NCR V-8500 and V-8600 Systems

MANAGEMENT SUMMARY

In April 1984, NCR announced enhancements to the V–8500 and V–8600 line of mainframe computers. Redundant processing capability has been added with the announcement of three hardware options, a software facility, and an enhanced version of the VRX operating system. The incremental architecture combination of hardware and software products provides V–8500 and V–8600 users with an option for loose coupling, or a combination of loose and tight coupling within the same configuration when a dyadic processor (V–8575–II, V–8595–II, V–8645) is included. Within this architecture each host processor executes its own copy of the VRX operating system. If a hardware, software, or firmware failure occurs, copies of critical applications can be automatically activated to continue processing thus ensuring data integrity and high availability of the system. The failure can then be isolated and repaired while processing continues. The incremental architecture hardware components are the Dynamic Channel Director (DCD), the System-to-System Adapter (SSA), and a Channel Control Processor (CCP).

- The Dynamic Channel Director—An electronic switch which allows up to eight independent host processors to share a pool of common peripherals. The DCD allows any peripheral in the pool to operate through any available CCP. Up to four DCDs can be configured in a loosely coupled configuration.

- The Channel Control Processor—A microprocessor-based controller that connects the DCD to V–8500 or V–8600 processors. Each CCP can be connected to four different DCDs with a maximum of four CCPs per host. The CCP offloads the host processor of most input/output processing tasks.

Recent enhancements to the V–8500 and V–8600 computer systems have added redundant processing capabilities provided via the NCR incremental architecture. This hardware/software combination allows loose or combination loose/tight coupling within a configuration. This diverse family of computers can support batch, transaction, and distributed processing environments.

MODELS: V–8545–II, V–8555–II, V–8565–II E, V–8575–II, V–8595–II, V–8635, V–8645, V–8655, V–8665, V–8675, V–8685, and V–8695.
CONFIGURATION: Depending on product line, one to eight CPUs, 1 to 64 megabytes of memory, and a wide assortment of I/O devices are available.
COMPETITION: Burroughs B 1900 through B 6900; Hewlett-Packard HP 3000; Honeywell DPS 7 and DPS 8 Series; IBM System/38 and 4300 Systems; Sperry System 80, 1100/60 and 1100/80 Series.
PRICE: Purchase prices range from $41,500 (V–8545–II) to $2,895,000 (V–8695).

CHARACTERISTICS

MANUFACTURER: NCR Corporation, Dayton, Ohio 45479. Telephone (513) 445–5000.

MODELS: V–8545–II, V–8555–II, V–8565–II E, V–8575–II, V–8595–II, V–8635, V–8645, V–8655, V–8665, V–8675, V–8685, V–8695.

DATE OF INTRODUCTION: See Table 1.

NCR's V–8500 Group II Series includes five models that can have from one to four CPUs, 1 to 16 megabytes of memory, and a wide range of I/O devices. Performance is comparable to the IBM 4300 Series.

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TABLE 1. 8500 AND 8600 SYSTEM CHARACTERISTICS

	V-8545-II	V-8555-II	V-8565-II E	V-8575-II	V-8595-II
SYSTEM CHARACTERISTICS					
Date of introduction	Feb. 1982	Feb. 1982	1983	Feb. 1982	Feb. 1982
Number of main processors	1	1 to 2	1	2 to 4	2 to 4
Active production	Yes	Yes	Yes	Yes	Yes
Relative performance level, approximate	.75	1.0	1.25	1.65	2.48
System firmware	VS1	VS2	VS1,VS2	VS2	VS2
Operating system	VRX/B3	VRX;B1,B2	VRX; VRX/MP	VRX/MP	VRX/MP
Basic system rental per month	$4,230	$4,675	$8,255	$10,475	$18,255
MAIN PROCESSOR					
Cycle time, nanoseconds	84	56	56	56	56
Dynamic address translation hardware	Yes	Yes	Yes	Yes	Yes
Floating-point assist	Yes	Yes	Yes	Yes	Yes
VRX assist (instruction lookahead)	No	No	Yes	No	Yes
Instruction storage capacity, bytes	24K	32K	48K	64K	64K
Upgradable to	V-8555-II	V-8565-II E	—	8595-II	—
MAIN STORAGE (All MOS, error correcting)					
Memory circuitry	64K chip	64K chip	64K chip	64K chip	64K chip
Cycle time, nanoseconds	440	440	440	440	440
Minimum capacity, bytes	1M	1M	2M	4M	4M
Maximum capacity, bytes	2M	4M	8M	8M	16M
Increment size, bytes	512K	1M	2M	4M	4M
Interleaving	—	2-way	2-way	4-way	4-way
I/O CONTROL					
Channels (min./max.)	0 to 64	0 to 64	0 to 64	0 to 64	0 to 64
Channel Control Processors	0 to 4	0 to 4	0 to 4	0 to 4	0 to 4
Maximum disk subsystems per controller	4 strings of 8 drives	4 strings of 8 drives	3 strings drives	3 strings of 8 drives	NA drives
Maximum no. of common trunks	6	6	8	8	8
Common trunk data rates, bytes/sec.:					
Low-speed trunk	75KB	75KB	100KB	100KB	100KB
Medium-speed trunk	225KB	225KB	315KB	315KB	315KB
Very high-speed trunk	1200KB	1200KB	1200KB	1200KB	1200KB
I/O Link Controllers	Yes	Yes	Yes	Yes	Yes
COMMUNICATIONS CONTROL					
Integrated comm. control max. lines	20	20	20	NA	NA
External comm. control max. lines	256	256	256	256	256

- The System-to-System Adapter—The SSA is connected to the DCD to provide communication between host processors. It acts as an electronic mailbox for system messages. It also allows communication between applications operating on separate host processors.

These hardware options allow host processors to be used in an Instantready mode, which allows them to switch processing of critical applications from one processor to another in the event of a failure. Peripheral pooling and Instantready capabilities are accomplished via the Inter-Host Management Facility (IHMF) which enhances the VRX operating system.

The V-8500 Series is a five-model Group II family of systems, and includes the uniprocessor V-8545-II, V-8555-II, and the V-8665-IIE, and the dual processor V-8575-II, and V-8595-II. All systems use the VRX virtual memory operating system which can also run programs written for Century systems without recompiling. The V-8555-II and V-8565-II E uniprocessors can be connected into tightly coupled MP (dual-processor) configurations. The V-8575-II and V-8595-II, which are already tightly coupled dyadic systems, can be connected with another system of the same type to form a four-processor

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 exponent and a 24-bit fraction in the single-precision format and a 7-bit exponent and 56-bit fraction in the double precision format.

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

MAIN STORAGE

STORAGE TYPE: Metal oxide semiconductor (MOS). The new V-85X5-II models and the V-8600 models use 64K chips.

CAPACITY: The main memory capacity of the V-85X5-II and V-8600 systems is stated in Table 1.

CYCLE TIME: See Table 1.

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TABLE 1. 8500 AND 8600 SYSTEM CHARACTERISTICS (Continued)

	V-8635	V-8645	V-8655	V-8665	V-8675
SYSTEM CHARACTERISTICS					
Date of introduction	May 1983	May 1983	May 1983	May 1983	May 1983
Number of main processors	1	2	2	3	4
Active production	Yes	Yes	Yes	Yes	Yes
Relative performance level, approximate	3.0	5.70	5.88	8.23	10.76
System firmware	VS6	VS6	VS6	VS6	VS6
Operating system	VRX	VRX	VRX	VRX	VRX
Basic system rental per month	$14,667	$22,375	$33,680	$44,450	$52,205
MAIN PROCESSOR					
Cycle time, nanoseconds	38	38	38	38	38
Dynamic address translation hardware	Yes	Yes	Yes	Yes	Yes
Floating-point assist	Yes	Yes	Yes	Yes	Yes
VRX assist (instruction lookahead)	Yes	Yes	Yes	Yes	Yes
Instruction storage capacity, bytes	96K	192K	192K	288K	384K
Upgradable to	V-8645	V-8665 to V-8695	V-8665 to V-8695	V-8675 to V-8695	V-8685 to V-8695
MAIN STORAGE (All MOS, error correcting)					
Memory circuitry	64K chip	64K chip	64K chip	64K chip	64K chip
Cycle time, nanoseconds	380	380	380	380	380
Minimum capacity, bytes	4M	4M	8M	8M	8M
Maximum capacity, bytes	8M	16M	16M	24M	32M
Increment size, bytes	4M	4M	4M	4M	4M
Interleaving	4-way	4-way	4-way	4-way	4-way
I/O CONTROL					
Channels (min./max.)	16 to 32	16 to 32	16 to 64	16 to 64	16 to 64
Channel Control Processors	0 to 4	2 to 4	4 to 8	4 to 8	4 to 8
Maximum disk subsystems per controller	64	64	64	64	64
Maximum no. of common trunks	2	2	2	2	2
Common trunk data rates, bytes/sec.:					
Low-speed trunk	50KB	50KB	50KB	50KB	50KB
Medium-speed trunk	None	None	None	None	None
Very high-speed trunk	1.1MB	1.1MB	1.1MB	1.1MB	1.1MB
I/O Link Controllers	2.0MB	2.0MB	2.0MB	2.0MB	2.0MB
COMMUNICATIONS CONTROL					
Integrated comm. control max. lines	NA	NA	NA	NA	NA
External comm. control max. lines	256	256	512	512	512

configuration. NCR's multiprocessor systems share a single copy of VRX/MP, the multiprocessor version of VRX.

NCR's V-8500 and V-8600 systems are designed to operate in batch, transaction-oriented, remote job entry (RJE), and distributed processing environments. The VRX operating system supports multiprogramming and tightly and loosely coupled multiprocessing.

The single-processor V-8635 and dual-processor V-8645 are the base models of the V-8600 Series. The larger models are made up of various configurations of the base models. Migration Path Engineering concepts which are built into the V-8600 Series offer users of V-8500 systems an excellent growth path and protection of their software investment. The V-8600 Series offers a 32 percent faster central processor than the V-8500 Series, along with cache memory and an improved I/O System. The V-8600 systems use the VRX (Virtual Resource Executive) operating system exclusively.

PROCESSORS AND PERIPHERALS

The V-8500 and V-8600 Series processors are microcode based and make extensive use of emitter-coupled logic (ECL) circuitry. The system architectures in these product

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: The segment table origin register guards against inadvertent overriding and/or unauthorized reading of data in specified blocks of storage. This register is standard in the V-8500 and V-8600 systems.

CACHE MEMORY: The V-8600 systems have a cache memory for high-speed access to the most recently stored activities in memory. The V-8600 systems use from 32K bytes to 512K bytes of cache memory.

MEMORY INTERLEAVING: This feature allows either two or four contiguous words to be read from or written to memory without accessing any memory module continuously for more than a single cycle. It also permits multiple simultaneous memory access from several subsystems. Four-way interleaving is provided in the V-8565-II E, V-8575-II, V-8595-II, and all V-8600 systems. The V-8555-II has two-way interleaving, and the V-8545-II do not use interleaving.

CENTRAL PROCESSORS

The Central Processing Units for the V-8500 and V-8600 series systems are built around an Internal Transfer Subsys-

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TABLE 1. 8500 AND 8600 SYSTEMS CHARACTERISTICS (Continued)

	V-8685	V-8695
SYSTEM CHARACTERISTICS		
Date of introduction	May 1983	May 1983
Number of main processors	6	8
Active production	Yes	Yes
Relative performance level, approximate	16.17	21.52
System firmware	VS6	VS6
Operating system	VRX	VRX
Basic system rental per month	$78,385	$98,680
MAIN PROCESSOR		
Cycle time, nanoseconds	38	38
Dynamic address translation hardware	Yes	Yes
Floating-point assist	Yes	Yes
VRX assist (instruction lookahead)	Yes	Yes
Instruction storage capacity, bytes	576K	768K
Upgradable to	V-8695	—
MAIN STORAGE (All MOS, error correcting)		
Memory circuitry	64K chip	64K chip
Cycle time, nanoseconds	380	380
Minimum capacity, bytes	12M	16M
Maximum capacity, bytes	48M	64M
Increment size, bytes	4M	4M
Interleaving	4-way	4-way
I/O CONTROL		
Channels (min./max.)	24 to 64	32 to 64
Channel Control Processors	6 to 12	8 to 16
Maximum disk subsystems per controller	64	64
Maximum no. of common trunks	2	2
Common trunk data rates, bytes/sec.:		
Low-speed trunk	50KB	50KB
Medium-speed trunk	None	None
Very high-speed trunk	1.1MB	1.1MB
I/O Link Controllers	2.0MB	2.0MB
COMMUNICATIONS CONTROL		
Integrated comm. control max. lines	NA	NA
External comm. control max. lines	512	512

families are based on a high-speed Internal Transfer Subsystem, an internal bus with speeds of up to 72 million bytes per second. Various processor and peripheral subsystems, such as the Memory Subsystem and Common Trunk Subsystem, are connected to the internal bus for improved system flexibility. The 8500 processor's "personality," or operating mode, is controlled by firmware. Century emulation firmware permits batch processing, multiprogramming, and on-line transaction processing, and is used on some V-8500 systems. Virtual (on "V" systems) firmware uses virtual memory techniques that provide greater internal processing capabilities and better system resource management. The virtual firmware is available in the V-8500 and V-8600 systems. The V-85X5-II and V-8600 systems are designed specifically to use "V" firmware.

Various processor subsystems can be attached to the common Internal Transfer Subsystem. The Memory Subsystems use 64K MOS memory chips. Memory cycle times range from 380 to 440 nanoseconds. Memory size ranges from one megabyte on the V-8545-II and increases to 16 megabytes on the V-8695.

tem, or high-speed bus, onto which major system components are connected. The processors make extensive use of emitter-coupled logic (ECL) circuitry.

A Processor Subsystem is connected to the Internal Transfer Subsystem. The Processor Subsystem operates under firmware control and performs the following functions in all systems: 1) interprets and executes instructions from software; 2) manages data transfer from main memory to peripheral devices; and 3) performs console functions as requested by the operator.

These additional CPU functions are provided by the Service Subsystem (V-8500) and the System Control Unit (V-8600): 1) firmware loading during start-of-day procedure; 2) peripheral subsystem message management; and 3) system testing diagnostics, and error logging.

The System Control Unit (SCU) is the central control point of the V-8600 systems. Either one or two optional microprogrammed control processors control two independent console displays for operator communications and system diagnostics, two 1-megabyte flexible disk drives for firmware loading and error logging, an optional console printer, and channels for additional CRT/keyboard units which can operate as remote system consoles. From either of the system consoles or a remote console, both primitive level diagnostics (which test the basic hardware functions and

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The maximum memory available ranges from 2 megabytes on the V-8545-II to 64 megabytes on the V-8695. All memory subsystems have single-bit error correction and double-bit error detection. A high-speed cache memory is used in all V-8600 systems. I/O devices can be attached to the system via three peripheral subsystems: 1) the Common Trunk Subsystem, used on V-8500 systems (Trunk Channel Control Processor on V-8600), 2) the I/O Link Control Subsystem, used on V-8500 systems, and 3) the CCP/DCX I/O Subsystem, which is standard on the V-8600 system and optional on V-8500 systems. These systems can accommodate data transfer rates as high as two megabytes per second.

An optional Communications Subsystem is available on all models to connect remote terminals or satellite processors.

The Service Subsystem (V-8500 Series), and the System Control Unit (V-8600 Series) perform the following functions: 1) firmware loading during start-of-day procedures, 2) peripheral subsystem control, and 3) system testing and diagnostics.

The V-8500 Group II systems replaced the older V-8500M models and provide improved price/performance over their predecessors. The five-model product line includes the entry-level V-8545-II, a one-megabyte system that has one-third more power than the V-8535-II, which is now discontinued. It can have up to two megabytes of memory. The V-8555-II has about 40 percent more performance than the V-8545-II, one megabyte of memory, and can be expanded to up to four megabytes. The V-8565-II E has 29 percent more power than the V-8555-II and dual-processor models. This model features the same 56-nanosecond CPU as the larger dual-processor models, four-way memory interleaving for better performance, and a hardware-based Virtual Assist Unit that can boost virtual memory operations. The V-8565-II E has two to eight megabytes of memory. The V-8565-II E is the largest uniprocessor with a tuned firmware set.

At the upper end of the performance scale are two dyadic, or dual-processor systems, the V-8575-II and V-8595-II. These models feature 56-nanosecond processor cycle times and four-way interleaved memory. The V-8575-II has about 20 percent less power than NCR's previous dyadic system the, V-8585-II, which has been discontinued. Users can now upgrade from the V-8575-II to the V-8595-II. The V-8575-II has four to eight megabytes of memory. The largest system is the V-8595-II, which has 4 to 16 megabytes of memory. The V-85X5-II uniprocessor models cannot be field upgraded to the dyadic systems since a swapout of CPUs is required.

The V-8600 Series models include the V-8655 which is configured with two V-8635 processors, the V-8665 which is configured with one V-8635 single- and one V-8645 dual-processor, the V-8675 which is configured with two V-8645 dual-processors, the V-8685 which has three V-8645 dual processors, and the V-8695 which is configured with four V-8645 dual-processors. The smallest of the V-8600 Series processors, the V-8635, has a main memory

capabilities) and virtual level diagnostics (which test the virtual machine functions and capabilities) can be run on system elements while normal operations continue.

The Control Processor (CP) is the primary controlling unit of the SCU. To increase system availability, a second CP is available as an option. Each processor and its control elements operate independently. When the second CP is employed, it provides backup for the primary CP. Both CPs communicate with each other which results in the most efficient use of SCU resources.

Instructions are executed using a three-stage pipeline technique. The three stages are: 1) the fetch stage, which obtains the instruction; 2) the interpret stage, which assembles all necessary operands and decodes the instruction; and 3) the execute stage, which performs the specified operation. It takes three processor cycles to perform an instruction, and all three stages are active, continuously performing their respective functions on three separate instructions. This provides an effective execution rate of one instruction per processor cycle. All of the V-8600 systems include a high-speed cache buffer (32K bytes in the V-8635 and 512K bytes in the V-8695) for increased performance.

The 85X5-II series offers multiple processor configurations in either tightly or loosely coupled configurations. Loosely coupled configurations can include up to eight processors, and tightly coupled configurations can consist of either two uniprocessors or two dyadic processors connected together. A tightly coupled dyadic can be included in a loosely coupled configuration. Tightly coupled systems run under a single copy of VRX/MP with all processors sharing access to all memory and peripherals. Loosely coupled systems use a separate copy of VRX for each processor (one copy for a dyadic) in the configuration with all processors sharing a common peripheral pool.

The 86X5 series also offers multiple processor configurations. The base models in this series include the single-processor 8635 and the dual-processor 8645. The remaining 8655, 8665, 8675, 8685, and 8695 models are made up of multiple configurations of the base models and are termed the "processor complex" models. The 8655 consists of two 8635 processors, the 8665 consists of one 8635 single- and one 8645 dual-processor, the 8675 consists of two 8645 dual-processors, the 8685 consists of three 8645 dual-processors, and the 8695 consists of four 8645 dual-processors. The dual-processor 8645 is a tightly coupled system and the 8655 is loosely coupled; however, when a complex processor system includes both an 8635 and an 8645 system, a unique combination of both tight and loose coupling results.

Connecting two or more 85X5-II systems into a tightly coupled MP configuration requires an MP kit which contains all the necessary hardware. The MP conversion requires an Interbus Cable between each processor, an additional Instruction Storage Unit to hold the larger VRX/MP (also known as VS2) firmware, and a two-sided floppy disk for each processor that contains the VRX/MP firmware. The V-8575-II, and the V-8595-II, are dual-processor systems also operating under VRX/MP. The maximum four-processor configurations can be obtained by connecting two of the same models together via an Interbus Communications Adapter. No ISUs are needed.

INDEX REGISTERS: A separate set of sixty-four 32-bit registers is maintained in reserved storage for each active program. The 64-word set associated with the program currently being executed by the processor is brought from memory and contained in a hardware register set.

INSTRUCTION REPERTOIRE: There are two basic system instruction sets: the V-8500 Base Virtual Machine and the VRX Virtual Machine. The Base Virtual Machine uses

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Table 2. MASS STORAGE

Subsystems	658	6530	6540	6550
Cabinets per subsystems	1	1 or 2	1 or 2	1
Disk packs/HDAs per cabinet	1	2 to 4	2 to 4	2
Capacity, megabytes	100 to 200	27 to 81	540	1,092
Average access time, milliseconds	20 to 30	30	30	25
Average rotational delay, milliseconds	8.33	8.33	8.33	8.33
Data transfer rate, bytes/second	806,000	1,200,000	1,200,000	1,200,000
Controller model	IDC 625-0301	6539	6549	6559
Comments:	Bit Serial I/O Link Controller/Adapter combination recommended			

capacity of eight megabytes while the larger V–8695 has a main memory capacity of 64 megabytes. The V–8645 is a tightly coupled dyadic; however, a unique combination of both tight and loose coupling is achieved when a V–8635 and a V–8645 are configured together.

The current V–8500 and V–8600 systems can use most of the peripheral devices that have been used on the more mature Century and Criterion systems. Users have a wide variety of peripherals to select from, including mass storage devices ranging from 10 megabytes up to 1.1 gigabytes, 5 tape drives with numerous configurations, a large assortment of low-, medium- and high-speed printers, and various unit record and MICR devices.

Communications with remote terminals and remote hosts can be achieved via the Integrated Communications Subsystem (this applies to V–8500 uniprocessors only) and the 621–103 Communications Multiplexer. The ICS provides up to 20 lines for on-line remote communications with terminals operating at from 50 to 9600 bps. The free-standing 621–103 Communications Multiplexer can accommodate a mix of asynchronous and synchronous lines up to 255 lines. Asynchronous lines can handle devices ranging up to 9600 bps, and synchronous lines can accommodate up to 56,000 bps speeds.

SOFTWARE AND SUPPORT

A choice of operating systems is available for V–8500 systems. To provide a migration path for existing NCR Century operating systems, uniprocessor V–8500 models can function with any of these operating systems, provided the Century-emulating firmware is used. B–Series applications can be executed without the RS1 firmware if run under the VRX operating system. The Century operating systems can support single-user and multiprogrammed batch operations. Languages supported include Cobol–74, Fortran, RPG, Basic, and NEAT/3 assembler.

When using the Virtual Resource Executive (VRX), the user will effectively have 16 million bytes of storage available for each program, regardless of the real memory capacity. VRX operates under the VS1 firmware in a uniprocessor system and the VS2 and VS6 firmware in a multiprocessor environment. The virtual-memory VRX

the 71-instruction set found in the NCR Century 300 computer. The VRX Virtual Machine instruction set contains 95 instructions in the uniprocessor (VS1) version, and 103 instructions in the multiprocessor (VS2) version. The following table summarizes the instruction sets for both the Base Virtual Machine and the VRX Virtual Machine:

	Base Virtual Machine	VRX Virtual Machine
Fixed Point Binary	**11**	**11**
Decimal Arithmetic	**9**	**9**
Move Data	**3**	**6**
Logical	**8**	**12**
Transfer	**13**	**24**
Special	**15**	**17**
Input/Output	**—**	**4**
Floating Point	**12**	**12**

The additional instructions used in the multiprocessor VS2 set are for monitor and control functions within the larger system configuration.

A third virtual machine, the Cobol Virtual Machine, is a language processor that uses a portion of the VS firmware set to process object code generated by the VRX Cobol compiler.

VRX Fortran is available on V–85X5–II (with a hardware assist option) and V–8600 systems for processing ANSI Fortran 77 object code.

The VRX Virtual Machine permits programs currently running on the Base Virtual Machine and NCR Century processors to run on systems using the VRX operating system.

INSTRUCTION STORAGE UNIT (ISU): In all NCR V–8500 and V–8600 systems, most of the firmware that directs the system to perform the required functions (as a Century system or a virtual memory system) is stored in a high-speed memory called the Instruction Storage Unit. Capacity of the ISU ranges from 24K bytes on the V–8545 to 192K bytes on the V–8645.

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.

INPUT/OUTPUT CONTROL

Input/output control within the V–85X5–II systems is provided through three types of subsystems: Common Trunk

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can also run Century programs with minimal reconfigurations. The current version of VRX is Release 11.

As programs are executed under VRX, it uses special hardware called the Dynamic Address Translator to assign currently active portions of virtual storage to real memory. VRX supports various functions, such as batch, transaction processing, remote job entry (RJE), multiple RJE, direct program access, and on-line program development.

A primary feature of VRX is the 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. For even greater database management requirements, NCR offers the popular TOTAL, from Cincom Systems, and TOTAL IQL, an interactive query language.

Three compilers are available with VRX: Cobol–74, Fortran 77, Basic, and NEAT/VS. The VRX Cobol–74 compiler is an implementation of the ANSI 1974-standard language; it produces object code for the Cobol virtual machine which runs under VRX. The NEAT/VS compiler is compatible with NCR's NEAT/3, a macrooriented assembly language, and provides programming interfaces to VRX. The Fortran 77 compiler conforms to the ANSI Fortran 77 standards and requires an Extended Hardware Assist feature on all V–85X5–II Series processors. The Basic 78 compiler conforms to the ANSI Basic standard.

Transaction processing and on-line program development support are key elements in NCR's product strategies. Leading the transaction processing movement is VRX TRAN–PRO, a general-purpose monitor that utilizes the speed and efficiency of VRX to its maximum benefit. NCR has three systems to facilitate the transition from batch to on-line operations, including VRX IVS Telecomm/Development Package, which defines the network configuration, VRX TRAN–PRO transaction processing monitor which provides greater on-line efficiencies, and the DMS Data Entry System, for improved data entry operations.

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 disciplines, and existing Century on-line applications are supported.

Customer Operated Automatic Checkout (COACH) diagnostics, capable of isolating hardware problems to a faulty module, are available to V–8500 and V–8600 users. COACH enables the user to provide advanced information to the NCR field engineer concerning the nature of the problem prior to his/her 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

I/O Subsystems, the I/O Link Controller (IOLC) used on all V–8500 systems, and the CCP/DCD combination.

I/O control on V–8600 systems is maintained by two basic subsystems: Channel Control Processors (CCP) which can control up to 32 peripheral channels, and an optional Trunk Channel Control Processor (TCCP), both of which interface with a wide variety of peripherals.

The Trunk Channel Control Processor (TCCP) subsystem uses either low- or very high-speed trunks.

Low-speed trunks provide for single-byte transfers to and from the CPU. The CPU performs the data transfers using reserved memory locations for control registers.

Medium-speed trunks have two major improvements over their low-speed counterparts. The control registers implemented in memory are contained in the trunk circuitry, and a 4-byte interface is used instead of the single-byte interface. The CPU performs the data transfers to and from main memory.

Very high-speed trunks are direct memory access devices that do not require any CPU activity. They include all the features of the medium-speed trunks and also have memory address generation circuitry and up to two stages of data buffering. The very high-speed trunks perform all functions necessary to transfer data to and from main memory.

The I/O Link Controller Subsystem is based on three elements: the I/O Link Controller, I/O Links, and the I/O Link Adapter. The I/O Link Controller (IOLC) can attach up to four peripheral subsystems through I/O links. Up to six IOLCs can be configured in the V–8545–II and V–8555–II and up to eight in the V–8565–IIE, V–8575–II, and V–8595–II. The I/O Link is a coaxial cable that provides a two-megabyte-per-second bit-serial data path between the IOLC and the I/O Link Adapter (IOLA). The IOLA is a buffered interface that provides the timing necessary to connect the peripheral to the IOLC subsystem. Up to four I/O Link Adapters can be attached to an I/O Link Controller.

Channel Control Processors in the V–8600 I/O Subsystem (optional on 85X5–II) interface directly to main memory via the Internal Transfer Subsystem. All I/O management functions are performed by the CCP with no involvement of the CPU required. Two CCPs are standard on the V–8600, and two more are optional. Up to four are optional on the V–8555–II through V–8595–II models. On the 8635 and 8645, up to 32 channels connect various peripheral subsystems to the CCP through the Dynamic Channel Exchange (DCX), a switching center that provides bit-serial data paths between the peripheral and CCP. Since all CCPs connect to the DCX, the loss of a CCP does not result in the loss of I/O devices. Automatic load leveling is also provided with this arrangement. The maximum data transfer rate over each channel is two megabytes per second. In those situations where an I/O device is not compatible with the CCP, an optional Trunk Channel Control Processor (TCCP) can be used. Up to two NCR common trunks (either low- or very high-speed) can be connected to the TCCP for these devices. The configurations available include either one low-speed or two low-speed, or one low-speed and one high-speed.

The Dynamic Channel Director (DCD) is a solid-state electronic switch and is used on the V–8600 processor complex models in place of the DCX. The DCD offers additional I/O capabilities that provide the intersystem communication required for loose coupling. The basic 4-by-16 DCD module connects any of four CCPs to any of 15 channels and one System to System Adapter (SSA). DCDs are available in four sizes: 4-by-16, 8-by-32, 12-by-48, and 16-by-64. Additional DCDs can be connected to provide

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TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed Inches/Sec.	Transfer Rate, Bytes/Sec.
6340-215/205	9	1600	PE	50	80,000
6340-219	9	800 1600	NRZI PE PE/ NRZI	50	40,000 to 80,000
6370-0401	9	1600 6250	PE GCR	75	120,000 to 468,750
6370-0601	9	1600 6250	PE GCR	125	200,000 to 781,250
6370-0801	9	1600 6250	PE GCR	200	320,000 to 1,250,000
Printers	**Printing Speed**	**Print Positions**	**Horizontal Spacing, Chars./Inch**	**Vertical Spacing, Lines/Inch**	**Form Size, Inches**
647-201	2000 to 3500 lpm	132	10/15 cpi	6 or 8	Industry Std.
6420-0101	300 lpm	132	10/15 cpi	6 or 8	Industry Std.
6420-0201	600 lpm	132	10/15 cpi	6 or 8	Industry Std.
6420-0301	900 lpm	132	10/15 cpi	6 or 8	Industry Std.
6420-0601	1200 lpm	132	10/15 cpi	6 or 8	Industry Std.
Punched Card Equipment	**Columns**	**Speed Cards/Min.**	**Input Hopper Capacity**	**Output Stacker Capacity**	**Options**
6831-0201/0301	80	600	1000	1000	—
MICR/OCR Reader/Sorters	**Type Font**	**Speed, Documents/Min.**	**Number of Stackers**	**Document Size, Inches**	**Options**
670-101	—	600	11	variable	off-line sorting
671-101	—	1200	18	—	off-line sorting, endorser
6755-101	—	750	11	6	
6781-0101	E13B	800 to 1440	up to 34	6	—

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NCR specialists to the customer's system for even greater levels of diagnosis and analysis.

NCR COMMUNICATIONS NETWORK ARCHITECTURE

NCR's comprehensive communications network design, NCR/CNA, is composed of software and various services that define NCR's overall network strategy for the 1980s. NCR/CNA includes NCR/Data Link Control protocol, intranetwork disciplines, access methods, and other telecommunications functions. The NCR/CNA approach permits each processor to function in an independent or distributed mode, which reduces the need for a centralized host to control the network.

The network protocol, NCR/Data Link Control (NCR/DLC), is a bit-oriented control protocol in accordance with ANSI's ADCCP and ISO's HDLC. NCR/DLC will support SDLC and the protocols of other vendors, such as BSC and TTY. For short-distance communications links, NCR/DLC includes a proprietary, modemless technique for high-speed (48,000 bps) transmission. A Virtual Circuit Interface, based on CCITT's X.25, will also be supported, enabling the network to provide communications links with public packet switching networks.

CNA's processor access method, NCR/Telecommunications Access Method (NCR/TAM), will provide a standard, transparent telecommunications handler for application programs. The application program interface with NCR/TAM is the ANSI Cobol-74 Message Control System. The functions performed by NCR/TAM include system and link control queue management, resource scheduling, packet header processing, error recovery and reporting, and diagnostic support.

COMPETITIVE POSITION

The NCR V-8500 Series is marketed to compete with the IBM 4300 Series in the areas of price and performance. The V-8555-II has 40 percent more processing power than the V-8545-II, and is comparable to the IBM 4331-11. The V-8565-II E has 29 percent more power than the V-8555-II, and compares with the Burroughs B 5920. The V-8575-II is comparable to the IBM 4341-1. The top-end V-8595-II is comparable in performance to the IBM 4341 Model Group 11. According to NCR, dual-processor versions of the V-85X5-II series can provide up to twice the performance of comparable uniprocessor configurations.

The top-of-the-line V-8695 is equal in rank with the Honeywell DPS 8/70 with a total main memory capacity of 64 megabytes. The V-8695 has four times the main storage capacity as the previous V-8670. The V-8655 has the same amount of main storage capacity (16 megabytes) as the IBM 4341 Model Group 12. The low-end V-8635, with up to eight megabytes of maximum main storage, ranks equally with the Sperry 90/80-4.

high availability and/or additional I/O ports. The SSA is a bit-serial link device which allows multiple hosts to indirectly communicate with each other.

The Dynamic Channel Director, Channel Control Processor, and System-to-System Adapter are part of the combination hardware/software incremental architecture that provides multiprocessing capabilities. Computer users have the option of loose coupling, or a combination of loose and tight coupling in the configuration. Each loosely coupled host processor executes its own copy of VRX. In the event of a hardware, software, or firmware failure, duplicate copies of the critical applications can be automatically activated to continue processing at the exact point of failure, thus ensuring data integrity and high availability of the system. The failure can then be isolated and repaired while processing continues.

CONFIGURATION RULES: The number of I/O links and channel control processors that can be included with each type of system and the data rates for each type of interface are included in Table 1 in this report. On-line operations can be connected via the Integrated Communications Subsystem, or a common trunk. NCR's latest disk subsystems and other associated peripherals are interfaced through a fully buffered Bit Serial I/O Link Controller. This interface maximizes I/O throughput, lowers I/O and central processor contention, and eliminates the need for common trunk interfaces.

MASS STORAGE

For information on mass storage devices on the V-8500 and V-8600 systems, refer to Table 2.

INPUT/OUTPUT UNITS

Refer to Table 3 for information on tape units, printers, card equipment, and MICR/OCR equipment on the NCR V-8500 and V-8600 systems.

COMMUNICATION CONTROL

INTEGRATED COMMUNICATIONS SUBSYSTEM: The Integrated Communications Subsystem provides up to 20 lines for on-line/realtime 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 (Communications Line Controllers), controlled by firmware, supervise the access, transmission, and output to and from the terminals in the system. A multiplexer or front-end processor can be added to the system to handle additional communications lines. The Integrated Communications Subsystem is available on the V-8545-II, 8555-II and 8565-II E.

621-103 COMMUNICATIONS MULTIPLEXER: This system is capable of handling 15, 127, or 253 lines, using centralized character parity assembly and stripping, plus Centralized Block Checking (CBC), Cyclic Redundancy Checking (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 Subsystem. 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 4800 bits/sec., and synchronous devices at speeds ranging from 600 to 50,000 bits/sec. Asynchronous speeds up to 19.2K bits per second are available with the addition of a clock driver.

692-600 ASYNCHRONOUS LINE ADAPTER: An interface device that connects the 621-103 Communications

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ADVANTAGES AND RESTRICTIONS

The V–8600 series hardware has many performance advantages over the V–8500 series processors. The V–8600 has a 32 percent faster cycle time than the V–8500. A high-speed cache memory which acts as a buffer between the processor and main memory exists on the V–8600 and not on the V–8500. Retrieval of data from cache memory is approximately six times faster than from main memory, allowing the processor to work more efficiently. The 32-entry Dynamic Address Translator (DAT) on the V–8600 is double the size of the V–8500 DAT, which enhances virtual storage operations by reducing the frequency of time-consuming page faults. Arithmetic functions that were performed by microcode in the V–8500 are now performed by the Arithmetic Assist Unit (AAU) hardware. This feature significantly speeds up programs written in Fortran.

The announced enhancements to both the V–8500 and V–8600 provide fault-tolerance with automatic recovery. The concept of fault-tolerance emerged as a result of the need for more reliable computers for military and aerospace applications. These types of systems were first developed and built as custom systems in the 1950s. Characteristics of fault-tolerant systems are redundancy, fault-detection, fault-isolation, reconfiguration, and repair. Systems with these characteristics can achieve higher reliability and minimize the effects as well as the cost of computer system failures. The disk subsystem with the largest mass storage capacity available to the NCR V–8500 or V–8600 user is the 1.1-billion-byte 6550 Disk Subsystem with a data transfer rate of 1.2 megabytes per second. On a system that can access up to 64 megabytes of main memory, the user may find a need for larger disk capacities to accommodate large databases. In order to meet this need, NCR V–8500 or V–8600 users can configure multiple 6550s.

PL/1, a higher-level programming language, is not supported on the NCR V–8500 or on the V–8600 Series. PL/1 is supported on comparable systems of other vendors such as Burroughs, IBM, Honeywell, and Sperry.

USER REACTION

Datapro received a total of 141 NCR user responses in our 1984 survey of computer users. The user population consisted of a wide variety of business types, with banking/finance institutions (26 percent), retail/wholesale (20 percent), and manufacturing (14 percent) represented most frequently. The primary applications were payroll/personnel operations (67 percent), and traditional accounting/billing (67 percent) although many others were mentioned. The average installed time was a little more than three years for both the V–8500 and V–8600 systems. About 54 percent of the respondents had purchased their equipment from NCR, 24 percent rented the equipment from NCR and third-party leases averaged about 22 percent. Most users developed their applications programs in-house (85 percent), with the purchase of NCR-developed programs almost as popular (61 percent). The user responses for both

Multiplexer to one or more terminals. It can handle half- and full-duplex transmissions at speeds ranging from 45 to 19.2K bits per second. It meets both EIA RS–232–C and CCITT V.24 data communications interface standards.

693–600 SYNCHRONOUS LINE ADAPTER: An interface device that connects the 621–103 Communications Multiplexer to a data set for synchronous data transmissions. It can handle half- and full-duplex modes at speeds ranging from 600 to 50,000 bits per second. It meets both EIA RS–232–C and CCITT V.24 data communications interface standards.

7900 VISUAL DISPLAY TERMINAL: The 7900 Model 1 Terminal is a microprocessor-based CRT that operates asynchronously and can communicate with all V–8500 and V–8600 systems. The CRT has a 12-inch diagonal display with 25 lines of 80 characters each. It uses a 7-by-7 dot matrix display and features five cursor controls, blinking, reverse video, and underlining. The keyboard can generate a full 128-character ASCII set and includes a numeric pad. The 7900 can operate in either half- or full-duplex mode, and transmits at speeds ranging from 50 to 19,200 bits per second. The terminal has an EIA/20 ma current loop interface and a serial interface for printers.

SOFTWARE

OPERATING SYSTEM: NCR offers a virtual operating system (VRX) for the V–8500 Series computers.

VIRTUAL RESOURCE EXECUTIVE (VRX): Enhancements to the VRX operating system, which were announced in April 1984, make up the software component of NCR's incremental architecture. InstantReady and peripheral pooling capabilities are accomplished via the Inter-Host Management Facility (IHMF).

Instantready allows the user to put a backup copy of critical on-line applications in a secondary host processor. Peripheral pooling provides sharing of peripheral devices among multiple host processors.

VRX is a group of software modules that utilize the VS1, VS2, or VS6 firmware to make up a flexible operating system with multiprocessing, virtual-machine, and virtual-storage capabilities, while remaining compatible with older NCR Century programs. VRX supports multiple-processor systems and treats processing elements in the system as assignable resources. The current level of VRX is Release 11, which includes incremental architecture capabilities.

VRX uses virtual storage, allows supervisor routines to map main memory to disk, and allows executing programs to be relocated between main storage and secondary storage without directly involving the executing program itself. Using paging supervisor routines, VRX reads scheduled jobs from the page file on disk and writes changed pages back to disk as necessary. It attempts to optimize memory usage globally by allocating only enough real memory to a job to ensure efficient execution, releasing unused memory as soon as it becomes available.

In a virtual storage environment, a 16-million-byte virtual address space is available to each active job. Eight million bytes are used in common by the executive and certain software for all programs, and are referred to as the global software area. The remaining eight million bytes (local area) are used by the individual job for programs and data.

VRX monitors memory demands and performance for the entire job mix in order to detect excessive paging in or out (thrashing) and system underutilization. If it detects thrashing, the paging supervisor can reduce the number of active jobs; if it detects underutilization, it can activate new jobs

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the V-8500 and V-8600 systems are presented in the chart below.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	51	84	4	2	3.34
Reliability of mainframe	73	60	5	1	3.47
Reliability of peripherals	56	73	82	1	3.33
Maintenance service:					
Responsiveness	60	59	18	1	3.29
Effectiveness	36	81	18	2	3.10
Technical support:					
Troubleshooting	20	73	35	8	2.77
Education	17	93	24	3	2.91
Documentation	9	81	43	43	2.69
Manufacturers software:					
Operating system	44	76	14	1	3.21
Compiler & assemblers	35	84	15	2	3.12
Application programs	10	62	39	14	2.54
Ease of programming	21	93	22	1	2.98
Ease of conversion	45	66	21	4	3.12
Overall satisfaction	26	97	13	1	3.08

*Weighted Average on a scale of 4.0 for Excellent.

We also asked the users to rate the V-8500 and V-8600 in additional areas. Those user responses are represented in the chart below.

	Excellent	Good	Fair	Poor	WA*
Ease of conversion/ reconfiguration	58	68	8	3	3.32
Compatibility of terminals/peripherals carried over from other systems	56	47	18	9	3.15
Compatibility of programs data carried over from other systems	65	44	14	11	3.22
Power/energy efficiency	26	90	18	7	3.06
Productivity aids help keep programming costs low	18	64	48	5	2.70
Software/support promised by vendor	6	68	49	13	2.49

*Weighted Average based on a scale of 4.0 for Excellent.

We also asked the NCR users two final questions: "Did the system measure up to your expectations?" and, "Would you recommend it to another user?" Better than 90 percent of the V-8500 and V-8600 users felt their systems performed as they had expected. Less than 3 percent were unsatisfied with their computers. Approximately 85 percent of the V-8500 and V-8600 users said they would recommend their systems to others. About 7 percent in both user groups answered "no" to this question. □

and increase the system workload. Memory utilization statistics are recorded for every run and can be used to tune the system.

VRX multiprocessing (VRX/MP) enables the system to schedule and run multiple jobs at the same time by automatically allocating the peripherals, memory, and processor as needed. Each job may contain one or more related programs. Jobs are described to the system using a Job Control Language made up of Job Specification Language (JSL) statements and Monitor Control Language (MCL) statements. The Job Specification Language statements are used to define the hardware and media requirements of the job, while the Monitor Control Language statements identify the programs within each job and specify any runtime conditions for those programs. VRX permits users to assume as little or as much control over job processing as needed. Most scheduling, allocation, and processing decisions can be made by the software itself.

The VRX software, together with the virtual-storage firmware, enables the system to perform like two different machines using two different firmware instruction sets. The basic instruction set, called the Base VRX Instruction Set, makes the VRX system compatible with NCR Century systems and provides an interface for the virtual-storage software, while the optional VRX Cobol Instruction Set is designed to process VRX Cobol object code. A firmware routine automatically switches between the two firmware instruction sets as needed.

Virtual-storage firmware and software enable user programs, compilers, application software, and utility routines to run on the system without regard to the number of processors or the total amount of real memory. Only the active code of each program is in real memory during program processing.

The peripherals and memory are assigned dynamically, and the operating software is also brought into memory only when needed and assigned space where available. There are no fixed processor assignments, no fixed partitions, and no fixed areas in real memory for software or program code. All inactive software and program code is stored in the Page File. Page sizes may be 1024 bytes, 2048 bytes, 4096 bytes, or 8192 bytes.

When a job is first introduced, via punched cards or on-line terminals, into the VRX system, the executive stores job specifications and any data parameters for the job in a spool file on disk and then validates the specifications. Once in the system, the job progresses through three distinct phases: scheduling, execution, and output. During the scheduling phase, a job can be in any of several states. Between acceptance and specification validation, it is in an unprocessed state. Following validation, if specifications indicate that execution should be delayed until some event such as operator action or completion of another job has occurred, the system will place the job temporarily in a hold state. Otherwise, the job enters the scheduling state, where it is placed in a scheduled job queue to await execution. The order in which jobs are placed in the queue is determined by the priority given in the specifications. As memory and peripherals become available, VRX software accesses the scheduled job queue and attempts to execute the highest priority job. If sufficient memory and peripherals are not available to execute the highest priority job, the software scans the remaining jobs on the queue to see if any of these can be executed with the available resources.

When a job passes to the execution phase, it competes with other jobs in the execution mix for processor and shared resource time. Resource allocation is determined by execution priorities assigned in job specifications. During execution, control and user data are supplied on demand from the card input spool file. Print file output is also normally spooled on disk or, optionally, magnetic tape. When a job completes the execution phase, the executive releases all the peripherals and memory space used.

The job then enters the output phase, where it remains until its spooled print files have been printed. Job printing order is likewise determined by priorities assigned in the job specifications. At the end of the output phase, job accounting

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information is entered into the log and the job is removed from the system.

VRX provides two separate logs: a hardware log and a system log. The hardware log contains information valuable to the field engineer for system maintenance, while the system log contains operation and statistics messages that can be used for job accounting and performance evaluation.

VRX provides several levels of error recovery systems, each designed for specific applications. These facilities include a CAM (Criterion Access Method) file error recovery sytem, which uses CAM utilities to restore CAM files if an error occurs. There is also a batch recovery sytem, called Rescue/Restart, that enables a program to be continued from a previously defined rescue point rather than at the start.

VRX also provides for system recovery if an error condition results in the need to initialize the software again. A special Recovery Initialization system (REINIT) causes the software to save important system information such as spooled files before initialization so that currently active jobs can be started again.

The Inter Host Communication (IHC) facility is responsible for the communication between base processors in loosely coupled configurations. The two components which make up the IHC are: 1) a task which receives messages from other hosts via the SSA and routes those messages to the appropriate task within this host, and 2) a set of "user-callable" routines to perform output to other hosts. The capability for VRX and applications to communicate host to host is provided by the IHC. It is necessary to detect failure and to activate automatic recovery.

The VRX System Performance Measurement utility monitors the entire system's performance levels and produces printed reports to that effect in graphic or tabular format.

The Virtual Resource Executive incorporates facilities for handling NCR Century Series files, including sequential files, standard disk files, chained disk files, indexed sequential files, and NCR random filing system files. It also uses a file management technique called the Criterion Access Method (CAM) that has been specifically designed for high performance under VRX with applications programmed in Cobol–74 and NEAT/VS. The CAM file structure minimizes reorganization and allows rapid insertion of records, eliminating many of the inefficiencies inherent in traditional random and indexed sequential accessing methods.

The access method has been designed to meet Cobol–74 requirements for sequential, indexed, and relative file processing. Since record and key lengths are variable and records with identical keys are permitted, CAM allows records to be designed in the most natural manner, and at the same time reduces external storage requirements.

The VRX Remote Job Entry subsystem (RJE) enables jobs to be input to the central computer system from remote locations by telephone communications lines; printer output is returned to the remote locations over the same lines. A remote terminal can also send messages to the central system or to any other terminal in the system.

VRX provides the Interactive Virtual System (IVS) to generate source programs from remote locations. The program may be compiled and run on the remote terminal. It also permits a user to create and run a cataloged job or disk control string from a remote location, to access spooled print files, and to communicate with executing VRX jobs.

The VRX Base System Package provides standard batch operating systems functions. Specifically, it can compile programs written in VRX Cobol–74, sort and merge various types of files, utilize NCR disk subsystems such as the 658, 6530, 6540, and 6550 with the capability of accessing greater than 64K disk sectors, perform general housekeeping functions, provide system performance data, analyze Cobol programs to maximize program efficiency, and provide improved disk storage management in a realtime environment.

The VRX IVS Telecomm/Development Package permits the migration of a batch system to an on-line environment through user definition of the network configuration, user development of the on-line application, and direct user access to VRX print spool files and the VRX executive software.

Another tool to facilitate the change from batch to on-line is the DMS Data Entry System. Data enters the system through user-defined formats and is stored in the DMS data entry file. The system controls and validates the input data via batch totals, range checks, check digits, and arithmetic operations. Various utilities are provided to deal efficiently with batch data, and system performance statistics are available at the user's discretion.

VRX TRAN–PRO is a general purpose transaction processing monitor that supports on-line applications in a realtime environment. TRAN–PRO uses the VRX virtual memory to increase overall throughput and interfaces VRX tasking and dynamic storage allocation functions to decrease application program requirements. It operates in conjunction with the VRX Message Control System (MCS) to route the remote inputs into the TRAN–PRO system. VRX TRAN–PRO can be implemented in V–8500 and V–8600 systems.

TOTAL: This popular data base management system, developed by Cincom Systems, Inc., is marketed and supported by NCR through a one-time license fee of $36,000 per single-processor installation or a monthly license fee of $1,092. TOTAL is described in detail in Report 70E–132–01.

NCR also offers the DMS–Query interactive query language, a nonprocedural data retrieval language designed for use by nonprogrammers. The retrieval language permits users to direct inquiries to nearly any data file at any time. A data dictionary language allows the data base manager to limit specific user access to data at the field level by assigning passwords or access codes. DMS–Query is offered for a monthly license fee of $300.

COMPILERS AND ASSEMBLERS: VRX processes programs from several different compilers, such as NEAT/3, NEAT/VS, Century Cobol–68, Century Cobol–74, VRX Cobol, Fortran 66, VRX Fortran 77, VRX Basic, and NCR RPG. Certain compilers are designed to generate object code for B–series operating systems: NEAT/3, Century Cobol–68, Century Cobol–74, Century Fortran, and NCR RPG. The remaining compilers (NEAT/VS, VRX Cobol, VRX Basic, and VRX Fortran) are designed for the VRX virtual-storage operating system. B–series compilers generate object code which can be loaded and run by the VRX operating system. VRX compilers generate object modules which are then processed by the VRX Linkage Editor before loading and processing.

COBOL 74: Meets both ANSI and federal requirements for Cobol 74, providing the highest level of support for most modules and medium-level support for all other modules.

FORTRAN: Several levels of implementation of Fortran are supported, 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. Intermediate Fortran (1130 compatible), Fortran IV, and Fortran E (Educational) are available on all systems.

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ASSEMBLER: NEAT/3 is NCR's assembler language. Strong emphasis is placed upon the use of macroinstructions to facilitate coding. NEAT/3 Level 1 is a subset of NEAT/3 that provides an easy-to-learn programming language and fast compilation. NEAT/VS is an enhanced version of NEAT/3 that includes all the features of the original language plus extensions to exploit the virtual memory features of the VRX-based systems. Generally, the enhancements permit mixing of older Century programs with those written for execution under the newer operating systems. NEAT/VS can also process Century chained files, indexed-sequential files, or random files as well as the Criterion Access Method (CAM) files.

BASIC: Two versions of Basic are offered: a compiler and an interpreter. Programs are compiled as they are entered from remote teletypewriters and can be executed immediately with the interpretive version. 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.

TELECOMMUNICATIONS

VRX provides telecommunications software that has been designed to simplify the application programmer's task by alleviating the concern for network configurations and communications protocols. The Message Control System is a high-level interface that allows on-line programs to transmit messages using logical source/destination names with no reference to terminal characteristics. It consists of five verbs—SEND, RECEIVE, ENABLE, DISABLE, and ACCEPT (message count)—that reference an MCS queue list. NDL statements specify terminals and communication links. These statements are used by the Network Definition Language Processor to create the tables necessary for on-line operation. The tables are subsequently combined with programs at load time by the Link Editor.

NCR's communications structure is called the NCR Communications Network Architecture (CNA). It is designed around the concept of logical addresses for each communicating location, without regard for local line configurations and system protocols. The network is essentially transparent to the user. Message flow is regulated by all nodes in the network, rather than a single host, resulting in better use of processing power throughout the network.

NCR/CNA uses NCR/DLC, SDLC, BSC, X.25, or TTY communications protocols. NCR/DLC is similar to ANSI/ADCCP and ISO/HDLC protocols, and will be compatible with IBM's SDLC. The NCR Telecommunications Access Method (NCR/TAM) software provides the gateway from the field terminal to the application program, and typically uses the Cobol Message Control System (MCS).

APPLICATION 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:

Commercial Accounts Receivable

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

Stewardship and Management Accounting

Student Scheduling and Grade Reporting

Student Test Analysis

Utility Billing

Department Store Sales Audit

General Reporting System

Project Network Analysis (PNA)

Basic Estimating Technique (BETS)

Fashion Reporting

Stable Stock Replenishment

CIF 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

Computerized Loan and Savings System (CLASS)

Credit Management System

Delinquent Accounts Receivable

Purchase Order Management

Laboratory Reporting System

Pharmacy System (Hospital)

Interactive Financial Management System

Interactive Hospital Information System

On-Line Order Processing/Inventory Control

Bill of Material

Materials Management

Manufacturing Inventory Management

Material Requirements Planning

Routings

Standard Costings

NCR V-8500 and V-8600 Systems

Manufacturing Order Processing

Work-in-Process

Master Production Scheduling

Capacity Requirements Planning

Purchasing and Receiving

EQUIPMENT

The following configurations illustrate the V-8545-II, V-8565-IIE and V-8645 systems. The quoted prices include all necessary hardware components, but no software.

ENTRY-LEVEL V-8545-II SYSTEM: Includes V-8545-II central processing unit with a CRT console, 1024K bytes of main memory, 10 communications lines, and an I/O Link Controlller ; 297MB of fixed and removable disk (6540-2403 and 6530-1301), and one 720-lpm 6420-3202 band printer. The purchase price is $102,272, the annual maintenance cost is $9,252 and the monthly rental cost on a one year contract is $7,692.

MID RANGE V-8565-II E SYSTEM: Includes V-8565-II E uniprocessor with 2048K bytes of main memory, three IOLCs and a CRT console; one 1350-megabyte fixed disk storage subsystem, two 6370-4402 magnetic tape units, one 1440-lpm 6420-0601 line printer, one 6831-0201 600-card/minute card reader, and one 5600-P705 card reader interface. The purchase price is $276,985, the annual maintenance cost is $26,808, and the monthly rental cost is $9,126.

HIGH PERFORMANCE V-8645 SYSTEM: Includes V-8645 dual-processor with 4096K bytes of main memory, 128K bytes of cache memory, two Channel Control Processors, 16 I/O channels, two CRT consoles, and one System Control Unit, with one Control Processor; one 1092-megabyte 6550-0101 disk drive, two 6550-0201 disk drives, one 6559-0101 I/O link adapter, six 200-megabyte 0658-0401 disk drives, one 6589-0101 disk controller, one 6032-0707 auxiliary cabinet, four 9-track 6370-0801 magnetic tape units, one 6379-0801 I/O link adapter, one 200-lpm 0647-0201 train printer, one 0647-P001 I/O link adapter, one 0960-0164 print train, and one 6831-0202 600-card/minute card reader. The purchase price is $1,253,211, the annual maintenance cost is $70,524 and the monthly rental cost is $43,031 on a three-year contract.

PRICING

SOFTWARE: NCR continues its policy of unbundling software costs. In most cases there is a monthly licensing charge and for certain packages also an initial licensing fee. The monthly charge ranges up to slightly over $1,000 and initial fees range up to about $36,000.

The pricing policy for NCR applications software includes an initial license fee plus a monthly fee. The initial fee ranges from $653 to over $50,000. Payment of the initial fee provides for one year of use without additional monthly fees. Thereafter, the monthly license fees range from $10 to $700 a month.

SUPPORT: NCR has a Central Support plan in which a toll-free telephone number is supplied for telephone assistance. The Central Support Extended plan is an optional monthly fee for designated products and provides an on-site systems engineer if the problem cannot be resolved over the telephone. If this option is not taken, and the customer requests on-site service NCR systems support is offered to V-8000 Series users at the rate of $104 per hour for a systems engineer to test and resolve problems on site.

EDUCATION: All educational services are separately priced.

CONTRACT TERMS: The standard NCR 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 nine consecutive hours between 7 a.m. and 6 p.m. on Monday through Friday. Charges for maintenance coverage beyond this period are calculated by adding a percentage premium to the basic rates. The percentage increases for various coverage periods are as follows:

	9 hours	12 hours	16 hours	20 hours	24 hours
Monday-Friday	Base	8%	10%	18%	20%
Saturday	5%	N/A	7%	10%	10%
Sunday & Holiday	7%	N/A	9%	12%	12%

EQUIPMENT PRICES

		Purchase Price	Annual Maint.	One-Year Rental*
8545 PROCESSOR AND MAIN MEMORY				
V-8545-II	Virtual Memory Processor System; includes a CRT console, 1024K bytes of memory, and I/O Link Control	$41,500	$2,940	$4,230
Additional Memory for V-8545-II:				
AK 5600-P721	1024K-byte to 1536K-byte increment	3,750	604	423
AK 5600-P722	1536K-byte to 2048K-byte increment	3,750	604	423
8555 PROCESSOR AND MAIN MEMORY				
V-8555-II	Virtual Memory Processor System; includes a CRT console, 1024K bytes of memory, and I/O Link Control	54,000	4,380	4,675
AK 5600-P776	Tightly Coupled Multiprocessor backup kit	13,759	436	490
AK 5600-P831	Tightly Coupled Multiprocessor kit No.1	18,750	1,099	676
AK 5600-P832	Tightly Coupled Multiprocessor kit No.2	18,750	1,099	676
Additional Memory for V-8555-II:				
AK 5600-P72X	1024K-byte increments (up to 3)	7,500	1,209	845

*Includes maintenance **No new sale ***Three-year lease

NCR V-8500 and V-8600 Systems

		Purchase Price	Annual Maint.	One-Year Rental*
8565 PROCESSOR AND MAIN MEMORY				
V-8565-IIE	Virtual Memory Processor System; includes a CRT console, 2048K bytes of memory	70,000	7,608	8,255
AK 5600-P776	Tightly Coupled Multiprocessor Backup kit	13,759	436	490
AK 5600-P835	Multiprocessor kit No.1	18,750	1,099	683
AK 5600-P836	Multiprocessor kit No. 2	18,750	1,099	683
Additional Memory for V-8565-IIE:				
AK 5600-P805	2048K-byte to 4096K-byte increment	15,000	2,237	1,677
AK 5600-P807	4096K-byte to 6144K-byte increment	15,000	2,237	1,677
AK 5600-P808	6144K-byte to 8192K-byte increment	15,000	2,237	1,677
8575 PROCESSOR AND MAIN MEMORY				
V-8575-II	Virtual Memory Multiprocessor System; includes a CRT console, 4096K bytes of memory	123,300	10,664	10,475
AK 5640-P776	Multiprocessor Backup kit	13,759	374	484
AK 5640-P777	Multiprocessor kit	37,500	2,036	1,352
Additional Memory for V-8575-II:				
AK 5640-P801	4096K-byte to 8192K-byte increment	30,000	4,142	3,326
8595 PROCESSOR AND MAIN MEMORY				
V-8595-II	Virtual Memory Multiprocessor System; includes a CRT console, 4096K bytes of main memory	170,000	16,486	18,255
AK 5640-P776	Multiprocessor Backup kit	13,759	374	484
AK 5640-P777	Multiprocessor Conversion kit	37,500	2,036	1,352
Additional Memory for V-8595-II:				
AK 5640-P801	4096K-byte to 8192K-byte increment	30,000	4,142	3,326
AK 5640-P802	8192K-byte to 12,228K-byte increment	30,000	4,142	3,326
AK 5640-P803	12,228K-byte to 16,384K-byte increment	30,000	4,142	3,326
I/O CONTROL AND PROCESSOR OPTIONS FOR 8500 SERIES PROCESSORS				
I/O Control				
AK 56XO-PX40	Low-Speed Trunk	3,562	186	135
AK 56XO-PX41	Medium-Speed Trunk	5,380	268	204
AK 56XO-PX42	Very High-Speed Trunk	8,094	384	303
AK 56XO-PX43	I/O Link Control	3,710	285	146
AK 5600-P558	Channel Control Processor	9,000	635	500
AU 6281-0602	Dynamic Channel Director (4 x 16)	35,000	1,750	2,230
BU 6289-0101	System-to-System Adapter	6,950	350	340
Integrated Communications Lines (not on V-8575-II, or V-8595-II)				
AK 5600-P970	First Communications Line Controller (CLC); requires ICS Light Display	1,130	112	140
AK 5600-P971	Second CLC; requires ICS Light Display	1,130	112	140
AK 5600-P972	Third CLC; requires ICS Light Display	1,130	112	140
AK 5600-P973	Fourth CLC; requires ICS Light Display	1,130	112	140
AK 5600-P959	ICS Light Display	—	—	—
AK 5600-P978	MLA Upgrade for AK 5600-P970 through P973	1,530	66	134
Communications Lines (for V-8585-II only)				
AK 5600-P950	First Communications Line Controller; requires ICS Light Display	**1,795	788	145
AK 5600-P952	Second CLC; requires ICS Light Display	**1,795	788	145
AK 5600-P953	Third CLC; requires ICS Light Display	**1,795	788	145
AK 5600-P953	Fourth CLC; requires ICS Light Display	**1,795	788	145
AK 5600-P959	ICS Light Display	—	—	—
AK 5600-P954	First Communications Line Controller/MLA combination	**4,330	1,242	281
AK 5600-P955	Second CLC/MLA combination	**4,330	1,242	281
AK 5600-P956	Third CLC/MLA combination	**4,330	1,242	281
AK 5600-P957	Fourth CLC/MLA combination	**4,330	1,242	281
AK 5600-P958	MLA (Upgrade for P950)	**2,535	454	137
AK 5600-P960	MLA (Upgrade for P951)	**2,535	454	137
AK 5600-P961	MLA (Upgrade for P952 and P953)	**2,535	454	137

*Includes maintenance **No new sale ***Three-year lease

NCR V-8500 and V-8600 Systems

		Purchase Price	Annual Maint.	One-Year Rental*
➤ Processor Performance Upgrade (Requires same memory configuration on both systems)				
AK 5600-P815	V-8545-II to V-8555-II	12,500	1,450	990
AK 5600-P796	V-8555-II to V-8565-IIE	16,000	3,228	2,580
AK 5600-P780	V-8575-II to V-8585-II	**82,500	3,694	6,072
AK 5600-P781	V-8575-II to V-8595-II	49,760	5,822	7,780
AK 5600-P782	V-8585-II to V-8595-II	16,000	2,402	2,468

		Monthly License Fee
	Firmware Options	
	VRX Mode for V-8545-II	$302
	N Mode for V-8545-II	485
	VRX Mode for V-8555-II	403
	N Mode for V-8555-II	660
	MP Option for V-8555-II	683
	VRX Mode for V-8565-IIE	548
	N Mode for V-8565-IIE	858
	MP Option for V-8565-IIE	933
	VRX Mode for V-8575-II	712
	MP Option for V-8575-II	1,210
	VRX Mode for V-8595-II	1,096
	MP Option for V-8585-II	2,236

		Purchase Price	Annual Maint.	One-Year Rental*
8635 PROCESSOR AND MAIN MEMORY				
V-8635	Virtual Memory Uniprocessor System; includes 4 megabytes of main memory, 32K bytes of cache memory, 2 Channel Control Processors with 16 I/O channels, dual CRT consoles, and one System Control Unit with one Control Processor.	$455,000	$27,500	***$14,667
AK 5710-P370	V-8635-V-8645 Upgrade	240,000	2,500	***7,708
Additional Memory for V-8635:				
AK 5710-P520	4096K to 8192K bytes	64,800	4,032	3,220
8645 PROCESSOR AND MAIN MEMORY				
V-8645	Virtual Memory Dual Processor System; includes 4 megabytes of main memory, 128K bytes of cache memory, 2 Channel Control Processors with 16 I/O channels, dual CRT consoles, and a System Control Unit with one Control Processor	695,000	30,000	***22,375
Additional Memory for V-8645:				
AK 5710-P520	4096K to 8192K bytes	64,800	4,032	3,220
AK 5710-P522	8192K to 12,288K bytes	64,800	4,032	3,220
AK 5710-P523	12,288K to 16,384K bytes	64,800	4,032	3,220
8655 PROCESSOR AND MAIN MEMORY				
V-8655	System includes two V-8635 Virtual Memory Uniprocessor Systems (see V-8635 above for description)	995,000	—	33,680
Additional Memory for V-8655:				
AK 5710-P522	8192K to 12,288K bytes	88,000	4,032	3,216
AK 5710-P523	12,288K to 16,384K bytes	88,000	4,032	3,216

*Includes maintenance **No new sale ***Three-year lease ➤

		Purchase Price	Annual Maint.	One-Year Rental*
8665 PROCESSOR AND MAIN MEMORY				
V-8665	System includes one V-8635 Uniprocessor and one V-8645 Dual-Processor (see V-8635 and V-8645 above for descriptions)	1,325,000	—	44,450
Additional Memory for V-8665:				
AK 5710-P522	8192K to 12,288K bytes	88,000	4,032	3,216
AK 5710-P523	12,288K to 16,384K bytes	88,000	4,032	3,216
	4-megabyte increment (up to 2)	80,000	—	—
8675 PROCESSOR AND MAIN MEMORY				
V-8675	System includes two V-8645 Dual-Processor Systems (see V-8645 above for description)	1,595,000	—	52,205
Additional Memory for V-8675:				
AK 5710-P522	8192K to 12,288K bytes	88,000	4,032	3,216
AK 5710-P523	12,288K to 16,384K bytes	88,000	4,032	3,216
	4-megabyte increment (up to 4)	80,000	—	—
8685 PROCESSOR AND MAIN MEMORY				
V-8685	System includes three V-8645 Dual-Processor Systems (see V-8645 above for description)	2,395,000	—	78,385
Additional Memory for V-8685:				
AK 5710-P523	12,288K to 16,384K bytes	88,000	4,032	3,216
	4-megabyte increments (up to 8)	80,000	—	—
8695 PROCESSOR AND MAIN MEMORY				
V-8695	System includes four V-8645 Dual-Processor Systems (see V-8645 above for description)	2,995,000	—	98,680
Additional Memory for V-8695:				
	4-megabyte increment (up to 12)	80,000	—	—
I/O CONTROL AND PROCESSOR OPTIONS FOR THE V-8600				
AK 5710-P540	Additional CCP with 8 I/O channels	9,000	635	454
AK 5710-P541	Trunk CCP with one Low Speed Trunk	18,060	1,092	583
AK 5710-P542	Low Speed Trunk	3,360	132	123
AK 5710-P543	Very High Speed Trunk	7,635	276	277
AK 5710-P035	Second SCU Control Processor	9,000	180	320
AU 2600-0101	Thermal Hardcopy Device on Console	3,700	240	100
AU 6831-0203	System Card Reader; 600 cpm	12,140	675	473
AK 5600-P558	Channel Control Processor	9,000	635	500
AU 6281-0602	Dynamic Channel Director (4 x 16)	35,000	1,750	2,230
BU 6289-0101	System-to-System Adapter	6,950	350	340
MASS STORAGE				
AU 0658-0401	Disk Drive; 200MB; requires 0625-0301 controller	24,625	1,402	1,041
BU 6589-0101	I/O Link Adapter	18,660	667	699
AA 0958-0002	Disk Pack for 0658-0201 or 0658-0401 drives	525	—	—
BU 0656-6561	Disk Controller	7,750	2,490	533
AU 6530-2101	Cartridge Disk Drive; 27MB	16,955	1,146	685
AK 6530-P401	Upgrade Kit; expands AU 6530-1201 to 81MB	3,270	293	126
AU 6530-1301	Cartridge Disk Drive; 81MB	13,500	1,056	574
AU 6540-2401	Cartridge Disk Subsystem; 162MB	**27,355	2,400	1,155
AK 6530-P401	Upgrade Kit; upgrades AU 6530-2401 -0090 to 162MB	3,270	293	126
AA 6531-0101	Disk Cartridge, 13.5MB	199	—	—
AK 6549-K001	I/O Link Adapter Expansion kit	3,392	60	101
AU 6540-0201	Fixed Disk Drive; 135MB	10,800	959	589
AU 6540-2801	Fixed Disk Drive; 540MB includes four 135MB units	38,155	1,356	1,465
AU 6540-2802	Fixed Disk Drive; 540MB, includes four 135MB units	33,200	1,104	1,380

*Includes maintenance **No new sale ***Three-year lease

NCR V-8500 and V-8600 Systems

		Purchase Price	Annual Maint.	One-Year Rental*
BU 6559-0101	I/O Link Adapter for 6550	18,630	492	765
AU 6550-0101	Pack Disk Drive; 1092MB; 1st unit	50,560	2,203	1,906
AU 6550-0201	Pack Disk Drive; 1092MB; additional units	48,369	2,138	1,835
AU 6032-0707	Auxiliary Cabinet	1,500	—	45
MAGNETIC TAPE				
BU 6370-0401	Magnetic Tape Unit; 75 ips, 9-track, PE/GCR, 120/470KB, I/O Link Adapter	44,753	5,112	2,290
BU 6370-0601	Magnetic Tape Unit; 125 ips, 9-track, PE/GCR, 200/780KB, I/O Link Adapter	47,303	5,316	2,411
AU 6370-0801	Magnetic Tape Unit; 200 ips, 9-track, PE/GCR, 320/1250KB	27,795	2,981	1,192
BU 6379-0801	I/O Link Adapter for up to four 6370-0801 magnetic tape units	29,103	2,773	1,427
BU 6325-0101	Magnetic Tape Unit with Controller; 9-track, 45 ips, 80KB	16,900	912	792
AU 6325-0201	Magnetic Tape Unit; 45 ips; PE	11,400	828	500
PRINTERS				
BU 0647-0201	Train Printer; 2000 lpm, 132 positions, power stacker; includes controller	64,722	8,881	3,080
AK 0647-P001	I/O Link Adapter for BU 0647-0201	2,388	227	107
AK 0960-0152	Print Train; 52 characters	3,950	—	123
AK 0960-0164	Print Train; 64 characters	3,950	—	123
AK 0960-0157	Print Train; 57 characters, OCR-A	3,950	—	123
AK 0960-0196	Print Train; 96 characters, UC/LC	3,950	—	123
AU 6420-3202	Band Printer; 720 lpm, requires at least one print band	13,720	1,984	640
AU 6420-2301	Band Printer; 1130 lpm, requires at least one print band, includes quietized cabinet	21,400	3,786	1,263
AU 6420-0601	Band Printer; 1440 lpm, requires at least one print band, includes quietized cabinet	33,500	4,666	1,566
SK 6420-P003	Criterion Interface; required for 6420-2101, 3202, and 2301 printers	**2,650	801	273
AK 6420-K010	Print Band; 64-character ASCII, 1403, 10 cpi	**350	—	27
AK 6420-K019	Print Band; 96-character U/L case	**350	—	27
AK 6420-K022	Print Band; 48-character SDCII, 1403, 10 cpi	**350	—	27
AK 6420-K024	Quietized Cabinet	583	—	38
AU 6441-0202	Serial Matrix Printer; 70 lpm; requires interface	**4,245	650	193
RK 6441-K042	RS-232 Interface	830	257	70
AK 6441-K020	Upgrade Character Set for 6441 printer; 64-character	105	—	5
AA 1001-A004-000	Pedestal for 6441 printer	250	—	—
PUNCHED CARD I/O UNITS				
AU 6831-0201	Card Reader; 600 cpm	9,580	595	392
AK 5600-P705	Cardreader Interface	515	60	50
MICR I/O UNITS				
AU 6770-1101	MICR Reader/Sorter; 1400 dpm; 14 pockets	114,700	13,705	3,454
AU 6755-0101	MICR Reader/Sorter; 750 dpm, 11 pockets	58,850	7,800	2,250
BU 6781-0101	MICR Document Reader/Sorter; up to 1400 dpm, up to 34 pockets	**128,700	13,109	3,834
COMMUNICATIONS				
BU 0621-0101	On-Line Communications Multiplexer for up to 15 lines	12,720	858	254
AK 0621-F200	In-House Clock Driver for 0621-0103 multiplexer	**2,120	248	86
AK 0621-F201	Synchronous Adapter Connection Cable Kit	475	30	15
AK 0621-F202	Wideband Interface	725	30	22
AK 0691-0101	Auxilary Cage	7,950	138	136
AU 0690-0103	On-Line Auxiliary Bay	8,480	68	177

*Includes maintenance **No new sale ***Three-year lease

NCR V-8500 and V-8600 Systems

		Purchase Price	Annual Maint.	One-Year Rental*
AU 0692-0600	Dual Asynchronous Adapter, one line disabled	1,500	159	85
AK 0692-0600	Dual Asynchronous Adapter, second line enabled	1,500	159	85
AU 0692-0638	438-3 Adapter	**3,180	149	89
AU 0693-0600	Dual Synchronous Adapter, one line disabled	2,250	177	116
AK 0693-0600	Dual Synchronous Adapter, second line enabled	2,250	177	116
AU 0695-0600	On-Line Auto Dialer	995	167	56
AU 0698-0300	Integrated Asynchronous Modem	1,000	141	39
AU 0752-0200	Free-Standing External Modem	700	161	37
TERMINALS				
BU 7900-1102	Model 7900 CRT; TTY compatible	**2,000	371	106
AU 7900-2112	Model 7900 CRT; detachable keyboard; TTY compatible	**2,000	343	110
AU 0260-8000	Thermal Printer; receive only	**2,495	418	115
BU 7900-1303	Model 7900 CRT; asynchronous, pollable	3,500	453	178

SOFTWARE PRICES

	One-Time License Fee	Monthly License Fee
VS1 Basic System Software		
VRX Operating System	$ 0	$ 0
VRX Cobol 74 Compiler	0	132
VRX COBUG	0	12
VRX Fortran 77 Compiler	0	100
NRX NEAT/VS Compiler	0	158
VRX SORT/MERGE	0	121
VRX TRAN-PRO	25,475	637
VS1 On-Line System Software		
Terminal Communications Processor	0	60
Network Definition Language Processor	0	36
On-Line Program Development	2,810	61
Remote Job Entry	0	72
VRX Telecommunications	0	22
EZ-KEY Data Entry System	1,500	42
VS1 Data Management System Software		
VRX Utilities	0	35
VRX File Conversion Utility	0	48
VRX Total—V-85XX Series	36,000	1,092
Management Sciences Application Software		
Statistics	975	21
Linear Programming	653	13
Project Network Analysis	4,501	94
Vehicle Scheduling	653	13
Feed Information System (FIS)	11,877	366
General Application Software		
General Payroll	713	14
Payroll/Cost, Labor Scheduling	713	14
Accounts Receivable—Commercial	1,063	22
Accounts Receivable—Consumer	1,063	22
Accounts Receivable—Tape	1,063	22
Accounts Payable	1,063	22
General Ledger with Reporting Subsystem	713	14
Accounting System Interface	713	14

*Includes maintenance **No new sale ***Three-year lease

NCR V-8500 and V-8600 Systems

SOFTWARE PRICES

	One-Time License Fee	Monthly License Fee
Manufacturing Application Software		
Inventory Material Control (IMC)	1,585	33
Inventory Material Requirements (IMR)	805	17
Bill of Materials	1,585	33
Manufacturing Systems Inquiry	805	17
Production Scheduling	805	17
Inventory Requirements Planning	1,190	25
Work in Progress	10,900	273
Order Processing	10,000	250
MISSION Manufacturing System—Basic Module	40,000	1,000
Wholesale Application Software		
Emphasis	886	19
Order Billing Techinque II (ORBIT II)	1,744	36
Order Billing Technique III (ORBIT III)	1,744	36
SPIRIT V (not on 8600 series)	14,375	318
SPIRIT—Sales Analysis	1,300	—
Medical Application Software		
Post Discharge Accounts Receivable	1,705	50
In-Patient Records	1,265	33
Medical Audit Statistics	1,265	33
Criterion Loan and Savings System (CLASS)		
General Ledger	2,000	70
Savings	29,000	—
Loans	26,000	—
Education Application Software		
Stewardship & Management Accounting	1,738	50
SCHOLARS II	15,125	432
Student Test Analysis	704	20
School Bus Scheduling System	3,219	92
Government Application Software		
Financial Management Systems	6,000	180
Food Distribution Application Software		
Order Billing Technique I (ORBIT I)	1,579	37
Department Store Application Software		
Retail Sales Audit	855	20
Fashion Reporting	2,520	60
Pre-Edit Processing	1,620	40
Staple Stock Replenishment	2,020	50
MEDICS Application Software		
MEDICS 2950	50,000	1,315
MEDICS ADT	15,000	395

*Includes maintenance **No new sale ***Three-year lease ■