Rev 6/78

NCR Criterion Series

MANAGEMENT SUMMARY

In April 1976, NCR introduced the first two models of the Criterion Series computers, the Criterion 8550 and 8570. The two initial models span the performance range of the NCR Century 200, 201, and 251 and extend beyond the range of the Century 300. The Criterion 8550 is specifically designed to compete against the IBM 370/115 and 370/125, the Univac 90/30, the larger members of the Burroughs B 1700 family, and the Honeywell Level 62 and 64 systems. The Criterion 8570 is designed as competition for the IBM 370/125 and 370/135, the Honeywell Level 64 and 66, and the Burroughs B 2800 and B 3800 systems.

While the system architecture of the Criterion Series is completely different from that of the Century Series, the users of NCR's current installed base of more than 5000 Century computers will be happy to know that their systems are fully hardware and software compatible with the new Criterion systems. A basic ground rule followed by NCR when designing the Criterion Series was full compatibility with existing Century software and user programs. The product strategy was to introduce new hardware that would run existing software, and subsequently to introduce new software as a second step. The company felt that this approach would provide the easiest migration path possible for both the user and NCR. As a result of this approach, user programs written for use on Century series computers do not have to be recompiled, Century files do not have to be restructured, and most of the peripheral equipment used with Century systems can be used with Criterion systems as well.

SYSTEM ARCHITECTURE

In designing the Criterion Series computers, NCR's appraoch was to marry the latest technologies in ➢

NCR's new Criterion Series computers are unusually flexible systems that incorporate a host of "fourth generation" design features. Upward-compatible with the earlier NCR Century Series, these systems make extensive use of firmware. The hardware architecture is based on an Internal Transfer Bus of the type found in many minicomputer systems.

CHARACTERISTICS

MANUFACTURER: NCR Corporation, Dayton, Ohio 45479. Telephone (513) 449-2000.

MODELS: NCR Criterion 8550 and 8570 Computer Systems.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 1 or 2 BCD digits (in unpacked or packed format, respectively), or 8 binary bits. Four consecutive bytes form a "word."

FIXED-POINT OPERANDS: Can range from 1 to 256 bytes in length, in either decimal or binary mode. A "word binary" mode is available that takes particular advantage of the system's 4-byte adders; each 4-byte word is treated as a signed 31-bit integer.

FLOATING-POINT OPERANDS: Consist of a 7-bit hexadecimal exponent and a 24-bit fraction (in "short" or "long" format, respectively).

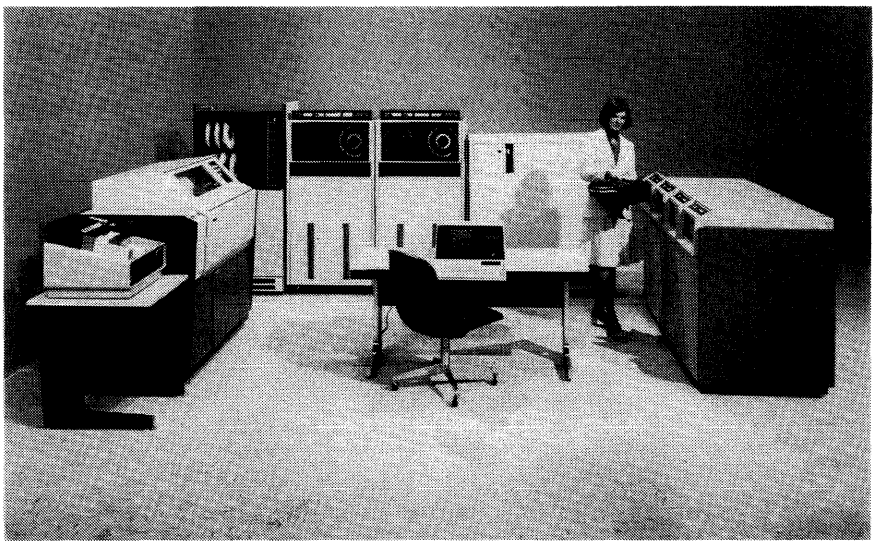
INSTRUCTIONS: 4 or 8 bytes in length, specifying 1 or 2 memory addresses, respectively.

INTERNAL CODE: ASCII.

MAIN STORAGE

STORAGE TYPE: Metal oxide semiconductor (MOS).

CAPACITY: The Criterion 8550 utilizes one integrated memory subsystem that ranges from 128K bytes to 512K ➢



This Criterion 8570 installation includes NCR's new 6590 Data Module Disc Units (at right), which use "Winchester-style" heads-in-pack technology to provide 35 million or 70 million bytes of data storage per module.

NCR Criterion Series

hardware, firmware, and software. Rather than striving for technical innovation, as they did when they developed the thin-film, short-rod main memory used in the Century Series, the company's design engineers set out to develop a unified architecture embodying many of the latest techniques that have been proven and have matured in other systems. As a result, the Criterion Series is the first to combine all of the following state-of-the-art features in a single system:

- Extensive use of ECL circuitry.
- MOS memory with error correction on 4K chips that can be expanded to 1 million bytes within the same mainframe.
- An extremely fast "pipeline" processor that cycles at speeds up to 56 nanoseconds.
- Multiple virtual storage, which provides up to 16 million bytes of virtual memory per program.
- A dedicated service processor to manage operating control and act as the diagnostic control center.
- Direct memory access by high-speed peripherals.
- Three levels of diagnostics, which automatically check components and isolate functions. A remote diagnostic capability can link NCR diagnosticians to a user's system.
- On-line program development to simplify application programming.
- An additional miniprocessor that serves as an intelligent disc interface, plus multiple microprocessors for low-cost communications interfacing.

The hardware architecture of the Criterion series is based upon a highly flexible Internal Transfer Bus (ITB) of the type found in many current minicomputer systems. The ITB is a very high-speed (72 million bytes per second) data path across which all Criterion subsystems communicate with one another, including the Main Processor, the Service Processor, the Memory Subsystems, the Common Trunk Subsystems, and the Integrated Disc Controller. The main advantage of the bus architecture is its flexibility. New hardware can be designed in the form of a subsystem that fits on the bus, interfacing through a Local Bus Adapter (LBA); thus, architectural extensions such as multiple processors, new I/O subsystems, and new integrated controllers are possible.

The use of firmware in the Criterion systems is a major departure from the NCR Century architecture. Firmware is really a form of programmable hardware. In the Criterion systems, a microprogrammable processor executes firmware, most of which is stored in a high-speed memory called the Instruction Storage Unit (ISU) or "control store." The control store in the Criterion system

bytes, in increments of 64K bytes. The Criterion 8570 utilizes two integrated memory subsystems with a combined range of 256K bytes to 1 million bytes, in increments of 128K bytes. Although there are two integrated memory subsystems in the Criterion 8570, they are treated as one functional unit.

CYCLE TIME: See table. In the Criterion 8570, word addresses are interleaved among the two memory subsystems. One subsystem contains all even addresses and the other contains all odd addresses. This technique allows two separate subsystems to alternately access the two integrated memory subsystems at the same time.

CHECKING: All data paths between the central processor and main storage are parity-checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. When the data is retrieved, single-bit errors are detected and corrected automatically, and most multiple-bit errors are detected and signaled so that appropriate program action can be taken.

STORAGE PROTECTION: Provided by multiple base address and limit registers. For each active program, one base address register (BAR) and one limit address register (LAR) define the lower and upper address limits of main storage that can be accessed.

CENTRAL PROCESSOR

The Criterion Central Processing Unit consists of the Internal Transfer Bus (ITB), the Main Processor, and the Service Processor.

The Main Processor is designed for fast interpretation and execution of object programs by firmware. The firmware is executed out of a high-speed control store, which operates at the same cycle time as the Main Processor: 112 nanoseconds for the Model 8550 or 56 nanoseconds for the 8570. Through the use of a "pipeline," firmware instructions are executed at the effective speed of one instruction per processor cycle. The pipeline consists of three phases of instruction processing: fetch, interpretation, and execution. Each phase requires one processor cycle, but the pipeline is designed so that three firmware instructions are processed in parallel, one in each phase.

The Service Processor operates in parallel with the main processor, and is concerned primarily with input/output control and diagnostics. It controls and drives the card reader, flexible disk, console CRT, and any hard-copy console devices. It also performs the firmware load function, in which firmware is read from the flexible disk and distributed to each firmware-driven subsystem, and controls the integrated communications option.

The Service Processor has primary responsibility for error control and system diagnostics, including a start-of-day diagnostic which is run as part of the initial firmware load process. If a malfunction occurs in the system, the Service Processor provides the tools for detection and isolation of the problem.

The Internal Transfer Bus is the focal point of the Criterion system architecture. The ITB is a very high-speed data path (72 million bytes per second) that serves as the medium for intercommunication among all the Criterion subsystems, including the Main Processor, the Service Processor, the Memory Subsystem, the Common Trunk Subsystem, and the Integrated Disk Controller.

INDEX REGISTERS: A separate set of 63 index registers is maintained in reserved storage for each active program. The index registers are normally accessed relative to the contents of the BAR. By convention, all but 27 of the 63 registers are reserved for system software use.

INDIRECT ADDRESSING: Up to five levels of indirect addressing can be used, and indirect addressing can be combined with indexing.

INSTRUCTION REPERTOIRE: There are 71 instructions available, all standard. The class breakdown and number of instructions within each class are as follows:

NCR Criterion Series

CHARACTERISTICS OF THE CRITERION SYSTEMS

	Criterion 8550	Criterion 8570
SYSTEM CHARACTERISTICS		
Maximum no. of processors supported by standard software	1	1
Operating systems	RS, VRX	RS, VRX
Basic system rental, per month	$5,900	$10,300
MAIN STORAGE		
Read/write cycle time	475 nanoseconds	475 nanoseconds
Bytes accessed per cycle	4	4
Minimum capacity, bytes	128K	256K
Maximum capacity, bytes	512K	1024K
Storage increment size, bytes	64K	128K
Main storage type	MOS	MOS
Interleaving	None	2-way
Storage protection	Standard	Standard
Minimum control store (ISU)	8K bytes	10K bytes
Maximum control store (ISU)	24K bytes	24K bytes
CENTRAL PROCESSOR		
Machine cycle time, nanoseconds	112	56
No. of hardware instructions	71	71
Index registers	63 for each active program	63 for each active program
Maximum no. of interrupts	16	16
High-speed floating-point	Optional	Optional
Decimal instructions	9	9
Divide hardware	Standard	Standard
Indirect addressing	5 levels	5 levels
Instruction times (fixed-point decimal, in microseconds):		
Add, unsigned, unpacked (10 digits)	13.38	8.59
Add, signed, packed (10 digits)	14.06	8.98
Multiply, signed, packed (10 digits)	27.83	15.43
I/O CONTROL		
Standard no. of trunks	2	3
Maximum no. of trunks	4	6
Common trunk transmission rates, bytes/sec:		
Low-speed trunks	50 KB	100 KB
Medium-speed trunk	150 KB	315 KB
Very high-speed trunks	1018 KB	1149 KB

is a "writeable control store," and is loaded with the required firmware from a flexible disk. Because the firmware can be tailored to perform exactly the required functions, one processor can be used for a variety of different functions.

Until loaded with firmware, the Criterion is a "faceless" computer. Only after being firmware-loaded does the hardware acquire a specific set of attributes. Where the firmware interfaces directly with software, it takes the form of what NCR calls a "virtual machine," defined simply as a machine, implemented in firmware, which executes software. A particular virtual machine may be designed to execute existing programs in the same manner as an existing machine, as in the case of the Criterion real-storage (RS) firmware, which duplicates an NCR Century computer and runs the existing B1, B2, and B3 operating system software; or it may take the form of a new machine designed to match the needs of new software or to reflect the attributes of a specific programming language. In the latter case, firmware enables the virtual machine to be designed to execute instructions much more like those of the source language

Decimal Arithmetic: 10 instructions for adding, subtracting, multiplying, dividing, and comparing signed, packed BCD fields; for adding and subtracting unsigned, unpacked BCD fields; and for packing and unpacking BCD fields.

Fixed-Point Binary: 10 instructions for adding, subtracting, multiplying, dividing, and shifting word-oriented (4-byte) binary operands; for adding, subtracting, and comparing variable-length binary fields; and for performing binary-to-decimal and decimal-to-binary conversions.

Floating-Point: 12 instructions for adding, subtracting, multiplying, dividing, and comparing floating-point operands in both short (1-word) and long (2-word) formats.

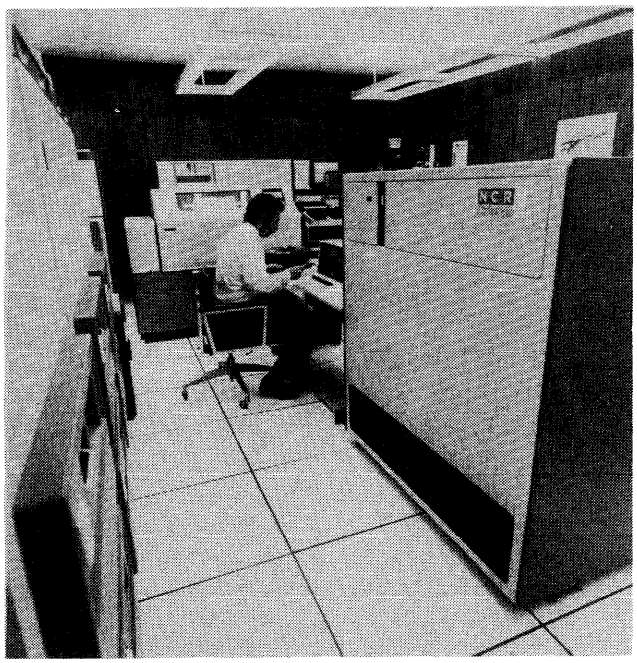
Data Movement: 3 instructions for internal data transfer operations.

Logical: 8 instructions for editing, scanning, code translation, and Boolean operations.

Transfer: 13 instructions for testing, branching, and counting.

Special: 15 instructions for various hardware functions such as input/output, loading base and limit address registers, repeating an instruction, setting up trace/monitor conditions, handling interrupts, etc.

NCR Criterion Series



The Criterion 8550, designed to compete against systems such as the IBM 370/115 and 370/125, offers from 128K to 512K bytes of MOS main memory with a cycle time of 475 nanoseconds per 4-byte access. The microprogrammed CPU has a 112-nanosecond machine cycle time.

than was previously feasible with hard-wired logic. Virtual machine commands may correspond nearly one-for-one with the verbs of the higher-level language, as is the case with the Criterion COBOL virtual machine. The result should be greatly improved performance for COBOL programs.

The Criterion virtual-storage (VS) firmware includes the COBOL virtual machine as well as a virtual machine designed to match the needs of the new Virtual Resource Executive (VRX) operating system software. These two virtual machines—COBOL and VRX—reside together in the firmware control store and are executed concurrently as required by the software, thus providing multiple virtual machine operation. The switching between virtual machines is performed by a firmware routine, and does not require any control store loading process or program awareness while the switching is occurring.

Several subsystems on the ITB are firmware-driven, including the Main Processor, the Service Processor, the Integrated Communications Module, and the Integrated Disk Controller. Each of these subsystems has firmware loaded into its writeable control store as part of the start-of-day procedure, under control of the Service Processor.

The Main Processor is designed for fast interpretation and execution of object programs by firmware. The firmware

INSTRUCTION EXECUTION TIMES: See table.

INTERRUPTS: See table.

INSTRUCTION STORAGE UNIT: In Criterion Series computers, most of the firmware that directs the system to perform the required functions (i.e., to function as a Century system, a Criterion system, or a COBOL virtual machine), is stored in a high-speed memory which NCR calls the Instruction Storage Unit (ISU) or writeable control store. In the 8550 the minimum ISU size is 8K bytes, the maximum 24K bytes. In the 8570 the minimum is 10K bytes, the maximum 24K bytes.

The firmware for the RS1 and VS1 systems is not totally contained in the control store. NCR breaks the firmware set into three classes according to frequency of use, and only the first two classes (most frequently used instructions) are stored in the ISU. In the 8550 the total amount of firmware required using RS1 is 25K bytes, of which 8K is stored in the ISU and 17K in main memory; and using VS1 the total firmware requirement is 48K, of which 24K is stored in the ISU and 24K in main memory. In the 8570 the total amount of firmware required for RS1 is 25K bytes, of which 10K is stored in the ISU and 15K in main memory; and using VS1 the total requirement is 48K, of which 24K is stored in the ISU and 24K in main memory.

TIME OF DAY CLOCK: Used by the software for such functions as providing time indication for operator messages and timing program runs by logging the starting and ending times of program execution. The Time of Day Clock is accessed by addressing main memory location (hex) 108. The 32-bit contents of the word at this location are incremented every millisecond. The contents are decoded by software to arrive at the actual time of day.

INTERVAL TIMER: Provides the operating system with the ability to interrupt a program after the specified number of milliseconds. Thus, in a multiprogramming environment, the Interval Timer prevents any program from using more of the Main Processor time than specified. By doing this, the timer also detects and prevents program loops.

INPUT/OUTPUT CONTROLS

I/O CHANNELS: See Table.

The Criterion 8550 operates with a minimum configuration of two common trunk subsystems, each with eight I/O positions. The basic common trunk configuration consists of one low-speed trunk and one very high-speed trunk. Additional trunks, including a medium-speed (150KB) trunk, are optional. The permitted trunk configurations for the 8550 are shown in the following table.

Low-Speed	Medium-Speed	Very High-Speed	Total
1	0	1	2
1	1	1	3
2	0	1	3
1	0	2	3
1	0	3	4
1	1	2	4
2	1	1	4
2	0	2	4

For the 8550 the maximum low-speed trunk data transfer rate is 50K bytes/second, the medium-speed transfer rate is 150K bytes/second, and the very high-speed transfer rate is 1018K bytes/second.

The Criterion 8570 operates with a minimum configuration of three common trunk subsystems, each with eight I/O positions. The basic common trunk configuration consists of one low-speed, one medium-speed, and one very high-speed trunk. Additional trunks are optional. The permitted trunk configurations for the 8570 are shown in the following table.

executes out of a high-speed control store that has the same cycle time as the main processor: 112 nanoseconds for the 8550 and 56 nanoseconds for the 8570. Through the use of a pipeline, firmware instructions are executed effectively at the speed of one instruction per processor cycle.

The Service Processor operates in parallel with the Main Processor, and is concerned primarily with input/output control and diagnostics (including a start-of-day diagnostic which is run as part of the initial firmware loading process) and with control of the integrated communications subsystem. Should a malfunction occur in the system, the Service Processor provides the tools for isolation and detection of the problem.

The Criterion 8550 and 8570 systems can use most of the peripheral devices that were available with the Century systems. In addition to these, four new peripherals were introduced with the Criterion systems: a 600-card/minute card reader, a 173-characters/second matrix printer, a 1000-characters/second paper tape reader, and a Winchester-style disc unit that uses removable 35- or 70-megabyte data modules.

SOFTWARE

Using real-storage firmware, the NCR Criterion functions as a Century system that runs existing B-series software and user programs. With virtual-storage firmware, it operates under control of the VRX operating system and functions as a virtual storage system.

The B-series software offered with the Criterion systems is the most current release and is already in operation at Criterion installations. The B1, B2, and B3 operating systems are available to Criterion users, together with a full set of Century B-series compilers, utilities, and application programs. Current NCR Century applications can be transferred directly to Criterion systems without recoding, recompiling, or restructuring files.

Customer Operated Automatic Checkout (COACH) diagnostics, capable of isolating hardware problems to a faulty module, are also available to Criterion users. COACH enables the user to provide advanced information to the NCR field engineer concerning the nature of the problem prior to his arrival at the site. A more comprehensive set of diagnostic programs is available to the NCR field engineer for in-depth fault isolation. This on-site diagnostic capability is further enhanced by the use of a remote system console that can, via telephone, connect NCR specialists to the customer's Criterion system for even greater levels of diagnosis and analysis.

Virtual storage will be introduced with the VS firmware and the Virtual Resource Executive (VRX) operating system. Under VRX the Criterion user will effectively have 16 million bytes of storage available to each program, whether his actual hardware configuration includes 384K bytes or 1 million bytes of main memory.

Low-Speed	Medium-Speed	Very High-Speed	Total
1	1	1	3
2	1	1	4
1	1	2	4
2	1	2	5
1	1	3	5
1	1	4	6
2	1	3	6

For the 8570 the maximum low-speed trunk data transfer rate is 100K bytes/second, the medium-speed transfer rate is 315K bytes/second, and the very high-speed transfer rate is 1149K bytes/second.

The Criterion low-speed common trunk subsystem interfaces with the internal transfer subsystem. Any peripheral unit with a transfer rate that does not exceed the transfer rate of the low-speed trunk can be connected to the Criterion through the common trunk. If the system configuration includes two low-speed trunks, the peripheral units assigned to the two trunks should not have a combined bandwidth which exceeds the common trunk transfer rate.

The medium-speed common trunk subsystem is an optional feature of the Criterion 8550 and is standard on the 8570. Peripheral units which have transfer rates greater than the low-speed common trunk upper limits and less than the medium-speed upper limits can be assigned to the medium-speed common trunk.

Peripheral units capable of transferring data at very high rates are assigned to the very high-speed common trunk. Data handled by the very high-speed common trunk is transferred directly into main memory.

I/O DATA RATES: See table or preceding paragraphs.

MASS STORAGE

656-401 DISC SUBSYSTEM: Each 656-401 disc unit accommodates two recording discs: one optional fixed disc and one removable 956-1 disc pack. Each disc (fixed and removable) has a data storage capacity of 4.98 million bytes, providing a total data capacity of 9.96 million bytes per disc unit. The 656-401 disc unit uses the "master/satellite" technique of operation; that is, a master unit (one containing the disc controller) may control itself and one satellite (a 656-401 unit not containing a controller). Both versions are housed in identical low-profile cabinets.

Each disc pack used with the 656-401 disc unit contains 406 cylinders, with a total of 812 tracks. A track is divided into 12 sectors of equal length (9744 sectors per recording disc), with each sector containing one address area and one data area, separated by a gap. The address areas and separation gaps contain the information used by the disc unit to locate specific data areas on a track. The data areas are 512 bytes in length, and each disc pack has a capacity of 4,988,928 data bytes.

The 656-401 Disc Subsystem has a head movement time ranging from 10 to 70 milliseconds and averaging 35 milliseconds. Average rotational delay is 12.5 milliseconds, and data transfer rate is 312,500 bytes per second.

657-101/102 DISC SUBSYSTEM: Provides medium-capacity random-access storage in removable 11-high disc packs. Each NCR 957-1 disc pack stores up to 29.8 million bytes of data in standard-density format or up to 47.7 million bytes in "dual-density" format. The 957-1 pack is physically compatible with the IBM 2316 pack, although the recording formats differ. Each spindle holds one disk pack and has a comb-like access mechanism with one read/write head serving each of the 20 recording surfaces. Average head movement time is 60 milliseconds and average rotational delay is 12.5 milliseconds. Capacity and data transfer rate depend upon which of two controllers is used:

- The 625-201 Disc Controller records data at a density of 2200 bpi. Maximum data capacity is 7459 bytes per track, 149,180 bytes per cylinder, and 29.8 million

NCR Criterion Series

As programs are executed, VRX, operating in conjunction with special hardware called a dynamic address translator, assigns to real memory those portions of virtual storage that are currently active. The VRX software is scheduled for general release in mid-1977. NCR claims that its implementation of virtual storage in VRX is equivalent to IBM's OS/MVS.

A primary feature of VRX is a new data management system called the Criterion Access Method (CAM). CAM fully supports the input/output requirements of the COBOL 74 language and handles three different file organizations: sequential, relative, and indexed.

Two new compilers are provided with VRX: COBOL 74 and NEAT/VS. The VRX COBOL 74 compiler is primarily a high-level implementation of the ANSI 1974 standard language; it produces object code for the COBOL virtual machine (CVM) which runs under VRX. The NEAT/VS compiler is compatible with NCR's NEAT/3, a macro-oriented assembly language, and provides programming interfaces to the new software features available under VRX.

The VRX operating system also features an on-line program development capability for entry and modification of source programs, and a new Link Editor to assist in writing modular programs. The Link Editor binds together program modules written in either COBOL 74 or NEAT/VS prior to program execution.

VRX includes new telecommunications software that supports two new programming interfaces for development of on-line systems: a Message Control System (MCS) interface and a Low-Level Interface (LLI). MCS is compatible with the COBOL 74 language, and provides a terminal-insensitive interface to the application programmer. LLI is a more basic interface that gives the programmer more control over his telecommunications devices.

For communications users, VRX also offers a Network Description Language (NDL) to enable on-line configuration modification at execution time rather than at compilation time, thus providing more flexibility in a communications environment. Teletype-compatible devices, bisynchronous line discipline, and existing Century on-line applications are supported.

In summary, the Criterion computer family looks like a real fourth-generation entry for NCR, and could be a big winner. Highly flexible in design, the systems not only offer an easy migration path for current Century users, but appear to have the power and growth potential to meet the needs of many users of competitive equipment.

Over the years, NCR has been concentrating on software packages for selected markets, such as manufacturing, wholesale distribution, transportation, health care, and governmental agencies and municipalities. The combination of a computer system as promising as the

bytes per 11-disc pack. Data transfer rate is 315,000 bytes/second. The 625-201 can control up to eight 657-type spindles for a total on-line capacity of 238.4 million bytes.

- The 625-202 Dual-Density Disc Controller can record data at either 2200 or 3500 bpi, under programmed control. Maximum data capacity at the higher density is 11,944 bytes per track, 238,880 bytes per cylinder, and 47.7 million bytes per pack. Data transfer rate is 500,000 bytes/second. The 625-202 can control up to eight 657-type spindles for a total on-line capacity of 381.6 million bytes.

658-201 DISC SUBSYSTEM: Provides large-capacity random-access storage in interchangeable 10-high disc packs. The 658-201 subsystem has a capacity of 100 million bytes per drive but can be field-upgraded to a capacity of 200 million bytes per disc drive. It uses the NCR 958-2 Disc Pack, which has 19 tracks in each of 404 data cylinders plus 7 spares, and a basic capacity of up to 100 million bytes per disc pack. In the 200-million-byte recording mode, each 958-2 Disk Pack contains 808 cylinders plus 15 spares for a capacity of up to 200 million bytes. The double disc pack capacity is achieved through use of the NCR 0658-0002 Feature, which is required on each disc drive in the subsystem.

The 658-201 disc units can be connected to Criterion systems via the Integrated Disc Controller. The Criterion 8550 IDC can control a maximum of 8 spindles, while the Criterion 8570 IDC can control up to 24 spindles in up to 3 strings of 1 to 8 spindles each. Alternatively, up to eight 658-201 Disc Units in either 100-million-byte or 200-million-byte format can be attached to a 658-301 Control Unit. Attachment of additional disc drives, up to a maximum of 16 drives per control unit, requires the optional NCR 0625-0002 Drive Expansion Feature.

The 658 Disc Subsystem has a head movement time that ranges from 10 to 55 milliseconds and averages 30 for random accesses. Average rotational delay is 8.4 milliseconds, and data transfer rate is 806,000 bytes per second. Rotational Position Sensing and Command Retry are standard features. Error correction circuitry in the control unit permits detection and correction of errors in 11-bit bursts of data or address information. The Model 625-301 Control Unit contains a magnetic tape cassette handler for loading the control program, loading and reading on-line and off-line diagnostic programs, and recording statistical usage/error logging data. In addition, the control unit utilizes interchangeable address plugs to facilitate servicing of individual disc drives.

6590-0101 DATA MODULE DISC UNIT: A "Winchester" style unit similar to the IBM 3340, the 6590 disc unit contains two spindles that accommodate one 6591 data module each. The 6591 features head-in-pack technology with a storage capacity of either 35 or 70 million bytes. Both modules have two logical tracks per physical track and six physical tracks per logical cylinder. The 35-million-byte module has 348 logical cylinders, while the 70-million-byte module has 696 logical cylinders. Each module has a logical track capacity of 8,368 bytes and a logical cylinder capacity of 100,416 bytes.

Average rotational delay for the 6590 disc unit is 10.1 milliseconds, average seek time 25.0 milliseconds, average access time 35.1 milliseconds, and data transfer rate is 885,000 bytes per second. An optional 6590 RPS kit provides Rotational Position Sensing for the 6590 disc drives. One kit per dual-spindle 6590 unit is required.

The 6590 disc units can be connected to Criterion systems via the Integrated Disc Controller. The Criterion 8550 IDC can control a maximum of 8 spindles (4 dual-spindle units), while the Criterion 8570 IDC can control up to 24 spindles in up to 3 strings of 1 to 8 spindles each.

INPUT/OUTPUT UNITS

633 MAGNETIC TAPE HANDLERS: Six models of 633 Series tape units are offered. Data transfer rates range from 10,000 to 240,000 bytes/sec. All use standard ½-inch tape,

NCR Criterion Series

Criterion, together with an extensive line of problem-solving software aimed at their own industries, many strike many users as the best way to go.

The key to success for the Criterion Series appears to be the VRX operating system. If it can live up to NCR's expectations and promises, competitive vendors may find the Criterion a tough nut to crack.□

have vacuum-capstan drives, and use photocell sensing. Up to 8 tape units can be connected to a 624-type control unit. The following models are available:

633-111: 9 tracks; phase-encoded; 1600 bytes/inch; 80,000 bytes/sec. Forward tape speed 50 ips, rewind speed 150 ips. Requires 624-111 Controller.

633-117: 7 tracks; NRZI; 200, 556, or 800 char/inch; 10,000, 27,800, or 40,000 char/sec. Forward tape speed 50 ips; rewind speed 150 ips. Requires 624-179 Controller.

633-119: 9 tracks; NRZI; 800 bytes/inch; 40,000 char/sec. Forward tape speed 50 ips; rewind speed 150 ips. Requires 624-119 or 624-179 Controller.

633-121: Dual-drive unit with same characteristics as 633-111.

633-211: 9 tracks; phase-encoded; 1600 bytes/inch; 144,000 bytes/sec. Forward tape speed 90 ips; rewind speed 240 ips. Requires 624-211 Controller.

633-311: 9 tracks; phase-encoded, 1600 bytes/inch; 240,000 bytes/sec. Forward tape speed 150 ips; rewind speed 380 ips. Requires 624-311 Controller.

634 MAGNETIC TAPE SYSTEM: The NCR 634 Series tape units provide low-speed tape handling capabilities for 7- and 9-track magnetic tape. The 634 Series employs a "master/slave" operating technique in which each "master" unit contains a tape drive, the control electronics, and the trunk interface, and can control up to three additional "slave" units each containing a tape drive and associated read/write electronics. Three master units and three slave units are available; 9-track master tape units with the dual-mode option permit NRZI and phase-encoded tape units to be intermixed in one master/slave combination. The following "master" units and their associated "slave" units are available:

634-117 Master Unit: 7 tracks; NRZI; 200/556/800 bits/inch; 5,000/13,900/20,000 char/second. Forward tape speed is 25 ips; rewind speed is 160 ips.

634-107 Slave Unit: 7 tracks; 200/556/800 bits/inch; 5,000/13,900/20,000 char/sec.

634-119 Master Unit: 9 tracks; phase encoded or dual mode (phase encoded and NRZI); 1600 bytes/inch (phase encoded)/800 bytes per inch (NRZI); 40,000/20,000 bytes/sec. Forward tape speed is 25 ips; rewind speed is 160 ips.

634-109 Slave Unit: 9 tracks; phase encoded and/or NRZI; 1600 bytes/inch (phase encoded)/800 bytes/inch (NRZI); 40,000/20,000 bytes/sec.

634-107 Slave Unit (described above).

634-219 Master Unit: 9 tracks; phase encoded or dual mode (phase encoded and NRZI); 1600 bytes/inch (phase encoded)/800 bytes/inch (NRZI); 80,000/40,000 bytes/sec. Forward tape speed is 50 ips; rewind speed is 160 ips.

634-209 Slave Units; 9 track; phase encoded or dual mode; 1600 bytes/inch (phase encoded)/800 bytes/inch (NRZI); 80,000/40,000 bytes/sec.

634-107 Slave Unit (described above).

The Criterion Series firmware is loaded via flexible disks, as shown here. Different sets of firmware enable the system to duplicate the operating characteristics of the earlier NCR century systems, or to operate as a COBOL 74 virtual machine. Also shown is the standard console display unit and keyboard.

635 MAGNETIC TAPE SYSTEM: The NCR 635 Magnetic Tape Units are high-performance, 9-track tape drives that can read or write data with either the NRZI or phase encoded recording techniques. Up to eight Model 635 Magnetic Tape Units can be connected to a 624-401 Control Unit. Controllers equipped with the 0624-0001 Dual-Model feature can be used to control 7-track NCR 634-107 Magnetic Tape Units recorded with the NRZI recording technique as well as the 635 Magnetic Tape Units. Features available with the Model 635 drives included automatic tape reel latching and automatic tape threading. Two models are available:

- 635-109: 9 tracks; 1600 bytes per inch (phase encoded)/800 bytes/inch (NRZI); 160,000/80,000 bytes/sec. Forward tape speed is 100 ips; rewind speed is 480 ips.
- 635-209: 9 tracks; 1600 bytes/inch (phase encoded)/800 bytes/inch (NRZI); 320,000/160,000 bytes/sec. Forward tape speed is 200 ips; rewind speed is 640 ips.

636-301 CASSETTE HANDLER: Consists of a controller and one or optionally two cassette handlers. Each cassette cartridge contains approximately 280 feet of tape with two parallel recording tracks, only one of which can be accessed at a time. The capacity of each track is 2040 80-character blocks or 984 256-character blocks. Recording density is 800 bits per inch in phase-encoded mode, tape speed is 7.5 inches per second, and data transfer rate is 750 characters per second.

684-101/301 CARD READ/PUNCH: Reads 80-column cards serially at speeds of up to 500 cpm and punches column-by-column at 100 to 460 cpm, depending on the number of columns punched in each card. The Model 684-301 operates as a card punch only and can be field-upgraded to a Model 684-101 Card Read/Punch unit. Both Hollerith and binary code can be read and punched, either in one pass or in separate passes. Can operate as a card reader, card punch, or reader/punch for updating punched card files. Has a 1200-card input hopper and a 1300-card output stacker plus a card offset capability. Attaches to a position on a common trunk.

686-102 CARD READ/PUNCH: Reads 80-column cards serially at up to 800 cpm and punches column-by-column at 83 to 294 cpm, depending on the number of columns

NCR Criterion Series

punched. Has a single card feed path, a 1500-card input hopper, and two 1800-card programmable output stackers plus a 100-card reject stacker. Does not require a controller.

686-111 CARD READ/PUNCH: Reads 80-column cards serially at up to 560 cpm and punches column-by-column at 60 to 180 cpm, depending on the number of columns punched. Has a 1500-card input hopper and two 1800-card programmable output stackers plus a 100-card reject stacker. Does not require a controller.

686-201 CARD READER: Reads 80-column cards serially at up to 750 cpm. Has a 1500-card input hopper and two 1800-card programmable output stackers plus a 100-card reject stacker. Does not require a controller.

686-302 CARD PUNCH: Punches 80-column cards at 83 to 294 cpm, depending on the number of columns punched. Does not require a controller.

686-311 CARD PUNCH: Punches 80-column cards at 60 to 180 cpm, depending on the number of columns punched. Does not require a controller.

686-301 CARD PUNCH: Punches 80-column cards at 100 cpm. Has an 800-card input hopper and an 800-card output stacker. Requires a 622-701 controller.

660-101 PUNCHED TAPE READER: Reads 5-, 5-, or 8-channel tape at 1500 char/sec. Uses photoelectric read cells with either continuous or start/stop operation with a rewind rate of 150 inches/sec. Does not require a controller.

665-101 TAPE PUNCH: Punches 5-, 7-, or 8-channel tape at 200 char/sec. Operates in either continuous or start/stop modes.

626-101 PRINTER CONTROLLER: Connects any of the following free-standing printers through a common trunk attachment: 640-102, -200, -210, or -300.

640-200 PRINTER: Has 132 print positions and 64 printable characters, with 160 print positions and a 52-character print set optionally available. Peak speed is 1,500 lpm. Optional 52-character set enables all-numeric printing at 3,000 lpm. Continuous Form Tab Set Handling is available. Requires the 626-101 Controller.

640-210 PRINTER: Same as the 640-200, except has 160 print positions.

640-300 PRINTER: Usable in the same manner as the 640-200. Has 132 print positions and up to 128 printable characters (double alpha). Peak speed is 1,200 lpm. Requires the 626-101 Controller for attachment to a common trunk.

646-201 TRAIN PRINTER: Prints at up to 1,200 lines per minute with 16, 20, 44, or 48 character sets and somewhat slower speeds with 52, 57, 64, or 96 character sets. Maximum speed in the burst mode is 2,500 lines per minute with a 16-character set. Has 132 print positions. Print spacing of 6 or 8 lines per inch is available. Has an integrated controller.

647-201 TRAIN PRINTER: Prints at a peak speed of 2,000 lines per minute with a set of up to 48 characters, and at 3, 500 lines per minute in the burst mode with a 16-character set. Can be equipped with 16, 20, 44, 46, 48, 52, 57, 64, or 96 character sets. Prints at 6 or 8 lines per inch in 132 print positions. Includes an integrated controller.

671-101 MICR SORTER/READER: Reads MICR-encoded documents at up to 1200 per minute. Has 18 pockets. An endorser feature is avaialable as an option. Also usable for off-line sorting. Includes a controller.

COMMUNICATION CONTROL

INTEGRATED COMMUNICATIONS SUBSYSTEM: The Integrated Communications Subsystem provides up to 10 lines for on-line/real-time communications with remote devices using various transfer rates. The ICS links the computer system with remote terminals through either public or private communications networks. Integrated microprocessors, controlled by firmware, supervise the access, transmission, and output to and from the terminals in the system. A multiplexer can be added to the system to handle additional communications lines.

621-103 COMMUNICATIONS MULTIPLEXOR: Capable of handling 16 or 256 lines, using ROM transmission/control character tables, centralized character parity assembly and stripping, plus centralized BCC, CRC, and function code control. A Hardware-Assisted Software Queue (HASQ) feature is also available to help identify the terminals. The 621-103 connects to the common trunk. A "bucket" operation capability is also available to permit the transmission of records of indeterminate length through a hardware technique of using dual buffers. The 621-103 simultaneously handles both synchronous and asynchronous devices using various transmission codes and speeds. Asynchronous devices can operate at 16 speeds ranging from 45 to 2400 bits/sec, and synchronous devices at speeds ranging from 600 to 50,000 bits/sec.

796 VISUAL DISPLAY TERMINALS: The 796-101, -201, and -301 were announced in February 1974. Each includes an 8-by-10-inch CRT display with a capacity of 1920 characters in 24 lines of 80 characters each, a typewriter keyboard, a 10-key numeric pad, and an optional NCR 260 Non-Impact Printer for hard-copy output. The basic 796-101 display is teletypewriter-compatible and transmits in asynchronous mode, one character at a time, at a speed of 110 bits per second. The 796-201 Block/Conversational Terminal can transmit in the conversational (one character at a time), message, or page operational mode and has a maximum data transfer rate of 2400 bits per second. The 796-201 can also be equipped with an optional 11,520-element graphics matrix for preparation of charts and graphs and an integrated acoustic coupler for communication through a telephone handset. The 796-301 Pollable CRT Terminal operates in either page or message mode at transmission speeds of up to 9600 bits per second. The 796-401 Block/Conversational CRT Terminal was announced in November 1975 and features a selection switch for operation at 110, 300, 1200, 2400, or 9600 bits per second; the conversational, page, and message operational modes are supported, and the graphics and printer options are available.

692-600 ASYNCHRONOUS ADAPTER: Handles up to 16 transmission speeds ranging from 45 to 2400 bits/second, and permits attachment of popular NCR devices such as the 270 Financial Terminal, 260 General Purpose Terminal, and 399 Accounting Computer, as well as other non-NCR devices.

693-600 SYNCHRONOUS ADAPTER: Supports speeds from 600 to 50,000 bits/second for popular IBM binary synchronous (BSC) terminal devices or processor-to-processor communications. Operates under the B2 Software Executive and the BSC application package in IBM 2780 mode. A flexible, multitask communications capability is supported.

SOFTWARE

OPERATING SYSTEMS: With the Criterion series, NCR offers the Real Storage (RS) and the Virtual Resource Executive (VRX) operating systems.

REAL STORAGE (RS) OPERATING SYSTEM: The RS operating system is a superset of the Century B1, B2, and B3 operating systems, and is compatible with Century software at the object-code level. The following paragraphs describe the B-series operating systems used on the Century computers; the RS operating system for the Criterion can effectively function in any of the Century modes.

Each B-series operating system consists of a Monitor, an Executive, and several other routines. The Monitor controls the sequencing, loading, and linking of programs. The Executive is a run-time supervisor that handles all I/O operations, error conditions, and program overlays.

NCR Criterion Series

BASIC EXECUTIVE (B1): All Century computers can use the basic B1 operating system. This system handles batch-mode processing of one program at a time. The B1 system consists of a Monitor, an I/O executive, and Disc Management, Log, and Display routines.

The Monitor is called into main memory at the start of each day and at the end of each program. It controls the sequencing, linking, and loading of programs. It can run a series of programs as directed by a control string entered via punched cards, punched tape, or the console keyboard. The Monitor provides calendar and date-controlled protection of files and calendar-controlled scheduling and modification of programs. The I/O Executive is divided into a memory-resident portion and a disc-resident portion. The memory-resident portion occupies about 4000 bytes of main memory and handles all I/O operations, error conditions, program overlays, and subroutine calls. The disc-resident routines are called into main memory when needed to deal with less frequent situations such as open and closing of files, retries of I/O operations that failed, etc.

The Disc Management routines are used primarily to ensure that the system discs always contain accurate, up-to-date versions of the NCR software. The Log routines maintain a system disc log of status information such as hardware malfunctions and incorrect operating procedures. The Display routines provide communication links between the operator and either the programmer or the operating system.

ON-LINE OPERATING EXECUTIVE (B2): Usable on all Century systems with at least 32K bytes of main storage, this operating system divides main memory into two distinct areas which can be used for processing either two concurrent batch programs or one communications program plus one background batch program. A Dynamic Storage allocation feature allows memory for servicing terminals to be allocated as a central pool. The Resident Sector Management feature allows the operating system to map program and software overlays into unassigned areas of memory.

The Queue Executive Interface (QXI), released for the B2 dual-program executive in August 1975, includes on-line communications drivers for handling teletype-writer-compatible terminals and the NCR 796-301 Visual Display Terminals. A specialized Financial/Retail On-Line Communications Driver is also available for handling communications networks configured with the specialized NCR banking and retail terminals.

The B2 system's resident portion occupies about 11K to 15K bytes of main storage.

MULTIPROGRAMMING EXECUTIVE (B3): This operating system divides main memory into two or more partitions of at least 16K bytes each. Each partition has its own set of 63 index registers and, in the original B3 release, its own disc unit and its own job stream so that its operations were largely independent of other partitions.

Principal extensions added to the B3 operating system after its initial release include resource-sharing features such as: 1) the use of a single system disk unit, shared by all active programs, rather than a separate disk unit for each partition; 2) the capability for programs running in different partitions to access a shared disc unit; 3) a Common Program Library Disc that permits programs in several partitions to store programs, utility routines, and user routines on a single disk unit; and 4) a Peripheral Reassignment feature that permits the oeprator to reassign peripherals among partitions without interrupting operation of the system.

A new version of B3 released in July 1974 included the following major extensions: 1) the use of a common disc unit for the Common Program Library and the Common System Disc; 2) software overlay pooling; and 3) operator-initiated dynamic allocation of memory between two partitions. Further enhancements added to the B3 system in August 1975 included card input spooling, common disk backup for software overlays to facilitate recovery from a read error, dynamic assignment of partition priorities, and operator-controlled job scheduling. The latest release of the B3 operating system also provides facilities for automatic propagation of utility routines from a master disc pack. One or more user partitions in a B3 system can contain an on-line program running under the B2 executive.

VIRTUAL RESOURCE EXECUTIVE: VRX is NCR's virtual memory operating system. VRX supervises the activity of all system components to provide the processing power of virtual storage, controlling program segmentation, job scheduling, page storage and retrieval, memory alllocation, and data input and output. In the VRX environment, existing NCR Century and Criterion RS programs can be executed without recoding or recompiling.

As programs are executed, VRX, in conjunction with special hardware called the dynamic address translator, assigns to real memory those portions of virtual storage that are currently active. Virtual storage is assigned in blocks of coding or data called pages, which may consist of 512, 1024, 2048, or 4096 bytes each, depending on the system requirements. A page is assigned to a like-sized area of real memory called a page frame, and remains there until it is no longer needed or is displaced by a higher-priority task. Individual pages may be assigned to any available frame, regardless of how they are organized in virtual storage. Initial page structuring and page assignment are handled automatically by the executive. From the user's standpoint, the entire process is transparent. VRX is scheduled for release in mid-1977.

COBOL: Three different levels of COBOL 68 compilers are currently available from NCR for use on Century series computers. These will be supplanted by a new ANSI COBOL 74 compiler to be released with VRX.

FORTRAN: The Criterion systems support several levels of implementation of FORTRAN, up to the full ANS level plus the following extensions: mixed-mode arithmetic, an unlimited number of dimensions in an array, random READ and WRITE statements, and extensions to the CALL statement.

FORTRAN E: The FORTRAN E compiler incorporates the features of full FORTRAN, described above, with the exception of random I/O. The compiler is designed for use in educational environments and features fast compilation, immediate execution of programs, and comprehensive error statements. Execution speeds of FORTRAN E programs are slower than those produced by the Intermedia or Full FORTRAN compilers, however, and there are no facilities for saving FORTRAN E object programs.

BASIC: A compiler for BASIC, an algebraic language designed for time-sharing computers, can be used on the Criterion computers. Programs are compiled as they are entered from remote teletypewriters and can be executed immediately. Diagnostic messages permit on-the-spot correction of many errors. An accounting routine facilitates billing by recording the amount of computing time used by each programmer at each terminal.

ASSEMBLER: NEAT/3 is NCR's version of an assembler language for the Century Series. Strong emphasis is placed upon the use of macro-instructions to facilitate coding. The disc-oriented NEAT/3 Compiler is usable on all Century and Criterion systems.

NEAT/3 Level 1 is a subset of NEAT/3 that provides an easy-to-learn programming language and faster compilation.

RPG: An RPG compiler is available for use on the Criterion systems.

TOTAL: This popular data base management system, developed by Cincom Systems, Inc., is marketed and supported by Cincom for NCR computers and has a license fee of $30,000 per single processor installation and a yearly maintenance charge of $1,500 after the first year. TOTAL is described in detail in Report 70E-132-01.

NCR Criterion Series

UTILITY ROUTINES: In addition to a Generalized Sort Routine, NCR provides a Tag Sort and a Large Memory Sort that expands to utilize more than 64K bytes of memory for more efficient processing. There is also a complement of utility routines to handle file creation, library maintenance (SPUR and OPUR), data transcription, overlay control (OMPA), disc file management, and memory dumps. A Symbolic Debug Routine is provided to facilitate debugging of COBOL and NEAT/3 programs. The Propagate Utilities routine can be used to copy selected software routines from a source disk pack to up to 12 destination disc packs to assist users in implementing new versions of utility programs.

APPLIATION PROGRAMS: NCR offers "packaged" programs to handle key applications in manufacturing, food processing, wholesale distribution, retailing, schools, financial institutions, hospitals, and local government. Among the application programs available to users are:

Retail Accounts Receivable
Accounts Payable
Payroll and Personnel Management
Medical Audit Statistics System (Mass)
Hospital Accounts Receivable
Hospital Clinical Analysis
Inpatient Accounting
Post-Discharge Accounts Receivable
Order Entry
Stewardship and Management Accounting
Student Scheduling and Grade Reporting
Student Test Analysis
Requirements Planning
Production Scheduling
Emphasis
Utility Billing
Department Store Sales Audit
General Reporting System
Project Network Analysis (PNA)
Basic Estimating Technique (BETS)
Fashion Reporting
Stable Stock Replenishment
CIF-DDA Bank System
Linear Programming
Law Enforcement Control System
Building Contractors System
Statistical Analysis
Personal Trust Accounting
Dedicated Commercial Bank Inquiry System
Local Government Administration System
Bill of Materials Processor
Manufacturing Inventory Control System
Medics

PRICING

EQUIPMENT: A basic *Criterion 8550* system, including 128K bytes of main memory, an integrated 600-cpm card reader, a 1200-lpm printer, and a 200-million-byte disk unit, rents for $5,900 a month under a five-year agreement, including maintenance, with a purchase price of $258,950.

A basic *Criterion 8570* system, including 256K bytes of main memory, an integrated 600-cpm card reader, a 1200-lpm printer, and 300 million bytes of disk storage, rents for $10,300 a month under a five-year agreement, including maintenance, with a purchase price of $458,250.

SOFTWARE: In May 1976, NCR announced an "unbundled" pricing policy for its software. The new policy applies to new NCR Century and Criterion users. There was no change in pricing for current Century users of software installed or on order prior to May 1, 1976. Current Century users who subsequently move to other Century systems can continue to use software installed or on order prior to May 1 with no change in pricing. Century customers who move to Criterion systems may carry the Century application packages forward at no charge, provided they were in use prior to May 1, but Criterion Series systems and applications software is unbundled.

The new pricing policy for applications software includes an initial license fee plus a monthly fee. The initial fee ranges from $250 for most programs to over $3,000 for a totally integrated system of financial application modules. Payment of the initial fee provides for one year of use without additional monthly fees. Thereafter, the monthly license fees range from $5 to $135 a month. Systems software is subject to monthly license fees only, ranging from $5 to $150 a month. The new policy, over a period of time, will result in a fully unbundled pricing policy.

SUPPORT: NCR systems support is billed to Criterion users at the rate of $35 per hour or $238 per day.

EDUCATION: All educational services are separately priced.

CONTRACT TERMS: The standard NCR Criterion rental contract permits unlimited use of the equipment for all processor models. There are no extra-use charges. The basic maintenance charge covers maintenance of the equipment for 16 hours a day, from 8 a.m. to 12 pm.m, five days per week, Monday through Friday.

NCR offers a 10 percent discount on all Criterion systems and peripherals to users willing to sign a five-year lease agremement. A graduated purchase option credit accrues toward subsequent purchase of Criterion systems.□

NCR Criterion Series

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
CRITERION 8550 PROCESSOR & MAIN MEMORY				
5600-0301-0000	Processor; with 128K Memory, Low-Speed Trunk, Very High-Speed Trunk, 8K Instruction Storage, Card or Tape Interface, Console Stand, Console Display, Console Keyboard, and Auxiliary Stand	107,400	565	2,900
Required Additions				
6831-0201	System Card Reader, 600 cpm *or*	11,500	30	275
6640-0101	System Paper Tape Reader, 1000 cps	13,500	40	335
5600-P399	RS-1 Package; *or*	NC	NC	NC
5600-P398	VS-1 Package	13,350	110	400
Additional Main Memory				
5600-P320	128K to 192K Memory Addition	16,500	32	400
5600-P321	192K to 256K Memory Addition	16,500	32	400
5600-P322	256K to 320K Memory Addition	16,500	32	400
5600-P323	320K to 384K Memory Addition	16,500	32	400
5600-P324	348K to 448K Memory Addition	16,500	32	400
5600-P325	448K to 512K Memory Addition	16,500	32	400
I/O Control				
5600-P340	Additional Low-Speed Trunk	4,150	10	100
5600-P341	Medium-Speed Trunk	6,300	15	150
5600-P342	Additional Very High-Speed Trunk	9,300	22	225
5600-P345	Integrated Disk Control (IDC), Control Module	14,700	80	400
5600-P346	IDC, 6590 Attachment	1,500	0	40
5600-P347	IDC, Expansion to 8 Spindles	6,000	30	160
5600-P348	IDC, 658 Attachment	5,500	0	150
Communications				
5600-P950	First Medium-Speed Line	2,500	45	100
5600-P951	Second Medium-Speed Line	2,500	45	100
5600-P952	Third Medium-Speed Line	2,500	45	100
5600-P953	Fourth Medium-Speed Line	2,500	45	100
5600-P954	Five Low-Speed Lines	6,000	70	200
5600-P955	Additional Five Low-Speed Lines	6,000	70	200
Miscellaneous				
5600-P301	Fast Floating Point Assist	6,400	10	150
5600-P302	Additional Power Supply	9,200	20	240
5600-P370	NCR 8550 to NCR 8570 Upgrade	108,600	59	NC
5600-P371	NCR 8550 Memory to NCR 8570 Memory Upgrade	9,100	0	NC
5601-P102	260 Thermal Output Writer	3,700	20	100
5600-P901	Special EMI Shielding	800	0	20
5600-P903	Audible Alarm	2,200	2	50
1001-A565	Additional Auxiliary Table	800	0	20
6440-0302	Console Printer, 173 cps	3,900	40	125
6440-P004	Criterion Attachment	3,100	8	75
Dual Console Option				
5600-P902	Additional Console Channel	800	3	20
7200-0605	Additional Console Display Unit	6,400	20	160
5851-0101	Console Keyboard	950	5	25
5601-0201	Console Stand	—	—	—
5601-P002	Console Top without 260 Output Writer	—	—	—
CRITERION 8570 PROCESSOR & MAIN MEMORY				
5600-0401-000	Processor; with 256K Interleaved Memory, Low-Speed, Medium-Speed, and Very High-Speed Trunk, 10K Instruction Storage, Card or Tape Interface, Console Stand, Console Display, Console Keyboard, and Auxiliary Stand	282,700	743	6,900
Required Additions				
6831-0201	System Card Reader, 600 cpm *or*	11,500	30	275
6640-0101	System Paper Tape Reader, 1000 cps	13,500	40	335
5600-P499	RS-1 Package *or*	NC	NC	NC
5600-P498	VS-1 Package	13,350	105	400
Additional Main Memory				
5600-P420	256K to 384K Memory Expansion	42,100	64	1,000
5600-P421	384K to 512K Memory Expansion	42,100	64	1,000
5600-P422	512K to 640K Memory Expansion	42,100	64	1,000
5600-P423	640K to 768K Memory Expansion	42,100	64	1,000
5600-P424	768K to 896K Memory Expansion	42,100	64	1,000
5600-P425	896K to 1024K Memory Expansion	42,100	64	1,000

*Rental prices include equipment maintenance.

NCR Criterion Series

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
CRITERION 8570 PROCESSOR & MAIN MEMORY (Continued)				
I/O Control				
5600-P440	Additional Low-Speed Trunk	4,150	10	100
5600-P441	Additional Very High-Speed Trunk	9,300	22	225
5600-P445	Integrated Disk Controller (IDC), Control Module	20,700	110	560
5600-P446	IDC, 6590 Attachment	1,500	0	40
5600-P447	IDC, 658 Attachment	5,500	0	150
5600-P448	IDC, Second String Control, 6590	4,100	10	100
5600-P449	IDC, Second String Control, 658	4,100	10	100
5600-P450	IDC, Third String Control, 6590	4,100	10	100
5600-P451	IDC, Third String Control, 658	4,100	10	100
5600-P455	IDC, Dual Control Attachment	20,700	100	600
Communications				
5600-P950	First Medium-Speed Line	2,500	45	100
5600-P951	Second Medium-Speed Line	2,500	45	100
5600-P952	Third Medium-Speed Line	2,500	45	100
5600-P953	Fourth Medium-Speed Line	2,500	45	100
5600-P954	Five Low-Speed Lines	6,000	70	200
5600-P955	Additional Five Low-Speed Lines	6,000	70	200
Miscellaneous				
5600-P401	Fast Floating Point Assist	6,400	10	150
5601-P102	260 Thermal Output Writer	3,700	20	100
5600-P901	Special EMI Shielding	800	0	20
5600-P903	Audible Alarm	2,200	2	50
2002-A565	Additional Auxiliary Table	800	0	20
6440-0302	Console Printer, 173 cps	3,900	40	125
6440-P004	Criterion Attachment	3,100	8	75
Dual Console Option				
5600-1902	Additional Console Channel	800	3	20
7200-0605	Additional Console Display Unit	6,400	20	160
5851-0101	Console Keyboard	900	5	25
5601-0201	Console Stand	—	—	—
5601-P002	Console Top without 260 I/O Writer	—	—	—
Data Module				
6590-0101	Data Module Drive	37,500	85	900
6590-P001	Drive String Attachment	1,125	8	40
6590-P003	RPS Kit	700	4	20
6591-0101	35MB Data Module	1,500	Time & Mat'ls.	70
6591-0201	70MB Data Module	2,000	Time & Mat'ls.	85
MASS STORAGE				
625-101	Controller for up to four 655-201 Disc Units	14,000	16	305
625-201	Single-Density Controller for up to eight 657-type spindles; requires High-Speed Trunk)	40,250	40	875
625-202	Dual-Density Controller for up to eight 657-type spindles	49,450	70	1,075
625-301	Controller for up to eight 658 Disc Units	38,200	200	900
0658-0001	Drive Expansion Feature; required for attaching more than eight 658-01 Disc Units to a 625-301)	2,250	10	50
655-201	Common Trunk Disc Unit; (requires 625-101 controller) 8.4 MB, 65 msec access time	26,500	135	590
955-1	Disk Pack for 655-type disc units; 4.2 MB	160	—	—
656-102	Disk Unit; 4.9 MB, 47.5 msec access time (requires disc controller)	13,020	71	340
6562	Fixed Disc; 4.9 MB, 47.5 msec access time (add-on unit for 656-102)	4,275	17	105
6563	Dual Spindle Attachment for second 656-102 (requires 6561 Disc Controller)	450	3	12
6561	Disc Unit Controller for one or two 656-102's	6,750	29	165
956-1	Disc Pack for 656-102; 4.9 MB	120	—	—
657-101	Single-Spindle Disk Unit; 30/48 MB	26,450	97	590
657-101	Dual-Spindle Disc Unit, 60 MB or 96 MB (96 MB capacity requires 625-202 Controller; 60 MB capacity requires 625-201 or -202):			
	First Unit	41,400	108	915
	Second Unit	32,200	108	715
	Three or more units	27,600	108	615
957-1	Disc Pack for 657-type disc units; 30 MB or 48 MB	235	—	—
625-301	Controller for up to eight 658-301 Disc Units	38,200	200	900
658-201	Disc Drive, 100 MB	24,000	115	615
0658-0002	200 MB Feature	14,200	45	300
0625-0002	Drive Expansion Feature; required to attach more than 8 drives to 625-301	2,250	10	50
958-2	Disc Pack	860	NA	NA

*Rental prices include equipment maintenance.

NCR Criterion Series

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
INPUT/OUTPUT UNITS				
624-111	Controller for up to eight 633-111 and/or 633-121 Magnetic Tape Units	18,060	24	435
624-119	Controller for up to eight 633-119 Magnetic Tape Units	12,600	24	310
624-211	Controller for up to eight 633-211 Magnetic Tape Units	21,000	24	510
624-179	Controller for up to eight 633-119 and/or 633-117 Magnetic Tape Units with same speeds	13,020	24	315
624-311	Controller for up to eight 633-311 Magentic Tape Units	23,100	24	560
624-401	Controller for up to eight 635-109 and/or 635-209 Magnetic Tape Units	24,150	65	580
0624-0001	Dual Model for 624-401 Controller permits NRZI and PE operation	1,925	20	55
633-111	Single Magnetic Tape Unit; PE, 80KB, 9-track, 1600 bpi	12,600	71	310
633-117	Single Magnetic Tape Unit; NRZI, 10/28/40KC, 7-track, 200/556/800 bpi	12,650	76	330
633-119	Single Magnetic Tape Unit; NRZI, 40KB, 9-track, 1600 bpi	14,700	76	365
633-121	Dual Magnetic Tape Unit; PE, 80KB, 9-track, 1600 bpi	24,750	105	560
633-211	Single Magnetic Tape Unit; PE, 144KB, 9-track, 1600 bpi (requires high-speed trunk)	21,375	71	485
633-311	Single Magnetic Tape Unit; PE, 240KB, 9-track, 1600 bpi (requires high-speed trunk)	2,050	71	535
634-117	Magnetic Tape Unit with Controller; NRZI, 5/13.9/20KC, 7-track, 200/556/800 bpi	26,670	123	645
634-107	Magnetic Tape Unit; up to three per 634-117	10,710	68	260
634-119	Magnetic Tape Unit with Controller; PE, 40KB, 9-track, 1600 bpi	25,830	112	625
634-109	Magnetic Tape Unit; up to three per 634-119	10,500	63	255
634-219	Magnetic Tape Unit with Controller; PE, 80KB, 1600 bpi	30,870	117	745
634-209	Magnetic Tape Unit; up to three per 634-219	12,810	68	310
0634-0001	Dual Mode for 634-119/219; permits attachment of 634-107	630	8	15
0634-004	Dual Mode for 634-119/109 Magnetic Tape Units; permits NRZI and PE operation	630	8	15
0634-005	Dual Mode for 634-219/209 Magentic Tape Units; permits NRZI and PE operation	630	8	15
635-109	Magnetic Tape Unit; PE, 160KB, 1600 bpi	21,375	103	485
635-209	Magnetic Tape Unit; PE, 320KB, 1600 bpi	24,150	112	585
0635-0001	Dual Mode for 635-109/209 Magnetic Tape Units; permits NRZI and PE operation	1,125	12	25
0635-0002	High Altitude Kit for 635-109 Magnetic Tape Unit	0	0	0
0635-0003	High Altitude Kit for 635-209 Magnetic Tape Unit	0	0	0
680-201	Card Reader, 1200 cpm	32,500	141	705
684-101	Card Read/Punch, 500/100-460 cpm	25,830	254	635
684-301	Card Punch, 100-460 cpm	22,860	222	560
686-102	Card Read/Punch, 800/83-294 cpm	24,000	135	545
686-111	Card Read/Punch, 560/60-180 cpm	20,500	135	440
686-201	Card Reader, 750 cpm	14,750	88	330
686-302	Card Punch, 83-294 cpm	20,500	135	440
686-311	Card Punch, 60-180 cpm	14,750	135	335
687-301	Card Punch and Controller, 100 cpm	15,500	112	355
660-101	Paper Tape Reader, 1500 cps (available for Century 50 with 6051 feature)	14,750	41	325
665-101	Paper Tape Punch, 200 cps (available for Century 50 with 6051 feature)	18,000	64	400
640-102	Printer, 450/900 lpm, 132 positions (requires 626-101 Controller)	27,500	71	620
640-200	Printer, 1500/3000 lpm, 132 positions (requires 626-101 Controller for Common Trunk Attachment)	49,000	129	1,285
640-210	Printer, 1500/3000 lpm, 160 positions (requires 626-101 Controller for Common Trunk attachment	53,250	129	1,385
640-300	Printer, 1200 lpm, 132 positons (requires 626-101 Controller)	38,950	100	1,015
626-101	Printer Control Unit for Common Trunk attachment of 640-102, 640-200, 640-205, 640-210, 640-215, or 640-300 Printers	14,000	29	325
6401	6/8 Lines per Inch for 640-102 Printer	1,000	0	25
6402	Continuous Form Tab Set Handling Feature for 640-200 Printer	300	2	10
646-201/961-201	Train Printer and Control, 1200 lpm, 132 positions	53,850	288	1,250
647-201/961-201	Train Printer and Controller, 200 lpm, 132 positions	69,650	407	1,720
960-152	Print Train; 52 characters	2,950	Time & Mat'ls.	100
960-164	Print Train; 64 characters	2,950	Time & Mat'ls.	100
960-157	Print Train; 57 characters, OCR-A	2,950	Time & Mat'ls.	100
960-196	Print Train, 96 characters	2,950	Time & Mat'ls.	100
649-300	Printer; 300 lpm, 132 positions (includes controller)	24,150	93	620
6491	6/8 Lines Per Inch for 649-300 Printer	675	1	15
670-101	MICR Sorter, 600 dpm, 11 pockets (includes 622-401 Controller)	45,000	192	1,065
671-101	MICR Sorter, 1200 dpm, 18 pockets (includes 622-401 Controller)	117,500	618	2,540
6711	Endorser Feature for 671-101	12,000	53	325
675-101	MICR Reader/Sorter	58,000	425	1,350
622-401	MICR Sorter Control Unit	15,100	12	215
636-301	Cassette Handler	9,000	55	225
636-0001	Dual Cassette Transport Feature	2,000	10	50

* Rental prices include equipment maintenance.

NCR Criterion Series

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
DATA DISPLAY SYSTEMS				
796-101	TTY-Compatible CRT Terminal	2,000	32	85
796-401	Block/Conversational CRT Terminal	3,100	20	130
796-301	Pollable CRT Terminal	3,500	20	160
260-1	Thermal Printer	1,960	10	75
0796-0001	Parallel Printer Interface	185	—	8
COMMUNICATION CONTROL				
692-600	Asynchronous Adapter for 621-103	1,500	8	80
693-600	Synchronous Adapter for 621-103	2,250	8	105
695-600	Auto Dialer	1,600	10	47
698-300	Integrated Asynchronous Modem	1,000	8	32
752-200	Freestanding Asynchronous Modem	1,100	8	37
753	Modem	695	8	27
6901	Transparency Feature	675	0	15
6902	Wide Band Feature	450	0	10

*Rental prices include equipment maintenance.

SOFTWARE PRICES**

Product Identification	Type		Initial License Fee	Monthly License Fee
8210-0903	I-S	COBOL 74 Compiler, VRX	0	90
8210-0904	I-S	COBUG, VRX	0	10
8210-0905	I-S	NEAT/VS Compiler, VRX	0	50
8210-0906	I-S	Sort/Merge, VRX	0	40
8210-0907	I-S	Terminal Communications Processor	0	60
8210-0908	I-S	Network Definition Language Processor	0	25
8210-0909	I-S	On-Line Program Development	0	50
8210-0910	I-S	Remote Job Entry, VRX	0	40
8210-0911	I-S	Symbolic Debug, VRX	0	10
8210-0912	I-S	CAM/VRX Utilities	0	10

**This list reflects only those Software Program Products being released concurrently with the Criterion Systems.