Control Data Cyber 170 Series

MANAGEMENT SUMMARY

The four new processor models announced by Control Data as the Cyber 170 Series on April 10, 1974, were introduced as important new elements of the company's "total services" marketing strategy. The new systems offer improved price/performance and incorporate state-of-the-art technology in the form of LSI and MSI integrated circuits and metal oxide semiconductor (MOS) main memories. Other new features include enhanced software and a new communications processor, all oriented toward operation in network computing environments.

Thus, the new Cyber 170 central processors should play an important role in the continued success of Control Data's CYBERNET time-sharing service, and the new programmable Host Communications Processor and its future software support should contribute substantially to the integration of the computing facilities of the CYBERNET and the IBM System/370-oriented time-sharing facilities acquired from IBM as part of the settlement of Control Data's well-known antitrust suit against IBM.

The four new models of the Cyber 170 line, the Cyber 172, 173, 174, and 175, will supersede the earlier Cyber 72, Cyber 73, and Cyber 74 systems, introduced in March 1971. No upgrade was introduced for the Cyber 76 supercomputer, which will continue to be manufactured and marketed. Monthly rentals for the new systems range from $20,000 to over $70,000 per month, with purchase prices ranging from $1 million to over $4 million, not including charges for software. Cyber 170 system deliveries are scheduled to begin in January 1975. ▷

The Cyber 170 Series offers four new processor models that are upward-compatible with Control Data's earlier Cyber 70 and 6000 Series equipment. The new systems feature MOS main memories and offer new peripheral equipment, software improvements, lower hardware prices, and the most fully unbundled software pricing policies of any mainframe vendor.

CHARACTERISTICS

MANUFACTURER: Control Data Corporation, 8100 34th Avenue South, Minneapolis, Minnesota 55440. Telephone (612) 853-8100.

MODELS: Cyber 170 Series: Models 172, 173, 174, and 175.

DATA FORMATS

BASIC UNIT: 60-bit word in main storage and Central Processors; 12-bit word in Peripheral Processors and I/O channels.

FIXED-POINT OPERANDS: 60 or 18 bits in Central Processors; 6, 12, or 18 bits in Peripheral Processors.

FLOATING-POINT OPERANDS: One 60-bit word, consisting of 48-bit-plus-sign fraction and 11-bit exponent. (Unrounded floating-point operations generate double-precision results, and the upper and lower halves, each consisting of a 48-bit fraction and 11-bit exponent, can be separately recovered.)

INSTRUCTIONS: Central Processor instructions are 15 or 30 bits in length; each 60-bit word holds 2 to 4 instructions. Most 15-bit instructions consist of a 6-bit operation code and three 3-bit register designators. Most 30-bit instructions consist of a 6-bit operation code, two 3-bit register designators, and an 18-bit operand address. ▶
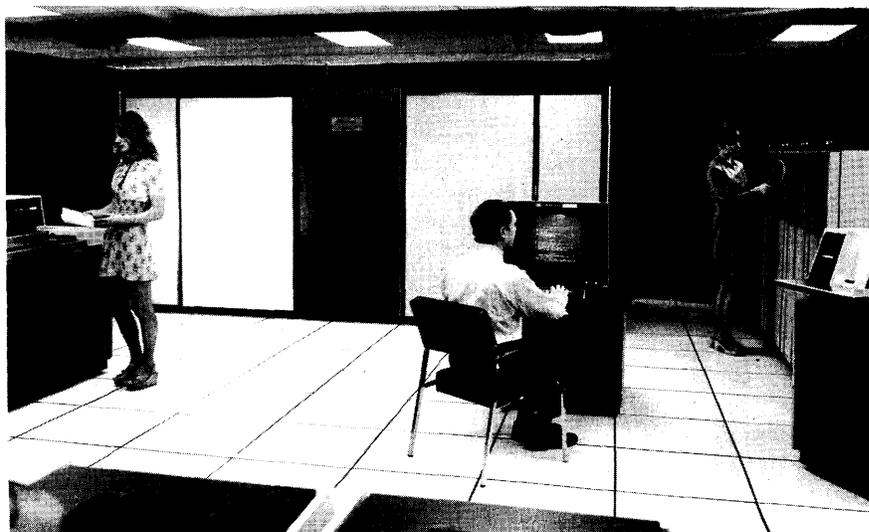
Every Cyber 170 Series system includes the display-oriented system console shown at center. Monthly rentals for Control Data's new large-scale systems range from $20,000 to over $70,000 per month, with purchase prices ranging from $1 million to over $4 million.

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▷ With the Cyber 170 announcement, Control Data became the most fully unbundled of the mainframe vendors by unveiling its Separate Element Pricing policy. All software, including separate elements of the operating systems, and all systems support software, will be priced separately from the system hardware. Control Data claims that users can achieve savings of up to 20 percent on the monthly rentals of their systems by carefully selecting only the software required for their particular operating environments.

The new central processors incorporate essentially the same system architecture and 60-bit word structure as the earlier Control Data 6000 Series and Cyber 70 product lines, but their performance will range from slightly faster (for the Cyber 172, 173, and 174 systems) to nearly three times as fast (for the Model 175) as their predecessor Cyber 70 Models. All of the new Cyber 170 systems incorporate MOS main memory, and the Models 172, 173, and 174 use emitter coupled logic (EMC)-based integrated circuitry. The Model 175, however, uses discrete component circuitry. The Models 172, 173, and 174 also incorporate the same instruction set as the earlier Cyber 70 models, including the use of the Compare/Move instructions originally introduced with the Cyber 72 and 73 central processors. These instructions permit high-speed move and comparison operations on strings of 6-bit characters and improved performance in business environments. The Model 175, oriented primarily toward scientific applications, does not include the Compare/Move instructions in its instruction repertoire.

BACKGROUND

The Cyber 170 systems represent the culmination of almost a decade of evolutionary enhancements to the Control Data 6000 Series and Cyber 70 hardware and software. The intial member of the 6000 Series, the CDC 6600, went into operation in 1965. The 6000 Series was augmented by the slower and less expensive 6400 in May 1966 and by the 6500, a dual-processor version of the 6400, in December 1967. The 6700, a dual-processor version of the 6600, was delivered in July 1970, and the 6200, a lower-priced version of the 6400, completed the 6000 Series in November 1970.

All of the 6000 Series computers were built around the concept of one or two powerful Central Processors and a fast central memory serviced by multiple independent Peripheral Processors. In the design of the 6000 Series, Control Data was an early implementor of the distributed processing concept, in which each processing function is assigned to the hardware element able to perform it in the most cost-effective manner. Thus, in the 6000 Series, the Cyber 70, and the new Cyber 170 systems, the fundamental hierarchy of processing functions is as follows: computation is performed by the ▷

▶ Peripheral Processor instructions are 12 or 24 bits (1 or 2 words) in length. The 12-bit format consists of a 6-bit operation code and a 6-bit operand address or literal operand. The 24-bit format consists of a 6-bit operation code and an 18-bit operand address or literal operand.

INTERNAL CODE: 6-bit BCD is standard "display code."

MAIN STORAGE

STORAGE TYPE: Metal oxide semiconductor (MOS).

CAPACITY: In Model 172: 32,768, 49,152, 65,536, 98,304, or 131,072 60-bit words in eight banks of either 4,096, 6,144, 8,192, 12,288, or 16,384 60-bit words. In Models 173, 174, and 175, an additional optional storage unit expands the storage capacity to 196,608 or 262,204 60-bit words. The minimum main storage size for Models 173, 174, and 175 is 65,536 words. The Model 175 main storage consists of 16 banks of 4,096, 6,144, 8,192, 12,188, or 16,384 60-bit words. All Cyber 170 memories are field-upgradable.

CYCLE TIME: In Models 172, 173, 174, and 175: 400 nanoseconds per word.

MAXIMUM DATA RATE: One 60-bit word per 50 nanoseconds with 8-bank interleaving.

CHECKING: Each Central Memory word in all models contains 60 data bits plus 8 single-error correction, double-error detection check bits (SECDED). When the word is retrieved, single-bit errors are corrected automatically, and multiple-bit errors are detected and signalled for appropriate program action.

A parity bit is generated with each 12-bit word stored in the Peripheral Processor Subsystem. A program-controlled Status and Control Register in each Peripheral Processor Subsystem monitors address and data parity errors and indicates error conditions on a visual status display.

STORAGE PROTECTION: Any attempt to reference an address outside the established main storage boundaries for the currently active program results in an interrupt.

EXTENDED CORE STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: In Models 172, 173, 174, and 175: 0, 125,952, 251,904, 503,808, 1,007,616, or 2,015,232 60-bit words in 125,952-word banks.

CYCLE TIME: In Models 172, 173, 174, or 175: 3.2 microseconds per 480-bit (8-word) record.

MAXIMUM DATA RATE: In Models 172, 173, 174, and 175: 100 million characters per second (achieved through bank interleaving, in systems with at least 503K words).

CHECKING: Parity bit with each 60-bit word is checked whenever storage is referenced.

STORAGE PROTECTION: Any attempt to reference an address outside the established ECS boundaries for the currently active program results in an interrupt.

PERIPHERAL PROCESSOR STORAGE

STORAGE TYPE: Metal oxide semiconductor (MOS).

CAPACITY: 4096 twelve-bit (plus one parity bit) words in each Peripheral Processor.

CYCLE TIME: 500 nanoseconds per 12-bit word. A PPU can be programmed through the Status and Control Register to execute at 1.0 microsecond per 12-bit word. ▶

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CHARACTERISTICS OF THE CYBER 70 AND CYBER 170 SYSTEMS

	Model 72	Model 73	Model 74	Model 76	Model 172	Model 173	Model 174	Model 175
MAIN STORAGE								
Word size, data bits	60	60	60	60	60	60	60	60
Cycle time, microseconds	1.0	1.0	1.0	0.275	0.40	0.40	0.40	0.40
Minimum capacity, words	32,768	32,768	32,768	32,768	32,768	65,536	65,536	65,536
Maximum capacity, words	131,072	131,072	131,072	65,536	131,072	262,144	262,144	262,144
EXTENDED CORE STORAGE								
Word size, data bits	60	60	60	60	60	60	60	60
Cycle time, microseconds	3.2	3.2	3.2	1.76	3.2	3.2	3.2	3.2
Words fetched per cycle	8	8	8	8	8	8	8	8
Minimum capacity, words	125,952	125,952	125,952	256,000	125,952	125,952	125,952	125,952
Maximum capacity, words	2,015,232	2,015,232	2,015,232	512,000	2,015,232	2,015,232	2,015,232	2,015,232
CENTRAL PROCESSORS								
No. of processors	1 or 2	1 or 2	1 or 2	1	1	1	2	1
Functional units/processor	1	1	10*	9	1	1	1*	9
Instruction stack	No	No	8 words	12 words	No	No	No	12 words
Typical speed, instructions/sec:								
Single processor	900,000	1,200,000	3,000,000	15,000,000	1,400,000	2,000,000	–	6,000,000
Dual-processor system	1,500,000	2,000,000	3,700,000	–	–	–	3,000,000	–
PERIPHERAL PROCESSORS								
No. of processors	10 to 20	10 to 20	10 to 20	6 to 13	10	10 to 20	10 to 20	10 to 20
Word size, data bits	12	12	12	12	12	12	12	12
Cycle time, microseconds	1.0	1.0	1.0	0.275	0.50	0.50	0.50	0.50
Storage capacity, words/PPU	4,096	4,096	4,096	4,096	4,096	4,096	4,096	4,096
NO. OF I/O CHANNELS	12 to 24	12 to 24	12 to 24	7 to 15	12	12 or 24	12 or 24	12 or 24

*Second CP in Model 74 system is a "unified" processor of the type used in Model 73 systems; second CP in Model 174 is a type-173 CP.

▷ Central Processor and central memory, and slower, lower-level functions, such as input/output and system control, are distributed among multiple Peripheral Processors.

To enhance its computational capabilities, the 6600 was provided with ten independent functional units for concurrent execution of various types of instructions, and an 8-word instruction stack to minimize instruction access times. The same features were incorporated in the design of the Cyber 74 Central Processor. In similar fashion, a 12-word instruction stack and nine independent functional units, originally introduced with the CDC 7600, have been incorporated in the new Cyber 175 processor unit.

Basic architecture of the Series 6000 Central Processors includes 24 operating registers to hold operands, addresses and address increments. These registers, supported by a repertoire of 15- and 30-bit instructions, greatly reduce the number of core storage references required to execute most programs. The identical register structure was incorporated into the design of the Cyber 70 and Cyber 170 processing units. Both the 6000 Series and Cyber 70 systems incorporate a central memory containing from 32K to 131K 60-bit words of 1-microsecond core storage. The central memory is ▷

CENTRAL PROCESSORS

CONFIGURATION RULES: A Model 172, 173, or 175 system includes one Central Processor. A Model 174 system includes two Model 173-type Central Processors.

FUNCTIONAL UNITS: Each Model 172, 173, and 174 Central Processor has a single, "unified" arithmetic unit that executes all instructions. The Model 175 Central Processor contains nine independent functional units: Boolean, Shift, Normalize, Floating Add, Long Add, Floating Multiply, Floating Divide, Increment, and Population Count (which counts the number of 1 bits in a word).

REGISTERS: Every Cyber 170 Central Processor has a total of 24 operating registers: eight 60-bit operand (X) registers, eight 18-bit address (A) registers, and eight 18-bit index (B) registers. The X registers hold operands and results. Five of these registers (X1 to X5) hold operands read from main storage and two (X6 and X7) hold results to be sent to main storage. Data is automatically transmitted between main storage and an X register whenever an address is placed into the corresponding A register. The AO and XO registers have no connection with main storage and can be used to hold intermediate results. Seven B registers (B1 through B7) serve as index registers, while the eight (BO) provides a constant zero value.

INDIRECT ADDRESSING: Not used in the Central Processors.

INSTRUCTION STACK: The Model 175 Central Processor has a stack of twelve 60-bit registers which hold from 14 to 48 instructions, minimizing the number of memory references required to access repetitive sequences ▶

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▷ referenced by both the Central Processors and the Peripheral Processors. In addition, each Peripheral Processor in the CDC 6000 Series and Cyber 70 Series contains 4K 12-bit words of 1-microsecond core storage. Finally, both 6000 Series and Cyber 70 configurations can include an optional Extended Core Storage unit which provides from 125K to 2015K 60-bit words of storage with a data transfer rate to and from central memory of 10 million words per second.

Although the Cyber 70 models closely resembled their 6000 Series counterparts in design and performance, the Cyber 70 central processors added some new features that were designed to improve their performance primarily in multiprogramming and business-oriented environments. These include an Interlock Register for use by the Peripheral Processors to facilitate I/O channel reservations, system interlocks, and inter-processor communications; four new Compare/Move instructions for character-oriented business data processing operations; and the Monitor Exchange Jump instructions and Central Memory Access Priority to ensure the optimum use of Extended Core Storage systems.

CYBER 170 IMPROVEMENTS

The new features added to the Models 172, 173, 174, and 175 systems clearly indicate the sphere in which Control Data expects the Cyber 170 Series to achieve its highest and best use. The new facilities are designed to improve the systems' reliability, availability, and serviceability, and thus, combined with new communications processors and improved software capabilities, enable the Cyber 170 systems to function effectively in large-scale computing networks. The new facilities introduced with the Cyber 172, 173, 174, and 175 models include:

● Use of integrated circuit (IC) technology in system logic modules of the Models 172, 173, and 174 and all Peripheral Processor Units, and MOS memory in all Central Memories and Peripheral Processor Unit memories. The use of these state-of-the-art technologies results in systems that are smaller, faster, and inherently more reliable.

● Twice as much central memory capacity in the Model 173, 174, and 175 systems, with from 65K to 262K 60-bit words of MOS memory now available for each of the three models.

● Extensive use of parity checking in both Central Memory and Peripheral Processor Unit memories. In addition, the central memory control unit performs automatic single-bit error correction and detects double-bit errors on all data stored in central memory. ▷

of instructions. Models 172, 173, and 174 have a single 60-bit instruction register. Models 173 and 174 also have two-word instruction overlap/lookahead.

INSTRUCTION REPERTOIRE: Consists of about 75 basic instructions divided into the following functional categories: 18 Branch and Control, 8 Boolean, 9 Shift, 6 Floating Add/Subtract, 2 Long Add (integer sum and difference), 4 Multiply, 3 Divide, 24 Increment, and 1 Pass (no operation). In addition, Models 172, 173, and 174 have 4 additional Compare/Move instructions to handle operations on variable-length strings of 6-bit characters.

Arithmetic facilities include floating-point addition, subtraction, multiplication, division, and normalization; 60-bit fixed-point addition, subtraction, and multiplication (with division handled as a special case of floating-point division); and 18-bit fixed-point addition and subtraction (for address arithmetic).

INSTRUCTION TIMES: Execution times, in microseconds, for representative instructions are listed below:

	Model 172	Model 173	Model 174	Model 175
Fixed-point add/subtract	0.60	0.25	0.25	0.100
Floating add/subtract	0.80	0.45	0.45	0.100
Floating multiply	3.15	2.80	2.80	0.125
Floating divide	3.15	2.80	2.80	0.500
Logical sum/difference	0.60	0.25	0.25	0.050
Load Register	1.19	0.84	0.84	0.575
Test and Branch	1.40	1.05	1.05	0.650

Note that the concurrent operation of the multiple functional units and the 12-word instruction stack in the Model 175 leads to higher overall performance than might be inferred from the times listed here.

INTERRUPTS: Three types of error conditions and one external condition cause Central Processor interrupts: address out of range (i.e., storage protection violation), operand out of range (i.e., exponent overflow), indefinite result, and execution of an Exchange Jump instruction by a Peripheral Processor or Central Processor.

PERIPHERAL PROCESSORS

CONFIGURATION RULES: A Model 172 system includes 10 identical Peripheral Processors. Models 173, 174, and 175 systems can include 10, 14, 17, or 20 Peripheral Processors.

INDEX REGISTERS: Any of the first 64 locations in memory can be used as an index register.

INDIRECT ADDRESSING: One level of indirect addressing is possible for load, store, and arithmetic instructions; indexing and indirect addressing can be combined.

INSTRUCTION REPERTOIRE: Consists of about 65 instructions oriented toward system control, I/O control, and logic functions. Arithmetic capabilities are limited to fixed-point addition and subtraction.

INSTRUCTION TIMES: Range from 0.5 to 2 microseconds and average 1 microsecond per instruction in Model 172, 173, 174, and 175 systems.

INTERRUPTS: The status of I/O channels, peripheral equipment, and other processors is indicated by hardware ▶

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▷● The capability to isolate a memory failure to a single memory module, to remove manually any 4K module in each of eight banks, and to continue to operate in a degraded mode.

● A Status and Control Register, available with each Peripheral Processor Subsystem, that displays abnormal system conditions and occurrences of parity errors and provides a number of programmed control functions for enhanced on-line maintenance.

● A new series of three Host Communications Processors, each incorporating a programmable minicomputer with up to 128K 16-bit words of memory, a communications multiplexer, and the capability to interface to up to two host central processors and up to 256 communications lines.

PERIPHERAL EQUIPMENT

Several high-performance peripheral devices, already successfully marketed by Control Data as plug-compatible replacements for comparable IBM peripheral equipment or as original equipment to other mainframe manufacturers, were made available with the Cyber 170 Series. Among the peripheral units that can be used with the Cyber 170 central processors are:

● The 844-21 Mass Storage Subsystem, an IBM 3330-style disk system that stores 118 million 6-bit characters per disk pack, or a maximum of 944 million characters in an eight-drive subsystem.

● The 844-41 Mass Storage Subsystem, an IBM 3330-style double-capacity disk system that offers twice the capacity of the 844-21: 237 million 6-bit characters per removable disk pack, or a total of 1.9 billion 6-bit characters of on-line storage.

● The Model 667 and 669 Magnetic Tape Subsystems, which include three 7-track tape units that offer data transfer rates of up to 160,000 characters per second and three 9-track tape units that transfer data at up to 320,000 characters per second.

● The Model 580 Fastrain Printer Subsystem, capable of printing at speeds of 1200, 1600, or 2000 lines per minute.

● The 2550 Series Host Communications Processors, a family of programmable front-end communications processors with the capacity to handle up to 256 communications lines. The Host Communications Processors permit software selection of full-duplex or half-duplex modes of transmission and 5- to 8-bit code lengths. For installations with large volumes of communications processing, a microprogrammed multiplex controller is available to manage the data ▷

flags that can be examined by the Peripheral Processors. Execution of an Exchange Jump instruction in a Peripheral Processor causes interruption of the current Central Processor program and initiation of another program whose parameters are defined in an associated "exchange package".

INPUT/OUTPUT CONTROL

I/O CHANNELS: A Model 172 system has 12 I/O channels; Models 173, 174, and 175 can have 12 or 24 I/O channels. All of the channels can be used by any of the Peripheral Processors.

CONFIGURATION RULES: Each I/O channel may be connected to one or more external devices, but only one device at a time can utilize the channel.

SIMULTANEOUS OPERATIONS: One input or output operation on each I/O channel can be overlapped with computing in the Central Processor and Peripheral Processors. Every I/O operation is executed under the direct control of a Peripheral Processor.

MAXIMUM DATA RATE: Four million characters per second.

MASS STORAGE

844-21 MASS STORAGE SUBSYSTEM: Provides fairly rapid access to large quantities of data stored in interchangeable 11-disk packs. An 844-21 subsystem consists of one or two 7054-1 or 7054-2 Controllers and from one to eight 844-21 Disk Storage Units. The 7054-2 Controller provides a second channel to provide access from two central processors. Two controllers are required for simultaneous read and/or write operations. Each Type 881 Disk Pack holds up to 118 million 6-bit characters, for a total on-line storage capacity of 944 million characters for an eight-drive system. Each of the 19 recording surfaces contains 404 data tracks, and each track is divided into twenty-four 644-character sectors. Head movement time ranges from 10 to 55 milliseconds and averages 30 for random accesses. Average rotational delay is 8.3 milliseconds, and data transfer rate is 1.13 million characters per second.

Features supported include Rotational Position Sensing, Command Retry, and Multiple Requesting. The 7054 Controllers use microprogrammed diagnostics which can be loaded from flexible disks to perform diagnostic routines while the disk drive is off-line. The Model 844-21 Mass Storage Subsystem was first delivered in June 1972.

844-41 MASS STORAGE SUBSYSTEM: This high-volume disk subsystem offers twice the capacity of the 844-21 Mass Storage Subsystem. The doubled disk pack capacity of the Type 883 Disk Pack is achieved through the use of twice as many tracks on each disk pack surface. Each pack holds 237 million 6-bit characters. A full eight-drive configuration provides up to 1.9 billion 6-bit characters of on-line storage.

The double-capacity 844-41 units use the same track length and record formats as the 844-21 disk drives. Performance characteristics are the same as those of the 844-21 Mass Storage Subsystem, with the exception of the data transfer rate, which is 1.08 million 6-bit characters per second. Either a 7054-41 or 7054-42 Controller can be used to control up to eight 844-41 Disk Storage Units or up to eight intermixed 844-21 and 844-41 Disk Storage Units. The 7054-42 Controller contains a second channel to provide access to the subsystem by two central processors or a redundant channel to the same central processor. Two control units are required for simultaneous read or write operations. A 7054-1 or -2 control unit is field-upgradable to a Model 7054-4x control unit. The 844-41 Mass Storage Subsystem was announced with the Cyber 170 Systems in ▶

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▷ flow between the Host Communications Processor and the communications lines. The Host Communications Processors can support Teletype, IBM 2741, IBM 2780, and IBM 3780 terminals, as well as Control Data remote terminals operating under the CDC Mod 4 protocol. They will be supported by CDD-supplied software.

SOFTWARE

With the Cyber 170 Series, Control Data announced the Network Operating System (NOS), which is basically an integration of the batch processing capabilities of the Scope operating system, originally announced for the 6000 Series, and the time-sharing facilities of the Kronos operating system, a newer support program released for the Cyber 70 Series that emphasizes interactive processing from remote terminals along with intermixed local and remote batch processing. The Network Operating System can handle five concurrent modes of operation: interactive processing, transaction processing, local batch, remote batch, and deferred batch processing. NOS will use the operating and applications software previously supplied for the Scope and Kronos operating systems, but NOS also features an enhanced and more efficient COBOL compiler, ANS FORTRAN, interactive BASIC, ALGOL-60, the COMPASS assembly language, and a new APL compiler.

Versions of NOS will also be released for Series 6000 and Cyber 70 Series processors. Alternatively, users who upgrade to Cyber 170 Series processors can elect to continue to operate under either the Scope or Kronos operating system. NOS is scheduled for delivery in January 1975.

In addition, Control Data announced a data base management capability for the Cyber 170 systems, and also for the older 6000 Series and Cyber 70 systems, in the form of Total, the widely used data base management package marketed by CINCOM Systems, Inc. Total provides a simple and straightforward set of facilities for organizaing a data base and for manipulating the data base within an application program. In the Control Data version, access to the data base structure can be made through CALL statements embedded in the user's COBOL, FORTRAN, or COMPASS assembly-language programs.

COMPATIBILITY

Control Data claims that the new Cyber 170 Series systems are upward compatible with the earlier Series 6000 and Cyber 70 processors. Since the basic operating system structure, file organization techniques, and more versatile job control language of the Kronos operating system are embodied in the Network Operating System, programs written for use under Kronos will run under ▷

▶ April 1974 and is scheduled for first delivery late in 1975.

INPUT/OUTPUT UNITS

667/669 MAGNETIC TAPE SUBSYSTEMS: These units read and record data on 1/2-inch tape in 7-track NRZI or 9-track NRZI or phase-encoded modes. Up to eight Model 667 or 669 Magnetic Tape Units can be connected to either a single- or dual-channel controller. A 7021-1 (1-channel) or 7021-2 (2-channel) controller can be connected directly to a Cyber 170 system. Seven-track and 9-track tape transports can be intermixed in one subsystem. Among the features supported in both the 667 and 669 tape transports are automatic reel hub latching, cartridge loading, automatic threading, and a power-operated window. Both tape subsystems employ a radial attachment instead of the conventional serial attachment technique, thus making it possible for individual drives to be switched off-line and exercised by diagnostic routines without interrupting the operation of the remaining drives. All subsystems can perform character-code translation during data transfer with no degradation of transfer rates. When selected, the translator can read 8-bit, EBCDIC-coded bytes as 6-bit, BCD-coded equivalents. Code translation is programmable and is defined at operating system initialization.

Tape transports with the 9-track capability can use either industry-standard NRZI or the phase-encoded recording method, selected under program control. All models can read both in the forward and reverse directions.

Six different transports are available, with the following recording modes, tape speeds, recording densities, and data transfer rates:

Model 667-2: 7 tracks; 100 ips; 200/556/800 cpi; 20,000/55,600/80,000 char/sec; NRZI.

Model 667-3: 7 tracks; 150 ips; 200/556/800 bpi; 30,000/83,400/120,000 char/sec; NRZI.

Model 667-4: 7 tracks; 200 ips; 200/556/800 bpi; 40,000/111,200/160,000 char/sec; NRZI.

Model 669-2: 9 tracks; 100 ips; 800 bpi (NRZI)/1600 bpi (phase-encoded); 80,000/160,000 char/sec.

Model 669-3: 9 tracks; 150 ips; 800 bpi (NRZI) 1600 bpi (phase-encoded); 120,000/240,000 char/sec.

Model 669-4: 9 tracks; 200 ips; 800 bpi (NRZI)/1600 bpi (phase-encoded); 160,000/320,000 char/sec.

The Model 667/669 Magnetic Tape Subsystems were announced in August 1973 and first delivered in October 1973.

405 CARD READER: Reads standard 80-column cards photoelectrically at up to 1200 cpm; can also read 51-column cards at up to 1600 cpm. Reads both Hollerith-coded and binary cards. Has a 4000-card input hopper, a 4000-card primary stacker, and a 240-card secondary stacker. The 3447-2 Controller connects a single card reader to one Model 172, 173, 174, or 175 I/O channel via a 6681 Data Channel Converter. Each controller contains a full-card buffer.

415-30 CARD PUNCH: Punches standard 80-column cards, in either Hollerith or binary format, at up to 250 cpm. Has a 1200-card input hopper and a 1500-card output stacker. The 415-30 contains its own controller which connects to one Model 172, 173, 174, or 175 channel via a 6681 Data Channel Converter. The integrated controller contains a full-card buffer.

512-1 LINE PRINTER: Uses a 48-, 64-, or 96-character horizontal "train" of engraved type slugs. Rated printing speed is 1160 lpm with the 48-character trains. Has 136 ▶

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▷ NOS without modification. Conversion of Scope programs to NOS will require file restructuring and modification of the job control language. A set of conversion aids is available to facilitate the transition from Scope to NOS. The new hardware features of the Cyber 170 systems are supported by NOS through specific parameter settings during generation of the NOS operating system. These settings can be disabled, thus allowing NOS to be used on 6000 Series and Cyber 70 systems as well.

Like the 6000 Control Data Series and Cyber 70 Series, the Cyber 170 offers very little program compatibility with other competitive systems, except that available with CDC's ANS-compatible COBOL and FORTRAN compilers.

However, the 7021 control unit associated with the Model 667/669 Magnetic Tape Units has a translation and data conversion feature which translates 8-bit EBCDIC-coded bytes to 6-bit BCD-coded equivalents. Interchange of data between IBM System/370 and Cyber 170 computer systems is regulated by a software package called FORM, under control of the NOS operating system.

PRICING AND SUPPORT

Rental prices for the smaller Cyber 170 Series central processors have been reduced substantially below those of comparable models in the Cyber 70 line. A Model 172 Central Processor with 32K words of central memory, for example, rents for $7,450 as compared to $13,400 for a comparable Cyber 72 central processor on a one-year lease. The one-year monthly rental for a Model 173 Central Processor with 65K words of central memory is approximately 30 percent less than that for a comparable Model 73 Central Processor. Prices for Extended Core Storage units remain the same.

To some extent the reduction in hardware cost results from the adjustment of Control Data's pricing policies to more realistically reflect hardware and software development costs. Since January 1970, Control Data has established separate charges for technical support, education courses, equipment maintenance, and all software. In announcing the Cyber 170, Control Data further refined its software pricing by introducing a Separate Element Pricing policy, in which individual elements of the operating system are individually priced.

The basic module of the NOS operating system, which provides local and remote batch processing capabilities, the COMPASS assembler language, and the Record Manager function, rents for $3,900 per month including maintenance. Addition of the time-sharing module and the Tranex transaction processing facility raises the monthly rental price of the operating system to $7,800, in addition to a $4,750 one-time installation charge. ▷

print positions. Six different interchangeable train cartridges are available, including the 48-character IBM AN and HN arrangements, the 64-character CDC 501 Line Printer set, a 64-character ASCII subset, and a 96-character ASCII subset. Other character sets are available on special order. Maximum skipping speed is 70 inches/second. The 3555-1 Controller includes a full-line buffer and connects one printer to a single Model 172, 173, 174, or 175 channel via a 6681 Data Channel Converter.

580 FASTRAIN PRINTER SUBSYSTEM: Uses a 48-, 64-, or 96-character horizontal "train" of engraved type plugs. Rated printing speeds are 1200, 1600, or 2000 lines per minute with the 48-character trains. Six or eight line-per-inch spacing is selectable under program control. Six different interchangeable train cartridges are available: the 48-character IBM AN and HN arrangements, the 64-character CDC 501 Line Printer set, two 64-character ASCII subset trains, and a 96-character ASCII subset including upper and lower case characters. Maximum skipping speed in 90 inches per second. Has 136 print positions. The printer is enclosed in an acoustically-dampened cabinet with enclosed feed forms and stacking for quiet operation. Includes an integrated controller with on-line buffer that connects to a Model 172, 173, 174, or 175 system via a 6681 Data Channel Converter.

COMMUNICATIONS EQUIPMENT

2550 SERIES HOST COMMUNICATIONS PROCESSORS: A family of three programmable communications processor models which form the hardware portion of the Control Data Network Communications System. Each Host Communications Processor consists of a microprogrammable processor and a multiplexing subsystem for interfacing multiple terminals and communications lines to a host central processor.

The communications processor includes a minimum of 24K 16-bit words of memory, expandable in 8K increments to a maximum of 256K words. A channel coupler controls the exchange of data blocks between a Peripheral Processor Unit attached to one or more CDC Cyber 70, Cyber 170, or 6000 Series central processors and the communication processor memory. In addition, up to two Channel Couplers can share a single host processor data channel, thereby supporting multiple Host Communications Processors or multiple host central processor configurations for redundancy and load-sharing.

The Multiplex Subsystem utilizes a "demand-driven" multiplexing technique in which data movement between the communications line and the communications processor's memory occurs at the instigation of the line adapter instead of being limited by scanning rates in the system. The Multiplex Loop is the demand-driven mechanism that gathers input data and status information from communications lines and distributes output data and control information to the communications lines. The loop is composed of two high-speed serial transmission links, one for input and the second for output. Data cycles around the links at a speed of 20 million bits per second.

The Multiplex Loop consists of a Multiplex Loop Interface Adapter and from one to eight Loop Multiplexers. The Multiplex Loop Interface Adapter converts bit-serial loop data from the input loop to bit-parallel format for storage in the communication processor's memory, and converts bit-parallel data from storage to bit-serial format for placement on the output loop. Up to 8 Loop Multiplexers, each capable of managing the flow of data between the communications processor and 32 communications lines, can be incorporated into one Multiplex Loop for a total of 256 communications lines per Host Communications Processor.

For high throughput volumes, a microprogrammed Multiplex Loop Controller is added to the configuration ▶

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▷Thus, within the operating system, the user has the option of selecting only those modules which are required for his operating environment. In addition, Control Data offers substantially reduced software license fees to users who select a less comprehensive software maintenance category. Control Data claims that software costs now should account for from 20 to 25 percent of the monthly rental cost of a Cyber 170 computer system.

Control Data also raised the prices for the latest versions of the Scope and Kronos operating systems for new Control Data 6000 Series and Cyber 70 systems installed or ordered after July 1, 1974, and for all Cyber 170 systems. Current CDC 6000 or Cyber 70 installations using Scope, however, will be able to upgrade to Scope 3.4 for a minimal $250 monthly license fee, while installing Kronos 2.1 will cost current Control Data users $1,000 per month. Comparable charges for new systems are $5,600 per month for Scope 3.4 and $3,900 per month for Kronos 2.1, with a one-time charge of $4,750 for each operating system.

Although the Cyber 170 Series offers little in the way of dramatic architectural innovations, its improved price/performance, along with its useful new features, should make it an attractive upgrade for the more than 300 installed Control Data 6000 Series and Cyber 70 systems. The addition of new data base management capabilities, along with the versatility promised by the Network Operating System, should also make the Cyber 170 systems worthy of consideration in any environment where large-scale communications-oriented computing is a requirement. □

▶ to control the exchange of data and supervisory commands between the communications processor memory and the Loop Multiplexer or the communications line adapters.

Both synchronous and asynchronous communication line adapters are available for interfacing communications lines. Asynchronous communications line adapters support line speeds of 45 to 9600 bits per second between remote and local terminals and the Host Communications Processor. Synchronous communications adapters can support data transmission speeds of from 2000 to 56,000 bits per second. When data is being received, a programmed detection feature tests the line speed and code to determine the proper handling of the data by the Host Communications Processor, thus obviating the requirement for dedicating communications line adapters to a particular line speed or terminal type.

A Time-Division Multiplexer Line Adapter multiplexes data from many sub-voice grade lines into a single voice grade line for transmission to the host central computer.

Software support for the Host Communications Processor consists of a base operating system, host interface, multiplex system, application functions, terminal interface, and diagnostic routines. It is scheduled for release late in 1975. Most of the software will be written in a CDC-developed higher-level language called PASCAL, a communications-oriented language with both bit and byte manipulation capabilities. Source programs written in PASCAL can be compiled on a Cyber 170, Cyber 70, or 6000 Series computer system and loaded down-line into

the Host Communications Processor, thus allowing the user access to the full resources of a computer network.

Three models of the Host Communications Processor are available:

● **Model 2550-1**: The minimum system consists of a communications processor and loop multiplexer with interface adapter for supporting from 2 to 32 communications lines, with optional expansion to 64 lines. It provides 24K 16-bit words of memory with optional expansion to 32K words. The 2550-1 includes a channel coupler to interface to a Control Data 6000 Series or Cyber 70 or 170 central processor, and can support optional 300 or 600 cpm card readers and 300 or 1200 lpm printers. Either a Control Data 1711 Teletypewriter or 713 Conversational Display Station or an equivalent teletypewriter must be included as a communications console. Data throughput rate is 10,000 characters per second.

● **Model 2550-2**: Designed for low initial communication requirements with expansion capabilities, this model consists of a communications processor and loop multiplexer with interface adapter for supporting from 2 to 32 communications lines, with optional expansion to 128 lines. It provides 32K 16-bit words of memory, expandable in 8K-word increments to 65K words. The 2550-2 includes a channel coupler to interface to Control Data 6000 Series or Cyber 70 or 170 central processors, and can support optional 300 or 600 cpm readers and 300 or 1200 lpm printers. Either a Control Data 1711 Teletypewriter or 713 Conversational Display Station or an equivalent teletypewriter must be included as a communication console. Data throughput rate is 10,000 characters per second.

● **Model 2552-1**: Designed for large-volume communications requirements, this model consists of a communications processor and a microprocessor-based multiplex loop controller with interface adapter which supports from 2 to 32 communications lines. Line handling capability can be optionally expanded to 256 lines. Basic memory capacity is 32K 16-bit words, expandable in 8K-word increments to 128K words. The 2552-1 includes a channel coupler to interface to a Control Data 6000 Series or Cyber 70 or 170 central processor, and can support optional 300 or 600 cpm card readers and 300 or 1200 lpm printers. Either a Control Data 1711 Teletypewriter or Control Data 713 Conversational Display Station or an equivalent teletypewriter must be included as a communications console.

SOFTWARE

NETWORK OPERATING SYSTEM (NOS): The Network Operating System, a result of a merger of Control Data's earlier Scope and Kronos operating systems, is the principal operating system for all models of the Cyber 170 Series and will also be available for 6000 Series and Cyber 70 systems. Primary orientation of the Network Operating System is toward the support of a mixed-mode environment with an emphasis on network processing. NOS concurrently handles five types of job processing: local batch processing, remote batch processing, transaction processing, interactive terminal processing, and deferred batch processing of jobs entered via a remote terminal. In the interactive processing mode, a maximum of 512 active time-sharing terminals can be accommodated.

The basic module of NOS provides batch processing capabilities that permit the execution of jobs submitted either locally or from remote batch terminals. It includes the Record Manager package to provide logical input/output functions for block/record management for sequential and random files. Interactive terminal processing is supported by the Time-Sharing Subsystem. Time-sharing users are also allowed access to the facilities ▶

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of the batch subsystem. The Tranex transaction subsystem provides a general-purpose transaction processing capability, including centralized control for transaction terminals, a specialized data management system, support for multiple task libraries, journaling, and debugging and testing aids. Preliminary shared-processor support is provided by the Multi-Frame software package, which provides for shared mass storage files and shared input/output queues between two central processors.

Like its predecessors, Scope and Kronos, NOS uses the Peripheral Processors to handle system and I/O functions. Various components of the NOS software reside in main memory, Extended Core Storage, Peripheral Processor (PPU) storage, and the system disk unit. One PPU contains the Monitor routine and permanently controls the system.s overall operations. A second PPU is permanently assigned to control the console keyboard and displays. In the event of a malfunction, the Monitor and operator display functions can be reassigned to alternate PPU's. The remaining PPU's are used to perform I/O and system tasks on a dynamic pool basis. If the Time-Sharing Subsystem or the Remote Batch Subsystem is active, a PPU is dedicated to each subsystem.

Extended Core Storage is supported under NOS in the same manner as under the SCOPE operating system. It operates primarily as a high-speed swapping device and as a storage medium for user data files.

Jobs enter the NOS system from the central site and from remote time-sharing and batch terminals, and are divided into five basic categories according to their origin. User-supplied parameters in the scheduling algorithm control job scheduling. A Resource Executive builds a display for monitoring by the operator, indicating which magnetic tape unit and disk storage drives are required for execution of the job and whether any such assignment will conflict with other jobs being executed and cause a system deadlock.

An option allows automatic scheduling of programs through the Resource Executive without operator intervention. When this option is selected, the Resource Monitor initiates only those jobs that are assured of the required resources to complete execution.

Programming languages available under NOS include Interactive BASIC, FORTRAN Extended, COMPASS, ALGOL, APL, and COBOL.

COBOL: CDC's new COBOL 4.0 compiler operates under NOS, features full ANS language compatibility, and provides the following noteworthy facilities:

● SORT verb to sort files in conjunction with the Sort/Merge system.

● RERUN option to permit jobs to be restarted at any specified point in the program.

● RENAME option for alternate naming of elementary items.

● COMMON-STORAGE for sharing of data by separately compiled programs.

● COPY statement for access to a source library.

● Report Writer feature.

● Segmentation and object program overlays.

● 18-digit arithmetic operands.

● Use of formulas in conditional statements.

● Exponentiation with the COMPUTE function.

● Numeric procedure names in the Procedure Division.

COBOL 4.0 can handle up to 52 data files. It interfaces with the common I/O routines of the Record Manager with its five file organizations: sequential, direct access, indexed sequential, word addressable, and actual key. Control Data estimates that COBOL 4.0 can compile approximately 3000 source statements per second.

FORTRAN Extended: This compiler provides full ANS language compatibility plus optimization routines and a time-sharing option. Features include:

● Use of OCTAL and HOLLERITH data in language elements.

● Use of MASKING expression statements.

● Use of MASKING and MULTIPLE assignment statements.

● Two-branch ARITHMETIC and LOGICAL IF.

● Use of IMPLICIT and LEVEL specification statements.

● Various utility subprograms such as DUMP, TRACE, etc.

● PRINT, PUNCH, BUFFER IN, BUFFER OUT, NAMELIST, ENCODE, and DECODE input/output statements.

● A flexible subroutine structure that provides for mixed FORTRAN and COMPASS-coded routines, multiple entry points to subroutines, and return to one of several statements in the main program through multiple statements.

● Use of overlays to reduce the amount of storage required.

FORTRAN Extended interfaces with the common I/O routines of the Record Manager software.

ALGOL: A compiler for the ALGOL-60 language, with I/O procedures as defined in both the IFIP and ACM sets, is available for operation under NOS. NOS ALGOL 4 features interactive execution under TELEX, direct access to Extended Core Storage, linkages to subroutines coded in other languages, debugging and error recovery aids, and improved code optimization.

BASIC: The BASIC 2 compiler operates under NOS in either batch or interactive mode. The language is largely compatible with Dartmouth BASIC for the Honeywell G-200 Series computers; extensions include three-dimensional arrays, multiple assignment statements, file I/O, and improved diagnostics.

COMPASS: The standard symbolic assembly language for Cyber 170 computers, COMPASS can be used to prepare programs for either the Central Processor or Peripheral Processors. The language includes flexible macro facilities, pseudo-operations, and address-field expressions. The COMPASS 3 assembler runs under NOS and supports the Compare/Move instructions, permits assembly-time use of the Record Manager software for I/O, and provides extensions for object-program formatting.

QUERY UPDATE: This is a high-level English-like language that allows remote terminal users to query and manipulate mass storage files created under Record Manager organizations. QUERY UPDATE consults a user-supplied subschema (created by a Data Description Language) in accessing data from these files. Thus, the user needs no knowledge of the data structure involved. QUERY UPDATE provides many facilities normally associated with a high-level language, including use of arithmetic and Boolean expressions, subscripting, and performance of out-of-line procedures, which may be recorded as catalogued sessions. An extensive Report Writing facility is also available.

TOTAL DATA BASE MANAGEMENT SYSTEM: Total is a widely used data base management system, developed by Cincom Systems Inc., that embodies a network structure philosophy. Relationships from one file may be made on a direct basis to 2500 other files within the data base, using a chaining/threading scheme. Up to 65,000 files can be managed on an integrated basis within one data base. Total includes a Data Base Definition Language that is used to describe and declare the data base system, and a Data Manipulation Language that functions in conjunction with a host language, such as COBOL, ▶

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▶ FORTRAN, or COMPASS, at the CALL or MACRO level. Total is described in detail in Report 70E-132-01. The package can be leased for use on Cyber 170 systems for $1,000 per month or purchased (on a paid-up license basis) for $30,000.

UTILITY ROUTINES: Sort/Merge 4.0 provides an interface with the Record manager I/O routines under NOS and can execute in three modes: as a stand-alone program, as a subprogram called by macro instructions specified in a FORTRAN or COMPASS main program, or as part of an ANS COBOL program. It can be used for sort-only, merge-only, or sort-and-merge operations. A maximum of 100 sort keys per record can be handled, each of which can be specified for sequencing on either an ascending or descending basis. Standard collating sequences are by 6-bit display code, 6-bit internal BCD code, 6-bit ASCII code, or 6-bit COBOL code. Restart procedures permit restart dumps to be taken between each pass of intermediate merge phase processing or each time a specified number of input records is read into the sort phase.

The Network Operating System includes utility routines to handle diagnostic, loading, data transcription, data communications, and library maintenance functions.

APPLICATIONS PROGRAMS: Among the principal applications packages available for the Cyber 170 Series are:

    APT (numerical control)
    Math Science Library
    PERT/Time
    SIMSCRIPT (simulation language)
    SIMULA (simulation language)
    Seismic Data Processing

PRICING

EQUIPMENT: The following system configurations illustrate a few of the configuration possibilities within the Cyber 170 line. All necessary control units and adapters are included in the indicated prices. The quoted prices are for 1-year leases and include equipment maintenance.

MODEL 172 SYSTEM: Consists of 172-2 Central Computer with 32K words of main storage, 125K words of Extended Core Storage, 4-drive 844-21 Disk Storage Subsystem (472 million characters), eight 669-2 Magnetic Tape Transports (160 KC) and dual-channel controller, 1200-cpm card reader, 250-cpm card punch, and 1200-lpm printer. Monthly rental and purchase prices are approximately $29,800 and $1,313,350, respectively.

MODEL 173 SYSTEM: Same as Model 172 system above, with Model 173-4 Central Computer (65K words) replacing the 172-2. Monthly rental and purchase prices are approximately $42,700 and $1,694,350, respectively.

MODEL 174 SYSTEM: Consists of 174-4 Central Computer with 65K words of main storage, 503K words of Extended Core Storage, one 8-drive 844-41 Disk Storage Subsystem (1.89 billion characters), twelve 669-3 Magnetic Tape Transports (240 KC) and two dual-channel controllers, two 1200-cpm card readers, two 250-cpm card punches, and two 1200-lpm printers. Monthly rental

and purchase prices are approximately $76,100 and $2,940,000, respectively.

MODEL 175 SYSTEM: Same as 174 system above, with Model 175-8 Central Computer (131K words) replacing the 174-4. Monthly rental and purchase prices are approximately $110,423 and $4,427,000, respectively.

SOFTWARE: All Control Data software released after January 1, 1970, is separately licensed and priced to domestic commercial customers. All Cyber 170 systems, and all new Series 6000 and Cyber 70 systems ordered on or after July 1, 1974, have available "new" software products, including the Network Operating System, Scope 3.3, Scope 3.4, and Kronos 2.1. Each software product is licensed to a customer with a specific category of Control Data support, and the more comprehensive support categories naturally incur higher monthly royalties. Scope 3.4 and Kronos 2.1 are available for Series 6000 and Cyber 70 systems ordered before July 1, 1974, at significantly lower monthly royalties. Each separately priced product is licensed for a minimum of one year, and the license agreement can be terminated upon 90 days' notice thereafter. Each software license includes one copy of the associated documentation. Most software products are also available on a paid-up-license basis, for a fixed one-time charge.

SUPPORT: The services of Control Data analysts are available to Cyber 170 users at a price of $35 per hour or $1,220 per week, with a minimum charge of 3 hours per day for each analyst. Analyst services include systems analysis and design, application design and development, conversion and implementation planning, installation evaluation and improvement, major system modifications, installation of special utilities, etc. Installation and maintenance of standard Cyber 170 software products is included in the software license fees for users with Category I software support agreements. Comparable services are performed at the customer's expense for users with Category II software support agreements.

EDUCATION: All customer education and training courses (other than sales-oriented seminars and presentations) are provided by the Control Data Education Institutes and are separately priced. Most user-oriented Cyber 170 courses range from 2 to 5 days in length and cost from $105 to $300 per student.

CONTRACT TERMS: The standard Cyber 170 Series rental contract permits unlimited use of the equipment; there are no extra-use charges. Control Data maintenance service is separately priced.

LONG-TERM LEASES: The Commerical Credit/Control Data Computer Leasing Program offers flexible leases for 3- to 7-year periods. The basic lease plan covers a 3-year term, allows unlimited use, includes liberal substitution and add-on privileges, and is cancellable after 24 months upon 90 days' notice. The base 3-year lease price for a 65K Model 173 mainframe, for example, is $17,500, or nearly 10% lower than the standard 1-year monthly rental price of $19,400. Additional discounts from the base 3-year lease price are offered for longer lease terms (up to 7 years), for extensions of the non-cancellable period, and for payment of each year's rental in advance. ■

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental* (1-Year Lease)

PROCESSORS AND SEMICONDUCTOR STORAGE

Model 172	Central Computer; includes 10 PPU's, 12 I/O channels, system console, 2 Data Channel Converters, power and cooling equipment, and main memory as indicated			
172-2	1 CPU & 32,768 words	553,000	2,250	7,450
172-3	1 CPU & 49,152 words	612,000	2,375	8,675
172-4	1 CPU & 65,536 words	671,000	2,500	9,900
172-6	1 CPU & 98,304 words	789,000	2,750	12,350
172-8	1 CPU & 131,072 words	907,000	3,000	14,800
Model 173	Central Computer; includes 10 PPU's, 12 I/O channels, system console, 2 Data Channel Converters, power and cooling equipment, and main memory as indicated			
173-4	1 CPU & 65,536 words	934,000	3,500	19,400
173-6	1 CPU & 98,304 words	1,052,000	3,750	21,850
173-8	1 CPU & 131,072 words	1,170,000	4,000	24,300
173-12	1 CPU & 196,608 words	1,433,000	4,500	29,800
173-16	1 CPU & 262,144 words	1,696,000	5,000	35,300
Model 174	Central Computer; includes 10 PPU's, 12 I/O channels, system console, 2 Data Channel Converters, power and cooling equipment, and main memory as indicated			
174-4	1 CPU & 65,536 words	1,198,000	4,500	24,900
174-6	1 CPU & 98,304 words	1,316,000	4,750	27,350
174-8	1 CPU & 131,072 words	1,434,000	5,000	29,800
174-12	1 CPU & 196,608 words	1,697,000	5,500	35,300
174-16	1 CPU & 262,144 words	1,960,000	6,000	40,800
Model 175	Central Computer; includes 10 PPU's, 12 I/O channels, system console, 2 Data Channel Converters, power and cooling equipment, and main memory as indicated			
175-4	1 CPU & 65,536 words	2,390,000	7,051	49,800
175-6	1 CPU & 98,304 words	2,537,500	7,372	52,900
175-8	1 CPU & 131,072 words	2,685,000	7,693	56,000
175-12	1 CPU & 196,608 words	3,007,000	8,334	62,800
175-16	1 CPU & 262,144 words	3,329,000	8,975	69,800
	Model 173 & 174 PPU Upgrades:			
10314-1	Adds 4 PPU's (for total of 14) and 12 I/O channels (for total of 24)	74,000	420	1,540
10314-2	Adds 3 PPU's (for total of 17)	12,000	90	250
10314-3	Adds 3 PPU's (for total of 20)	12,000	90	250
	Model 175 PPU Upgrades:			
10314-51	Adds 4 PPU's (for total of 14) and 12 I/O channels (for total of 24)	74,000	420	1,540
10314-52	Adds 3 PPU's (for total of 17)	12,000	90	250
10314-53	Adds 3 PPU's (for total of 20)	12,000	90	250
	Main Memory Increments for Models 172, 173, & 174:			
10312-3	16,384 60-bit words (for 172-2)	59,000	125	1,225
10312-4	16,384 60-bit words (for 173-2)	59,000	125	1,225
10312-6	32,768 60-bit words (for 172-4, 173-4, & 174-4)	118,000	250	2,450
10312-8	32,768 60-bit words (for 172-6, 173-6, & 174-6)	118,000	250	2,450
10312-12	65,536 60-bit words (for 173-8 & 174-8)	263,000	500	5,500
10312-16	65,536 60-bit words (for 173-12 & 174-12)	263,000	500	5,500
	Main Memory Increments for Model 175:			
10313-6	32,768 60-bit words (for 175-4)	147,500	321	3,100
10313-8	32,768 60-bit words (for 175-6)	147,500	321	3,100
10313-12	65,536 60-bit words (for 175-8)	322,000	641	6,800
10313-14	65,536 60-bit words (for 175-12)	322,000	641	6,800
	Data Channel Converter for Models 172, 173, 174, & 175:			
10315-1	First additional Data Channel Converter	14,000	44	290
10315-2	Second additional Data Channel Converter	14,000	44	290
	Model Conversion for Models 172 & 173:			
10316-1	Model 172 to Model 173 conversion	263,000	1,000	9,500
10316-2	Model 173 to Model 174 conversion	264,000	1,000	5,500
10317-1	Model 173 Expansion (additional cabinet with power control)	0	0	0
	Extended Core Storage Coupler for Models 172, 173, 174, & 175:			
10318-1	ECS Coupler for Model 172, 173 & 174	0	0	0 0
10318-2	ECS Coupler for Model 175	0	0	0 0
	Extended Core Storage:			
7030-1	125,952 60-bit words	196,200	1,288	5,800
7030-2	251,904 60-bit words	319,400	1,703	9,560
7030-4	503,808 60-bit words	567,700	2,432	17,150
7030-8	1,007,616 60-bit words	1,085,300	3,512	32,960
7030-16	2,015,232 60-bit words	2,050,000	4,862	65,400

*Rental prices do not include equipment maintenance.

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-Year Lease)
MASS STORAGE				
844-21	Disk Storage Unit	28,000	100	550
844-41	Disk Storage Unit	35,000	110	760
7054-1	Mass Storage Controller (for 844-21)	90,000	290	1,710
7054-2	Mass Storage Controller (for 844-21)	126,000	350	2,250
7054-41	Mass Storage Controller (for 844-21 & 844-41)	93,500	290	1,790
7054-42	Mass Storage Controller (for 844-21 & 844-41)	129,500	350	2,330
10333-1	Mass Storage Controller Conversion (field-converts 7054-1/-2 to 7054-41/-42)	3,500	0	80
INPUT/OUTPUT UNITS				
657-1	Magnetic Tape Transport; 7.5/20.8/30 KC	17,890	76	320
657-2	Magnetic Tape Transport; 15/41.7/60 KC	29,150	125	430
657-3	Magnetic Tape Transport; 22.5/62.5/90 KC	36,970	146	670
657-4	Magnetic Tape Transport; 30/83.4/120 KC	46,640	157	810
659-1	Magnetic Tape Transport; 30/60 KC	18,550	87	325
659-2	Magnetic Tape Transport; 60/120 KC	26,235	119	460
659-3	Magnetic Tape Transport; 90/180 KC	38,160	157	685
659-4	Magnetic Tape Transport; 120/140 KC	43,885	168	810
667-2	Magnetic Tape Transport; 20/55.6/80 KC	18,500	115	305
667-3	Magnetic Tape Transport; 30/83.4/120 KC	23,500	125	405
667-4	Magnetic Tape Transport; 40/111.2/160 KC	26,250	140	450
669-2	Magnetic Tape Transport; 160/80 KC	19,250	115	315
669-3	Magnetic Tape Transport; 140/120 KC	24,250	125	425
669-4	Magnetic Tape Transport; 320/160 KC	27,000	140	470
3518-1	Magnetic Tape Controller; 1x8; for 657 drives only	32,860	152	560
3518-2	Magnetic Tape Controller; 1x8; for 657 and/or 659 drives at 200, 556, or 800 bpi only	39,355	179	690
3518-3	Magnetic Tape Controller; 1x8; for 657 and/or 659 drives at 200, 556, or 800 or 1600 bpi	46,640	195	855
3528-1	Magnetic Tape Controller; 2x8; for 657 drives only	53,000	303	1,065
3528-2	Magnetic Tape Controller; 2x8; for 657 and/or 659 drives at 200, 556, or 800 bpi only	61,480	308	1,160
3528-3	Magnetic Tape Controller; 2x8; for 657 and/or 659 drives at 200, 556, 800, or 1600 bpi	69,960	314	1,260
7021-1	Magnetic Tape Controller; 1x8; for 667 and/or 669 drives at 200, 556, 800, or 1600 bpi	27,500	130	555
7021-2	Magnetic Tape Controller; 2x8; for 667 and/or 669 drives at 200, 556, 800, or 1600 bpi	60,500	270	1,380
405	Card Reader; 1200 cpm	24,910	71	370
3447-2	Card Reader Controller	14,820	67	220
415-30	Card Punch and Controller; 250 cpm	46,620	141	725
580-12	Train Printer Subsystem; 1200 lpm	58,000	280	1,260
580-16	Train Printer Subsystem; 1600 lpm	79,950	345	1,645
580-20	Train Printer Subsystem; 2000 lpm	92,200	410	1,880
596-01	Train Cartridge; 64 chars. (for 580-XX)	3,300	30	80
596-02	Train Cartridge; 48 chars. (for 580-XX)	3,300	30	80
596-03	Train Cartridge; 48 chars. (for 580-XX)	3,300	30	80
596-04	Train Cartridge; 64 chars. (for 580-XX)	3,300	30	80
596-05	Train Cartridge; 64 chars. (for 580-XX)	3,300	30	80
596-06	Train Cartridge; 96 chars. (for 580-XX)	3,300	30	80
512-1	Line Printer; 1200 lpm	47,700	243	780
595	Train Cartridge (for 512-1)	3,180	0	105
3555-1	Line Printer Controller; for 512-1	28,620	49	605
7012-1	Second Console (single CRT plus typewriter)	19,000	70	395
COMMUNICATIONS EQUIPMENT				
2550-1	Host Communications Processor (2 to 32 lines, expandable to 64 lines; includes 24K words of memory, expandable to 32K words)	40,400	417	970
2550-2	Host Communications Processor (2 to 32 lines, expandable to 128 lines; includes 32K words of memory, expandable to 65K words)	53,000	577	1,250
2552-1	Host Communications Processor (2 to 32 lines, expandable to 256 lines; includes 32K words of memory, expandable to 128K words)	74,200	705	1,750
2554-8	Memory Expansion Module (8,192 words; for 2550-1/-2 and 2552-1)	3,200	38	80
2556-2	Communications Line Expansion (33 to 64 lines; for 2550-1/2-2 and 2552-1)	3,520	32	88
2556-3	Communications Line Expansion (65 to 96 lines; for 2550-1/-2 and 2552-1)	3,520	32	88
2556-4	Communications Line Expansion (97 to 128 lines; for 2550-1/-2 and 2552-1)	3,520	32	88
2558-1	Communications Coupler (additional; couples Host Communications Processor to second Cyber 70/170 or 6000 Series computer)	3,520	38	88

*Rental prices do not include equipment maintenance.

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-Year Lease)
2560-1	Communications Line Adapter—Synchronous (for 2 lines at up to 10,800 bps)	725	6	22
2560-2	Communications Line Adapter—Synchronous (for 2 lines at up to 50,000 bps)	725	6	22
2560-3	Communications Line Adapter—Synchronous (for 2 lines at up to 9600 bps)	725	6	22
2561-1	Communications Line Adapter—Asynchronous (for 2 lines at up to 9600 bps)	625	6	20
2562-1	Time-Division Multiplexer Line Adapter	5,000	47	125
2570-1	Line Printer, 300 lpm (for 2550-1/-2 and 2552-1)	17,000	192	370
2570-2	Line Printer, 1200 lpm (for 2550-1/-2 and 2552-1)	50,000	436	1,460
2572-1	Card Reader, 300 cpm (for 2550-1/-2 and 2552-1)	6,000	58	170
2572-2	Card Reader, 600 cpm (for 2550-1/-2 and 2552-1)	8,000	71	230

SOFTWARE PRICES

		Category	Initial Fee	Monthly Royalty	Paid-Up License
NOS 1 SOFTWARE (FOR MODELS 172, 173, 174, & 175)					
F501-01	Network Operating System, including NOS 1, COMPASS 3, and Record Manager 1 (requires F501-02)	I	4,750	3,900	NA
		II	4,750	1,800	85,750
F501-02	Maintenance Package, including Modify 1 and Update 2	III	0	0	0
F501-03	Time-Sharing Module 1	I	0	1,700	NA
		II	0	1,200	54,000
F501-04	Tranex 1 (requires F501-03)	I	0	2,200	NA
		II	0	1,500	67,500
F501-05	Multi-Mainframe Module 1	I	0	750	NA
		II	0	500	22,500
F501-06	Network Access Methods 1	I	NA	NA	NA
		II	0	0	0
F501-07	Conversion Aids Subsystem 1	I	0	150	NA
		II	0	100	4,500
F501-08	High-Speed Batch Subsystem 1	I	0	500	NA
		II	0	300	13,500
F501-09	Cyberlink 1	III	0	100	4,500
F501-10	Query Update 2 (requires F501-11)	I	0	400	NA
		II	0	250	11,250
F501-11	DDL 1	I	0	50	NA
		II	0	50	2,250
F501-12	FORTRAN Extended 4, including Interactive Option	I	0	600	NA
		II	0	375	16,875
F501-13	COBOL 4	I	0	600	NA
		II	0	375	16,875
F501-14	Sort/Merge 4	I	0	150	NA
		II	0	100	4,500
F501-15	ALGOL-60 4	I	0	600	NA
		II	0	375	16,875
F501-16	APL 1	I	500	600	NA
		II	500	325	17,375
F501-17	Interactive BASIC 2	I	0	500	NA
		II	0	300	13,500
F501-18	SIMULA 1	I	0	300	NA
		II	0	200	9,000
F501-19	SIMSCRIPT 3	II	500	350	16,250
F501-20	PERT/Time 1	I	0	0	N/A
F501-21	Export/Import-200 1	I	0	0	0
		II	0	0	0
F501-22	Math Science Library 1	II	450	450	20,750
F501-23	1700 MSOS Import 1 (requires F501-08)	I	0	50	NA
		II	0	50	2,250
F501-24	Communication Control Program 1 (2250 operations software; requires F501-06; requires F501-12 and F501-25 for maintenance)	I	500	200	NA
		II	500	0	500
F501-25	CCP Support Software 1	I	500	250	NA
		II	500	250	9,500
F501-26	Remote Job Entry Facility 1 (requires F501-06)	I	0	300	NA
		II	0	200	9,000
F501-27	Compiler Package; includes FORTRAN Extended 4, COBOL 4, ALGOL-60 4, BASIC 2, and APL 1	I	500	2,320	NA
		II	500	1,740	78,800
F501-28	TOTAL 1 Data Base Management System; includes a data base definition language and a data manipulation language which functions with COBOL, FORTRAN, and COMPASS	II	1,000	1,000	30,000
KRONOS 2.1 SOFTWARE (FOR CYBER 70 AND SERIES 6000, NEW SYSTEMS ONLY)					
F411-01	KRONOS 2.1 Time-Sharing Operating System, including KRONOS 2.1, COMPASS 3, Record Manager 1, and KRONOS Export/Import 200 1 requires F411-02)	I	4,750	3,900	NA
		II	4,750	1,800	85,750

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SOFTWARE PRICES

		Cate-gory	Initial Fee	Monthly Royalty	Paid-Up License
F411-02	Maintenance Package	III	0	0	0
F411-03	Interactive BASIC 2	I	0	500	NA
		II	0	300	13,500
F411-04	Interactive FORTRAN 1	I	0	500	NA
		II	0	300	13,500
F411-05	FORTRAN Extended 4	I	0	600	NA
		II	0	375	16,875
F411-06	COBOL 4	I	0	600	NA
		II	0	375	16,875
F411-07	Sort/Merge 4	I	0	150	NA
		II	0	100	4,500
F411-08	ALGOL-60 4	I	0	600	NA
		II	0	375	16,875
F411-09	SIMSCRIPT 3	II	500	350	16,250
F411-10	SIMULA 1	II	0	200	9,000
F411-11	PERT/Time 1	II	0	0	0
F411-12	Cyberlink 1	III	0	100	4,500
F411-13	APL Package 1	I	500	600	NA
		II	500	375	17,375
F411-14	Tranex 1	I	0	2,200	NA
		II	0	1,500	67,500
F411-15	Math Science Library 1	II	450	450	20,750
F411-16	Time-Sharing Module 1	I	0	1,700	NA
		II	0	1,200	54,000
F411-17	Compiler Package 1, including Interactive FORTRAN 1, FORTRAN Extended 4, COBOL 4, ALGOL-60 3, BASIC 2, and APL 1	I	500	2,720	NA
		II	500	1,980	89,600
F411-18	ALGOL-60 3	I	0	600	NA
		II	0	375	16,875

SCOPE 3.4 SOFTWARE (FOR CYBER 70 AND SERIES 6000, NEW SYSTEMS ONLY)

		Cate-gory	Initial Fee	Monthly Royalty	Paid-Up License
F312-01	SCOPE 3.4 Package, including SCOPE 3.4, COMPASS 3, 6RM 1, and FORM 1 (requires F312-02)	I	4,750	5,600	NA
		II	4,750	3,500	162,250
F312-02	Maintenance Package	III	0	0	0
F312-03	FORTRAN Extended 4	I	0	600	NA
		II	0	375	16,875
F312-04	COBOL 4	I	0	600	NA
		II	0	375	16,875
F312-05	Sort/Merge 4	I	0	150	NA
		II	0	100	4,500
F312-06	PL/1	I	500	600	NA
		II	500	375	17,375
F312-07	Intercom 4	I	0	1,200	NA
		II	0	1,000	45,000
F312-08	PERT/Time 1	I	0	0	NA
		II	0	0	0
F312-09	8231 Import High-Speed 1	III	0	0	0
F312-10	1700 Import High-Speed 1	III	0	0	0
F312-11	BASIC 2	I	0	500	NA
		II	0	300	13,500
F312-12	SIMULA 1	I	0	300	NA
		II	0	200	9,000
F312-13	1700 MSOS Import High-Speed 1	I	0	150	NA
		II	0	50	2,250
F312-14	1700 Interactive Graphic Import-274 2	I	0	100	NA
		II	0	50	2,250
F312-15	Math Science Library 1	II	450	450	20,700
F312-16	MARS VI 2	I	0	1,200	NA
		II	0	800	36,000
F312-17	Interactive Graphics-241 2	II	0	200	9,000
F312-18	241 Graphics Subsystem Resident 2	II	0	50	2,250
F312-19	SIMSCRIPT 3	II	500	350	16,250
F312-20	APEX-II 1	II	6,000	1,150	57,750
F312-21	APEX-I 1	II	0	350	15,750
F312-22	CDC Command 1	III	700	150	7,450
F312-23	CBM 1	III	700	200	9,700
F312-24	APT IV 1	II	500	250	11,750
F312-25	Conversion Aids System 1	I	0	150	NA
		II	0	100	4,500
F312-26	Query Update 2	I	0	400	NA
		II	0	250	11,250
F312-27	DDL 1	I	0	100	NA
		II	0	50	2,250

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SOFTWARE PRICES

		Category	Initial Fee	Monthly Royalty	Paid-Up License
F312-28	ALGOL-60 4	I	0	600	NA
		II	0	375	16,875
F312-29	Multi-Mainframe Capability 1	I	500	1,200	NA
		II	500	1,000	45,500
F312-30	GPSS-V 1	II	0	150	6,750
F312-31	Compiler Package 1, including FORTRAN Extended 4, COBOL 4, ALGOL-60 4, and BASIC 2	I	0	1,840	NA
		II	0	1,200	54,000
F312-32	Communication Control Program 1 (2250 operations software; requires F312-08; requires F3-1203 and F312-34 for maintenance)	I	250	100	NA
		II	500	0	500
F312-33	CCP Support Software 1	I	500	250	NA
		II	500	200	9,500

KRONOS 2.1 SOFTWARE (FOR INSTALLED BASE ONLY)

		Category	Initial Fee	Monthly Royalty	Paid-Up License
F403-01	KRONOS 2.1 Time-Sharing Operating System, including KRONOS 2.1, COMPASS 3, 6RM 1, SIS 2, SDA 1, and KRONOS Export/Import 200 1 (requires F403-02)	I	4,750	1,000	—
F403-02	Maintenance Package 1	III	0	0	—
F403-03	Interactive BASIC 2	I	0	0	—
F403-04	Interactive FORTRAN 1	I	0	250	—
F403-05	FORTRAN 2	I	0	0	—
F403-06	FORTRAN Extended 4	I	0	250	—
F403-07	COBOL 4	I	0	250	—
F403-08	Sort/Merge 4	I	0	50	—
F403-09	ALGOL-60 3	II	0	250	—
F403-10	SIMSCRIPT 3	II	500	350	—
F403-11	SIMULA 1	II	0	200	—
F403-12	PERT/TIME	II	0	0	—
F403-13	Cyberlink 1	III	0	100	—
F403-14	APL Package 1	I	500	250	—
F403-15	Tranex 1	I	0	300	—
F403-17	Math Science Library 1	II	450	450	—

SCOPE 3.4 SOFTWARE (FOR INSTALLED BASE ONLY)

		Category	Initial Fee	Monthly Royalty	Paid-Up License
F303-01	SCOPE 3.4 Package, including SCOPE 3.4, COMPASS 3, SAAM 1, and FORM 1 (requires F303-02)	I	0	250	—
F303-02	Maintenance Package	III	0	0	—
F303-04	FORTRAN Extended 4	I	0	250	—
F303-05	COBOL 4	I	0	250	—
F303-06	Sort/Merge 4	I	0	50	—
F303-08	Query/Update 1	I	0	100	—
F303-09	Intercom 4	I	0	200	—
F303-10	PERT/Time 1	I	0	0	—
F303-12	8231 Import High-Speed 1	I	0	0	—
F303-13	1700 Import High-Speed 1	I	0	0	—
F303-14	APT 2	III	0	0	—
F303-15	BASIC 2	I	0	0	—
F303-16	ALGOL-60 3	I	0	250	—
F303-17	SIMULA 1	I	0	200	—
F303-18	1700 MOS Import High-Speed 1	I	0	50	—
F303-20	1700 Interactive Graphic Import-274 2	I	0	30	—
F303-21	FORTRAN 2	I	0	0	—
F303-22	Math Science Library 1	II	450	450	—
F303-23	MARS VI 2	I	0	600	—
F303-27	Interactive Graphics-241 2 (requires F303-09 and F303-28)	II	0	100	—
F303-28	241 Graphics Subsystem Resident 2	II	0	20	—
F303-29	SIMSCRIPT 3	II	500	350	—
F303-32	APEX II Package 1	II	6,000	1,500	—
F303-34	CDC Command 1 Package	III	700	150	—
F303-35	CBM 1 Package	III	700	200	—
F303-36	APT IV 1	II	500	250	—
F303-38	Conversion Aids System 1	II	0	0	—
F303-39	Query/Update 2; includes Report Extractor which operates independently of DDL 1	I	0	300	—
F303-40	DDL 1	I	0	50	—
F303-41	ALGOL-60 4	I	0	250	—