equivalent)	850	6
DMC11-MA	Network Link; local line unit module; 1,000,000 bps	850	6
DMC11-MD	Network Link; local line unit module, 56,000 bps	850	6
DQ11-DA	Full/Half-Duplex Synchronous Interface; programmable characteristics; speed to 10K bps; interfaces Bell 201, 208, 209, or equivalent modems; data set controls included	3,570	24
DQ11-EA	Same as DQ11-DA above except for Bell 303 or equivalent modems; speed to 1M bps	5,450	25
DQ11-KA	Crystal Clock for DQ11-DA or DQ11-EA	250	1
DQ11-AB	CRC or LRC option for DQ11-DA or DQ11-EA	1,580	12
DQ11-BB	Protocol option for DQ11-AB; includes character recognition and sequence control	1,090	12
Multiple-Line Synchronous/Asynchronous Interfaces:			
DV11-AA	EIA/CCITT Synchronous 16-Line Multiplexer with internal CRC hardware; speed to 9600 bps, full duplex; uses DV11-BA adapters	4,840	29
DV11-BA	8-Line Synchronous Adapter for DV11-AA; maximum of 2	3,750	15
DV11-BB	8-Line Asynchronous Adapter for DV11-AA	3,750	15
DV11-BC	8-Line Synchronous/Asynchronous (4 lines each) Adapter for DV11-AA	3,750	15
Telegraph Interfaces:			
DJ11-AB	Asynchronous 16-Line Multiplexer; customer specifications; uses DC08 interfaces	4,020	27
DH11-AB	Asynchronous 16-Line Multiplexer; programmable characteristics; speeds to 9600 bps; uses DC08 interfaces	4,950	29
DC08-CS	Interface Panel for 16 DC08-CM adapters; includes wired cabinet and control modules	2,790	4
DC08-CM	Dual Line Interface for DC08-CS; 2 lines	310	2
DC06-EB	Telegraph Line Current Adjustment Panel; for up to 32 telegraph receive and transmit lines	NA	NA
DC08-D	Distribution Panel; facilitates connection of up to 32 telegraph lines	1,460	2
H316-A	Dual Telegraph Line Interface for two common-carrier or private telegraph circuits	1,320	3
Miscellaneous Communications Equipment:			
DN11-AA	Auto-dial system for 4 data sets; uses DN11-DA interfaces; includes wired cabinet	520	5
DN11-DA	Auto-dial interface for Bell 801 ACU; used with DN11-AA, maximum of 4	640	5
DF11-F	TTL to 20-ma active local Teletype loop adapter	210	5
DF11-G	TTL to Bell 303 adapter	1,710	5
DF11-K	TTL to active or passive 20-ma loop adapter	270	5
DF11-A	TTL to EIA/CCITT voltage levels adapter	330	5
H312-A	Null modem; allows direct connection of peripheral having an EIA interface		
DF11-BA	103-type originate-only modem; 300 bps; includes cable for Bell DAA connection	650	11
DF11-BB	103-type answer-only modem; 300 bps; includes cable for Bell DAA connection	700	11

DEC PDP-11 Family

EQUIPMENT PRICES

COMMUNICATIONS EQUIPMENT (Continued)		Purchase Price	Monthly Maint.
KG11-A	Check character option; computes LRC, CRC, and BCC characters; used with DU11 synchronous interface	NA	NA
DR11-B	DMA interface for customer devices; includes registers for word count, current address, and data	1,620	13
DR11-C	16-bit parallel General-Purpose Bidirectional Unibus Interface for customer devices; includes interrupt, address, and control signals	540	5
DR11-K	16-bit parallel General-Purpose Bidirectional Unibus Interface for customer devices; each line can generate an interrupt, includes interrupt, address, and control signals	770	5
DR11-KT	Packaged Unit; includes DR11-K, two BC08R cables, and H322 Distribution Panel	1,100	5
DRV11	Parallel Line Interface Unit; 16-bit diode-clamped input; 16-bit latched-drive output; protocol and control signals	210	5
DRV11-B	Parallel Line DMA Interface Unit; single-cycle rate of 250K words per second; protocol and control signals	580	8
DRV11-P	LSI-11 Bus Interface Foundation Module; preassembled bus interface logic and wire-wrapped area for custom interfaces; capacity up to 60 14-pin IC's	275	NA
KWV11-A	Programmable Crystal Clock with frequencies from 100 Hz to 1 MHz plus 60-cycle and external input	600	5
GRAPHICS EQUIPMENT			
GT41-BA	Graphic Display Terminal; includes an 11/04 processor with 32K bytes of MOS parity memory, bootstrap loader, asynchronous communications interface, VT11-A Display Processor, and LK40A Keyboard	18,000	170
GT41-B4	Same as GT41-BA but substitutes DECwriter II for LK40-A	19,500	157
GT43-AA	Graphic Display Terminal; includes an 11/34A processor with 32K bytes of MOS parity memory, memory management, bootstrap loader, real-time clock, serial line interface, programmer's console, VT11-A Display Processor, asynchronous communications interface, and LK40-A keyboard; SU 1 & 2 provide 1 hex slot; SU 3 to 5, 2 SU slots	25,500	152
GT43-AH	Same as GT43-AA but substitutes DECwriter II for LK40-A keyboard	26,500	165
GT62-HA	Graphics Display Terminal; includes an 11/34A processor with 32K bytes of MOS parity memory, bootstrap loader, asynchronous communications interface, programmer's console, VS60 Display Subsystem, LK11 Push Buttons, LK40-A Keyboard, and dual floppy disks	54,000	300
GT62-JA	Same as GT62-HA but substitutes DECwriter II for LK40-A	55,000	307
GT62-RA	Same as GT62-HA but adds credenza-style packaging	55,000	300
GT62-SA	Same as GT62-HA but adds credenza-style packaging and substitutes DECwriter II for LK40-A	56,000	307
VT11-AA	Display Processor; with 17-inch CRT and light pen	10,500	69
VS60-AA	Graphic Display Subsystem; includes display processor, 21-inch CRT, light pen, tip switch, and table	37,000	244
VS60-KA	Second CRT with light pen and table; for use with VS60-AA	18,000	66
LK11-A	16-lighted Push Button Box; includes control	1,200	9
LK40-B	ASCII Keyboard with DL11-A Serial Line Interface	1,770	12
HARDWARE			
BA11-FD	Rack-Mountable Extension Mounting Box; provides space for nine systems units; not for 11/03 or 11/60	2,530	5
BA11-KE	For five systems units; not for 11/03 or 11/60	2,420	16
BA11-LE	For two systems units; not for 11/03 or 11/60	1,600	10
BA11-PE	For six systems units; for 11/60 only	3,000	15
BA11-ME	Expander Box; includes H9270 backplane and power supply	1,000	7
BA11-NE	Expander Box; includes backplane for LSI-11	1,500	NA
KY11-LB	Programmer's Octal Keyboard Console; for 11/04 and 11/34A	660	—
H9600-AA	Double-Width High-Boy Expansion Cabinet; includes three-phase power control	2,375	—
H9601-AA	Double-Width, Low-Boy Expansion Cabinet; includes three-phase power control	2,375	—
H9602-BA	Single-Width, High-Boy Expansion Cabinet; includes single-phase power control	1,475	—
H9603-BA	Single-Width, Low-Boy Expansion Cabinet; includes single-phase power control	1,475	—
H9603-CA	Single-Width, Low-Boy Expansion Cabinet; without power control	1,090	—
H9504-XD	End Panel Set; for high-boy cabinet mounted to low-boy cabinet	190	—
H952-HA	Free-Standing Table; 19-inch	302	—
H960-DH	Free-Standing Equipment Mounting Cabinet; provides a single sliding extension mounting chassis with space for up to nine system units; includes fans, power supplies, power distribution panel, extension feet, and front bezel panels	3,630	16
H960-CA	Free-Standing Standard PDP-11 Equipment Cabinet; 72 inches high; includes fans, power distribution panel, extension feet, front bezel panels, and end panels	1,210	—
H961-AA	Same as H960-CA but without end panels	935	—
H967-CA	Free-Standing Standard Short PDP-11 Equipment Cabinet; 50 inches high; includes fans, power distribution panel, extension feet, front bezel panels, and end panels	1,210	—
H967-KC	Same as H967-CA but without end panels	825	—
H957-CA	Right-Side End Panel; for H967-KC	94	—
H957-CB	Left-Side End Panel; for H967-KC	94	—
DD11-B	Four-Slot Backplane; accommodates two hex and two quad SPC modules	350	—
DD11-CK	Backpanel Mounting Unit for BA11-KE, BA11-LE, or 11/34A; accommodates 2 hex and 2 quad slot modules	330	—
DD11-CF	Backpanel Mounting Unit for BA11-FD, BA11-PE, or H960-DH; accommodates 2 hex and 2 quad slot modules	330	—
DD11-DK	Backpanel Mounting Unit for BA11-KE or 11/34A; accommodates 7 hex and 2 quad slot modules	660	—
DD11-DF	Backpanel Mounting Unit for BA11-FD, BA11-PE, or H960-DH; accommodates 7 hex and 2 quad slot modules	660	—
BB11	Blank Mounting Panel; for custom design and mounting	187	—
BB11-A	BB11 with 18 unslotted, unwired blocks for bus interface	187	—
BB11-B	BB11 with 48 unslotted, unwired blocks for bus interface	263	—
DDV11-B	Backplane with prewired LSI-11 bus (without card guide) designed to accept one microcomputer and up to 16 I/O and/or memory modules; an additional nine unwired slots are also available	400	NA
H0341	Card guide assembly for DDV11-B backplane	39	NA

DEC PDP-11 Family

EQUIPMENT PRICES

HARDWARE (Continued)		Purchase Price	Monthly Maint.
H780-C	Power Supply for typical LSI-11/H9270 configurations; without console	650	NA
H780-H	Power Supply for typical LSI-11/H9270 configurations; with master console	700	NA
H780-K	Power Supply for typical LSI-11/H9270 configurations; with slave console	675	NA
H909-C	Expander box including H0341 card guide and space for DDV11-B and power supply (H780 cannot be used with this box)	350	NA
H9270	Backplane/card guide assembly; prewired for LSI-11 bus to accept one microcomputer and up to six I/O and/or memory modules	190	NA
H9271	Backplane/card guide assembly; unwired version of H9270	94	NA
H9281-AA	LSI-11/2 backplane assembly prewired to accept four 8.5 by 5 inch modules and power connections	75	NA
H9281-AB	For eight modules and power connections	110	NA
H9281-AC	For 12 modules and power connections	145	NA
H9281-BA	Housing assembly for four LSI-11/2 modules, including card guides and H9281-AA backplane	105	NA
H9281-BB	For eight LSI-11/2 modules	155	NA
H9281-BC	For twelve LSI-11/2 modules (H9281-AC backplane)	205	NA

SOFTWARE PRICES

		Purchase Price
All software listed below is in object form and is provided with a single use license and documentation.		
Interactive Operating System (IAS); includes executive, macro assembler, editor, task builder (linker and overlay builder); debugging tool, file utilities, and text output utility:		
QR300-A	With support services	\$17,160
QR300-C	Without support services	8,580
Massachusetts General Hospital Utility Multi-Programming System (MUMPS-11); includes executive, MUMPS language processor, data management facility and utilities:		
QJ820-A	With support services	16,500
QJ820-C	Without support services	NA
Resource-Sharing Timesharing System Extended (RSTS/E); includes executive, utilities, and BASIC-Plus language processor:		
QR430-A	With support services	12,100
QR430-C	Without support services	6,050
QR430-D	Single use license only	4,840
RSX-11M Real-Time Operating System; includes executive, macro assembler, task builder, editor, on-line debugger, librarian, PIP file utility, dump, file exchange program, FORTRAN IV compiler, and run-time system:		
QJ628-A	For RK05-based systems; with support services	5,500
QJ628-C	For RK05-based systems; without support services	2,750
QJ628-D	For RK05-based systems; single use license only	2,200
QJ629-A	For RK06-based systems; with support services	5,500
QJ637-A	For RP04, RP05, or RP06-based systems; with support services	5,500
QJ637-C	For RP04, RP05, or RP06-based systems; without support services	2,750
RSX-11D Real-Time Operating System; includes executive, macro assembler, line editor, task builder, debugging tool, PIP file utility, other utilities, file exchange program, FORTRAN IV compiler, and run-time system:		
QJ580-A	With support services	6,050
QJ580-C	Without support services	3,025
RSX-11S Real-Time Operating System; includes executive, on-line task loader, system image preservation program, and file control services for record devices (without directory support):		
QJ642-A	With support services	1,650
QJ642-C	Without support services	825
QJ642-D	Single use license only	825
RT-11 Disk-Based Operating System; includes foreground/background monitor, single-job monitor, editor, macro assembler, linker, librarian, debugging tool, and PIP file utility:		
QJ003-C	Without support services	1,380
QJ003-D	Single use license only	1,105
QJ013-A	RT-11 Version 3; with support services	NA
QJ013-C	RT-11 Version 3; without support services	NA
QJ013-D	RT-11 Version 3; single use license only	NA
QJ945-A	Remote/RT-11; with support services	1,100
QJ945-C	Remote/RT-11; without support services	550
QJ945-D	Remote/RT-11; single use license only	440
QJV13-A	RT ² ; with support services	NA
QJV13-C	RT ² ; without support services	NA
QJV13-D	RT ² ; single use license only	NA
QJ906-A	APL-11 with RSTS/E; with support services	1,650
QJ906-D	APL-11 with RSTS/E; single use license only	1,650
QJ907-A	APL-11 with RT-11; with support services	1,650
QJ907-C	APL-11 with RT-11; without support services	825
QJ907-D	APL-11 with RT-11; single use license only	660
QJ280-A	Industrial BASIC/RT-11; with support services	
QJ280-C	Industrial BASIC/RT-11; without support services	
QJ280-D	Industrial BASIC/RT-11; single use license only	

DEC PDP-11 Family

SOFTWARE PRICES

		Purchase Price
QJ830-A	RT-11 BASIC and extensions; with support services	830
QJ913-A	BASIC/RT-11; with support services	830
QJ913-C	BASIC/RT-11; without support services	550
QJ913-D	BASIC/RT-11; single use license only	440
QJ916-A	BASIC-PLUS-2 under RSTS/E; with support services	4,400
QJ916-C	BASIC-PLUS-2 under RSTS/E; without support services	3,300
QJ918-A	BASIC-Plus-2 under IAS/RXS-11M; with support services	4,400
QJ921-A	MU BASIC/RT-11; with support services	830
QJ921-C	MU BASIC/RT-11; without support services	550
QJ921-D	MU BASIC/RT-11; single use license only	440
QJV40-C	LSI-11 Microprogramming Tools; without support services	1,500
QJV40-XY	WCS Software Development Tools/RT-11	1,500
ZJV01-RB	LSI-11 Basic Diagnostics	126
ZJ215-RY	LSI-11 System Diagnostics	330
QF703-A	DX/RSTS; with support services	NA
QF703-C	DX/RSTS; without support services	NA
QF703-D	DX/RSTS; single use license only	NA
QF704-A	DX/11M; with support services	NA
QF704-C	DX/11M; without support services	NA
QF704-D	DX/11M; single use license only	NA
QP900-A	RSTS/E RMS-11K; with support services	2,750
QP900-C	RSTS/E RMS-11K; without support services	1,650
QP900-D	RSTS/E RMS-11K; single use license only	1,320
QP901-A	RSX-11M RMS-11K; with support services	2,750
QP901-C	RSX-11M RMS-11K; without support services	1,650
QP902-A	IAS RMS-11K; with support services	2,750
QP902-C	IAS RMS-11K; without support services	1,650
QP601-A	IAS/RSTS/E Sort-11; with support services	370
QP602-A	IAS/RXS-11M Sort-11; with support services	370
QP240-A	IAS/RXS-11M BASIC-11; with support services	830
QP240-C	IAS/RXS-11M BASIC-11; without support service	550
QP010-A	RSX-11D COBOL; with support services	7,700
QP010-C	RSX-11D COBOL; without support services	4,730
QP011-A	RSTS/E COBOL; with support services	7,700
QP012-A	IAS/RXS-11M COBOL; with support services	7,700
QP066-A	IAS/RXS-11M CORAL-66; with support services	6,600
QP066-C	IAS/RXS-11M CORAL-66; without support services	4,400
QP523-A	DIBOL-11/DECFORM; with support services	NA
QP523-C	DIBOL-11/DECFORM; without support services	NA
QP523-D	DIBOL-11/DECFORM; single use license only	NA
QJ922-A	FOCAL RT-11; with support services	370
QJ922-C	FOCAL RT-11; without support services	185
QJ922-D	FOCAL RT-11; single use license only	150
QJ813-A	FORTRAN/RT-11; with support services	880
QJ813-C	FORTRAN/RT-11; without support services	NA
QJ813-D	FORTRAN/RT-11; single use license only	490
QJ960-A	Scientific Subroutine Package for RT-11 FORTRAN; with support services	370
QJ960-C	Scientific Subroutine Package for RT-11 FORTRAN; without support services	185
QJ960-D	Scientific Subroutine Package for RT-11 FORTRAN; single use license only	150
QJ980-A	FORTRAN/RT-11 Extensions; with support services	880
QJE02-A	MSB/FORTRAN IV; with support services	NA
QJE02-C	MSB/FORTRAN IV; without support services	NA
QJE02-D	MSB/FORTRAN IV; single use license only	NA
QP100-A	IAS/RXS-11M FORTRAN IV-Plus; with support	3,300
QP100-C	IAS/RXS-11M FORTRAN IV-Plus; without support services	1,750
QP230-A	IAS/RXS-11M FORTRAN IV; with support services	880
QP230-C	IAS/RXS-11M FORTRAN IV; without support servies	610
QR435-A	RSTS/E FORTRAN IV; with support services	1,820
QJD58-A	RT11/LSI-11 2780 Emulation Software; with support services	NA
QJD58-C	RT11/LSI-11 2780 Emulation Software; without support services	NA
QJD58-D	RT11/LSI-11 2780 Emulation Software; single use license only	NA
QJD63-A	RT-11 2780 Emulation Software; with support services	3,030
QJD63-D	RT-11 2780 Emulation Software; single use license only	1,100
QJD68-A	RSX-11M 2780 Emulation Software; with support services	3,030
QJD68-D	RSX-11M 2780 Emulation Software; single use license only	2,420
QPD10-A	RSTS/E 2780 Emulation Software; with support services	4,400
QPD10-D	RSTS/E 2780 Emulation Software; single use license only	3,300
QPD70-A	RSX-11D 2780 Emulation Software; with support service	3,030
QPD70-D	RSX-11D 2780 Emulation Software; single use license only	2,420
QRD03-A	IAS/2780; with support services	NA
QRD03-C	IAS/2780; without support services	NA
QRD03-D	IAS/2780; single use license only	NA

DEC PDP-11 Family

SOFTWARE PRICES

		<u>Purchase Price</u>
QJD62-A	HASP-RCS; with support services	NA
QJD62-C	HASP-RCS; without support services	NA
QJD62-D	HASP-RCS; single use license only	NA
QJ070-A	MUX200/RSX-IAS; with support services	6,600
QJ070-C	MUX200/RSX-IAS; without support services	4,950
QJ070-D	MUX200/RSX-IAS; single use license only	3,960
QJ170-A	UN1004/RSX-IAS; with support services	5,500
QJ170-C	UN1004/RSX-IAS; without support services	3,850
QJ 681-A	DECnet-11M; runs under RSX-11M; with support services	1,650
QJ681-C	DECnet-11M; runs under RSX-11M; without support services	1,100
QJ685-A	DECnet/RT; with support services	NA
QJ685-C	DECnet/RT; without support services	NA
QJ685-D	DECnet/RT; single use license only	NA
QJ691-A	DECnet-11S; runs under RSX-11S; with support services	1,100
QJ691-C	DECnet-11S; runs under RSX-11S; without support services	500
QP680-A	DECnet RSX-11D; with support services	2,750
QP680-C	DECnet RSX-11D; without support services	2,200
QP680-D	DECnet RSX-11D; single use license only	1,760
QP690-A	DECnet/E; with support services	NA
QP690-C	DECnet/E; without support services	NA
QP690-D	DECnet/E; single use license only	NA
QR680-A	DECnet-IAS; with support services	2,750
QR680-C	DECnet-IAS; without support services	2,200
QP300-A	DATATRIEVE-11; with support services	NA
QP300-C	DATATRIEVE-11; without support services	NA
QP300-D	DATATRIEVE-11; single use license only	NA
QP375-A	IAS DBMS-11; with support services	16,500
QP375-C	IAS DBMS-11; without support services	8,250
QP376-A	RSX-11M DBMS-11; with support services	NA
QP376-C	RSX-11M DBMS-11; without support services	NA
QP376-D	RSX-11M DBMS-11; single use license only	NA