

NCR V-8500 and V-8600 Systems

MANAGEMENT SUMMARY

UPDATE: NCR has increased the maximum main memory capacity of the V-8600 System. The V-8635 maximum memory was increased from 8 to 16 megabytes. Maximum main memory for the V-8655 and the V-8665 was expanded from 16 and 24 megabytes respectively, to 32 megabytes. The V-8675 maximum memory was increased from 32 to 64 megabytes. No enhancements were made to the V-8500 System.

NCR's V-8500 and V-8600 line of mainframe computers are designed to operate in batch, transaction-oriented, remote job entry (RJE), and distributed processing environments. Both systems use the VRX virtual operating system which supports multiprogramming, and tightly and loosely coupled multiprocessing.

The V-8500-II models with the "E" designation succeed the V-8500-I models and provide improved price/performance over their predecessors. The five-model product line includes the entry-level V-8545-II E with one to two megabytes of main memory. The V-8555-II E has about 40 percent more performance than the V-8545-II E. The system comes with one megabyte of memory, and can be expanded to four megabytes. The V-8565-II E has 29 percent more power than the V-8555-II E. 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, and 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 E and V-8595-II E. These models feature 56-nanosecond processor cycle times ➤

The V-8500 and V-8600 computer systems feature 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 E, V-8555-II E, V-8565-II E, V-8575-II E, V-8595-II E, 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 A 3 and A 9 Series; Honeywell DPS 7 and DPS 8 Series; IBM System/38 and 4300 Systems; Sperry System 80, 1100/60, and 1100/70 Series.
PRICE: Purchase prices range from \$41,500 (V-8545-II E) to \$2,995,000 (V-8695).

CHARACTERISTICS

MANUFACTURER: NCR Corporation, 1700 South Patterson Boulevard, Dayton, Ohio 45479. Telephone (513) 445-5000. In Canada: NCR Canada Limited, 117 Eglinton Avenue East, Toronto, Ontario M4P 1J1.

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

DATE OF INTRODUCTION: V-8500, 1982; V-8600, 1983. ➤



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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▷ and four-way interleaved memory. The V-8575-II E has four to eight megabytes of memory. The largest system is the V-8595-II E, which has 4 to 16 megabytes of memory. The three uniprocessor models cannot be field upgraded to the dyadic systems since a swapout of CPUs is required.

The V-8600 Series comprises seven models: Uniprocessor model V-8635 with 4 to 16 megabytes of main memory and the V-8645 which is a tightly coupled dyadic with 4 to 16 megabytes of main memory. A unique combination of both tight and loose coupling is achieved when a V-8635 and a V-8645 are configured together. The V-8655, with 8 to 32 megabytes of main memory, is configured with two V-8635 processors. The V-8665, configured with one V-8635 single and one V-8645 dual processor, has a main memory capacity of 8 to 32 megabytes. The V-8675 is configured with two V-8645 dual processors, and 8 to 64 megabytes of main memory. The V-8685 has three V-8645 dual processors and from 12 to 48 megabytes of main memory. The top of the line model V-8695 is configured with four V-8645 dual processors and a main memory capacity of 16 to 64 megabytes.

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 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 Memory Subsystems use 64K-bit MOS memory chips. Memory cycle times range from 380 to 440 nanoseconds. Minimum memory size ranges from one megabyte on the V-8545-II E and increases to 16 megabytes on the V-8695. The maximum memory available ranges from two megabytes on the V-8545-II E 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.

Users of the V-8500 and V-8600 systems have a variety of peripherals to select from, including mass storage devices ranging from 27 megabytes up to 1.1 gigabytes, 5 tape ▷

▶ 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 V-8500-II E models and the V-8600 models use 64K-bit chips.

CAPACITY: See Table 1.

CYCLE TIME: See Table 1.

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 E, V-8595-II E, and all V-8600 systems. The V-8555-II E has two-way interleaving, and the V-8545-II E does not use interleaving.

CENTRAL PROCESSORS

The Central Processing Units for the V-8500 and V-8600 series systems are built around an Internal Transfer Subsystem, 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. ▶

NCR V-8500, V-8600, and V-8800 Systems

TABLE 1. SYSTEM COMPARISON (Continued)

MODEL	V-8635/V-8835	V-8645/V-8845	V-8655/V-8855	V-8665/V-8865
SYSTEM CHARACTERISTICS				
Date announced	Feb. 83/Sept. 86	Feb. 83/Sept. 86	Feb. 83/Sept. 86	Feb. 83/Sept. 86
Date first delivered	May 83/Aug. 86	May 83/Aug. 86	May 83/Aug. 86	May 83/Aug. 86
Field upgradable to	V-8645/V-8845	V-8655/V-8855	V-8665/V-8865	V-8675/V-8875
Relative performance	3.0/4.5	5.70/8.55	5.88/8.82	8.23/12.3565)
Number of processors	1	2	2	3
Cycle time, nanoseconds	38	38	38	38
Word size, bits	32	32	32	32
Operating systems	VRX	VRX	VRX	VRX
MAIN MEMORY				
Type	64K MOS	64K MOS	64K MOS	64K MOS
Minimum capacity, bytes	4M	4M	8M	8M
Maximum capacity, bytes	16M	16M	32M	32M
Increment size	4M	4M	4M	4M
Cycle time, nanoseconds	380/336	380/336	380/336	380/336
BUFFER STORAGE				
Minimum capacity	32K	128K	64K	160K
Maximum capacity	—	—	—	—
Increment size	—	—	—	—
INPUT/OUTPUT CONTROL				
Number of channels:				
Byte multiplexer	—	—	—	—
Block multiplexer	—	—	—	—
Word	—	—	—	—
Other	16 to 32	16 to 32	16 to 64	16 to 64

➤ system via three peripheral subsystems: 1) the Common Trunk Subsystem, used on V-8500 Systems (Trunk Channel Control Processor on V-8600/V-8800), 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 and V-8800 Systems 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-II) and the System Control Unit (V-8600/V-8800 Systems) perform the following functions: 1) firmware loading during start-of-day procedures, 2) peripheral subsystem control, and 3) system testing and diagnostics.

Users of the V-8500, V-8600, and V-8800 Systems have a variety of peripherals to select from, including mass storage devices ranging from 27 megabytes up to 1.6 gigabytes, tape drives with numerous configurations, and an assortment of low-, medium-, and high-speed printers, 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 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 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.

▶ **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 double-bit errors are detected and signaled so that appropriate program action can be taken.

RESERVED STORAGE: 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.

CENTRAL PROCESSORS

The Central Processing Units for the V-8500, V-8600, and V-8800 Systems are microprogrammed, register-to-register units that are built around an Internal Transfer Subsystem, 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 with a data transfer bandwidth of up to 70 megabytes. 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 System Control Unit (SCU), (Service Subsystem on the V-8500): 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 is the central control point of the V-8600 and V-8800 Systems. A micro-programmed control processor controls 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 addi-▶

NCR V-8500, V-8600, and V-8800 Systems

TABLE 1. SYSTEM COMPARISON (Continued)

MODEL	V-8675/8875	V-8685/8885	V-8695/8895
SYSTEM CHARACTERISTICS			
Date announced	Feb. 83/Sept. 86	Feb. 83/Sept. 86	Feb. 83/Sept. 86
Date first delivered	May 83/Aug. 86	May 83/Aug. 86	May 83/Aug. 86
Field upgradable to	V-8685/V-8885	V-8695/V-8895	—
Relative performance	10.76/16.14	16.17/24.26	21.52/32.28
Number of processors	4	6	8
Cycle time, nanoseconds	38	38	38
Word size, bits	32	32	32
Operating systems	VRX	VRX	VRX
MAIN MEMORY			
Type	64K MOS	64K MOS	64K MOS
Minimum capacity, bytes	8M	12M	16M
Maximum capacity, bytes	32M	48M	64M
Increment size	4M	4M	4M
Cycle time, nanoseconds	380/336	380/336	380/336
BUFFER STORAGE			
Minimum capacity	256K	384K	512K
Maximum capacity	—	—	—
Increment size	—	—	—
INPUT/OUTPUT CONTROL			
Number of channels:			
Byte multiplexer	—	—	—
Block multiplexer	—	—	—
Word	—	—	—
Other	16 to 64	32 to 96	32 to 128

▷ COMPETITIVE POSITION

NCR was one of the few computer manufacturers to surpass its 1986 goals. The company posted exceedingly good earnings in each quarter. NCR has proved that by marketing in well-defined market areas, mainframes are selling well and with a good profit. NCR sells most of its computer systems to banks, financial institutions, and retail stores—a very healthy market niche. To meet the performance requirements of these users and to expand its own market share, NCR brought out the V-8800 systems to replace the V-8600 systems.

The NCR Systems face strong competition in a tight market from the Unisys systems (Burroughs) A 3 and A 5 and (Sperry) System 1100/70; the Honeywell DPS 7 and DPS 8 Series; and the IBM System/38, 4300 and 308X Systems. All these systems offer batch, on-line, distributed, and transaction processing. In the financial sector the NCR systems compete with the Unisys A 3 and A 5. The A 3 and A 5 have an approximate MIPS (Millions of Instructions per Second) rating of .65 and 1.6 respectively. The purchase price for the A 3 with three megabytes of main memory is \$95,000, and the A 5 with a six-megabyte memory is priced at \$224,000. Sperry and Honeywell systems are concentrated mostly in manufacturing, also a stronghold for NCR. The System 1100/71 with a four-megabyte memory and a MIPS rating ranging from .50 to 5.6. is priced at \$360,000. The DPS 7 has an estimated MIPS rating of 1.36, two megabytes of memory and a price tag of \$160,000. The four-megabyte DPS 8 with a MIPS rating of approximately 1.2 is priced at \$153,000. The NCR V-8800 System with a rating of 1.5 to 12 MIPS and a memory capacity ranging from four to 16 megabytes competes with the eight-megabyte IBM 4381 with a MIPS rating of 3.5. The V-8835 is priced at \$480,000 and the price for the IBM 4381-13 is \$440,000. The V-8600 with a MIPS rating of 1 and a four-megabyte memory competes with the IBM 4361 which has

▷ tional 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 capabilities) and virtual level diagnostics (which test the virtual machine functions and capabilities) can be run on system elements while normal operations continue. The primary controlling unit for the SCU is the Control Processor (CP).

In all NCR V-8500, V-8600, and V-8800 Systems, most of the firmware that directs the system to perform the required functions is stored in a high-speed memory called the Instruction Storage Unit (ISU). Capacity of the ISU ranges from 24K bytes on the V-8545-II to 128K bytes on the V-8845.

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 and V-8800 Systems include a high-speed cache buffer ranging from 32K to 512K bytes to increase performance.

The V-8500-II Systems 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 the VRX/MP operating system 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 V-8600 and V-8800 Systems also offer multiple processor configurations. The "base models" include the uniprocessors V-8635 and V-8835 and the dyadic processors

NCR V-8500 and V-8600 Systems

TABLE 1. SYSTEM COMPARISON

MODEL	V-8545-II E	V-8555-II E	V-8565-II E	V-8575-II E	V-8595-II E
SYSTEM CHARACTERISTICS					
Date announced	—	—	—	—	—
Date first delivered	February 1982				
Field upgradable to	V-855-II E	V-8565-II E	—	V-8595-II E	—
Relative performance	0.75	1.0	1.25	1.65	2.48
Number of processors	1	1 to 2	1 to 2	2 to 4	2 to 4
Cycle time, nanoseconds	84	56	56	56	56
Word size, bits	32	32	32	32	32
Operating systems	VRX/B3	VRX/B3	VRX, VRX/MP	VRX/MP	VRX/MP
MAIN MEMORY					
Type	64K MOS				
Minimum capacity, bytes	1M	1M	2M	4M	4M
Maximum capacity, bytes	2M	4M	8M	8M	16M
Increment size	512K	1M	2M	4M	4M
Cycle time, nanoseconds	440	440	440	440	440
BUFFER STORAGE					
Minimum capacity	—	—	—	—	—
Maximum capacity	—	—	—	—	—
Increment size	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels:					
Byte multiplexer	—	—	—	—	—
Block multiplexer	—	—	—	—	—
Word	—	—	—	—	—
Other	0 to 8	0 to 64	0 to 64	0 to 64	0 to 64

TABLE 1. SYSTEM COMPARISON

MODEL	V-8635	V-8645	V-8655	V-8665	V-8675
SYSTEM CHARACTERISTICS					
Date announced	February 1983	February 1983	February 1983	February 1983	February 1983
Date first delivered	May 1983	May 1983	May 1983	May 1983	May 1983
Field upgradable to	V-8645	V-8655 to V-8695	V-8665 to V-8695	V-8675 to V-8695	V-8685 to V-8695
Relative performance	3.0	5.70	5.88	8.23	10.76
Number of processors	1	2	2	3	4
Cycle time, nanoseconds	38	38	38	38	38
Word size, bits	32	32	32	32	32
Operating systems	VRX	VRX	VRX	VRX	VRX
MAIN MEMORY					
Type	64K MOS	64K MOS	64K MOS	64K MOS	64K MOS
Minimum capacity, bytes	4M	4M	8M	8M	8M
Maximum capacity, bytes	16M	16M	32M	32M	64M
Increment size	4M	4M	4M	4M	4M
Cycle time, nanoseconds	380	380	380	380	380
BUFFER STORAGE					
Minimum capacity	32K	128K	64K	160K	256K
Maximum capacity	—	—	—	—	—
Increment size	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels:					
Byte multiplexer	—	—	—	—	—
Block multiplexer	—	—	—	—	—
Word	—	—	—	—	—
Other	16 to 32	16 to 32	16 to 64	16 to 64	16 to 64

➤ drives with numerous configurations, a laser page printer and an assortment of low-, medium-, and high-speed printers, 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.

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

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TABLE 1. SYSTEM COMPARISON

MODEL	V-8685	V-8695
SYSTEM CHARACTERISTICS		
Date announced	February 1983	February 1983
Date first delivered	May 1983	May 1983
Field upgradable to	V-8695	—
Relative performance	16.17	21.52
Number of processors	6	8
Cycle time, nanoseconds	38	38
Word size, bits	32	32
Operating systems	VRX	VRX
MAIN MEMORY		
Type	64K MOS	64K MOS
Minimum capacity, bytes	12M	16M
Maximum capacity, bytes	48M	64M
Increment size	4M	4M
Cycle time, nanoseconds	380	380
BUFFER STORAGE		
Minimum capacity	384K	512K
Maximum capacity	—	—
Increment size	—	—
INPUT/OUTPUT CONTROL		
Number of channels:		
Byte multiplexer	—	—
Block multiplexer	—	—
Word	—	—
Other	16 to 64	32 to 64

▶ COMPETITIVE POSITION

The NCR V-8500 Series is marketed to compete with the Burroughs A 3, the Honeywell DPS 8, and the IBM 4300 Series in the areas of price and performance. The V-8555-II E has 40 percent more processing power than the V-8545-II E, and is comparable to the IBM 4361 Group 3 with two megabytes of memory and a price tag of \$56,500. The V-8565-II E has 29 percent more power than the V-8555-II E, and compares with the Burroughs A 3 Model D with three megabytes of memory. The A 3 is priced at \$95,500. V-8575-II E is comparable to the Honeywell DPS 8/47 which has four megabytes of memory and is priced at \$153,000. The top-end V-8595-II E is comparable in performance to the IBM 4381 Model Group 1 which has four megabytes of memory and is priced at \$370,000.

The top-of-the-line V-8695 is equal in rank with the Honeywell DPS 8/70 with a memory capacity of 16 megabytes and a price of \$800,000. The V-8655 has the same amount of main memory (eight megabytes) as the IBM 4381 Model Group 3 which is priced at \$835,000. The low-end V-8635, with four megabytes of main storage, competes with the IBM 4381 Model Group 2, also with four megabytes of memory and a price of \$500,000.

ADVANTAGES AND RESTRICTIONS

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 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 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 V-8500-II E 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 V-8600 series also offers multiple processor configurations. The base models in this series include the single-processor V-8635 and the dual-processor V-8645. The remaining V-8655, V-8665, V-8675, V-8685, and V-8695 models are made up of multiple configurations of the base models and are termed the "processor complex" models. The V-8655 consists of two 8635 processors, the V-8665 consists of one 8635 single- and one 8645 dual-processor, the V-8675 consists of two 8645 dual-processors, the V-8685 consists of three 8645 dual-processors, and the V-8695

NCR V-8500 and V-8600 Systems

➤ 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. Another NCR plus is high system availability due to fault tolerance with automatic recovery. The 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.

On the minus side, users operating the systems in a dual mode report difficulties with debugging the "loosely coupled" operating system. Users also reported problems with the vendors application software, and the insufficient documentation.

USER REACTION

Datapro received a total of 132 NCR user responses in our 1985 survey of mainframe computer users. The user population consisted of a variety of business types with banking/finance institutions (26 percent), government offices (18 percent), and retail/wholesale (14 percent) represented most frequently. The primary applications were accounting/billing operations (67 percent) and payroll/personnel (65 percent), although many others were mentioned. The average installed time was a little less than ten months for both the V-8500 and V-8600 systems. About 71 percent of the respondents purchased their equipment from NCR, 12 percent rented the equipment from NCR, and about 15 percent leased the equipment through a third party. Most users developed their applications programs in-house (87 percent), and 50 percent of the users purchased NCR developed programs. Forty-one respondents use a data base management system, seventy-one users have a disaster recovery plan in place, and only twenty-six users have established an information center. User responses for both the V-8500 and V-8600 systems are presented in the following chart:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	41	72	6	3	3.24
Reliability of mainframe	59	53	8	2	3.39
Reliability of peripherals	57	56	8	1	3.39
Maintenance service:					
Responsiveness	59	57	12	3	3.31
Effectiveness	46	65	19	1	3.19

➤ 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 V-8500-II E systems into a tightly coupled multiple processor (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 diskette for each processor that contains the VRX/MP firmware. The V-8575-II E and the V-8595-II E, 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.

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 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-8500-II E (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-II E to 192K bytes on the V-8645.

NCR V-8500 and V-8600 Systems

TABLE 2. MASS STORAGE

MODEL	658	6530	6540	6550
Cabinets per subsystem	1	1 or 2	1 or 2	1
Disk packs/HDAs per cabinet	1	2 to 4	2 to 4	2
Capacity	91M or 182M	27M to 135M	135M to 540M	1092M
Tracks/segments per drive unit	823 tracks per surface	822 tracks per surface	—	—
Average seek time, msec.	24 or 30	30	21.7	16.7
Average access time, msec.	32.3 or 38.3	38.3	30	25
Average rotational delay, msec.	8.3	8.3	8.3	8.3
Data transfer rate	806KB	1.2MB	1.2MB	1.2MB
Controller model	6589	6539	6539	6559
Comments	Bit Serial I/O Link Controller/Adapter combination recommended			

	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>WA*</u>
Technical support:					
Troubleshooting	23	71	30	6	2.85
Education	28	71	26	4	2.95
Documentation	14	69	38	9	2.68
Manufacturers software:					
Operating system	41	77	11	2	3.20
Compiler & assemblers	30	90	9	1	3.15
Application programs	10	57	35	13	2.56
Ease of programming	18	81	24	2	2.92
Ease of conversion	47	46	24	6	3.09
Overall satisfaction	26	85	15	4	3.05

*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.

	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>WA*</u>
Ease of expansion	91	32	4	4	3.60
Compatibility of hardware carried over from other systems	57	48	11	9	3.22
Compatibility of programs/data carried over from other systems	71	36	10	8	3.36
Power/energy efficiency	22	86	19	5	3.02
Productivity aids help keep programming costs low	18	64	39	8	2.71
Software/support promised by vendor	15	53	48	12	2.55

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

NCR users were asked two final questions: "Did the system measure up to your expectations?" and, "Would you recommend it to another user?" Better than 93 percent of the V-8500 and V-8600 users felt their systems performed as they had expected. Less than 5 percent were unsatisfied with their computers. Approximately 84 percent of the V-8500 and V-8600 users said they would recommend their systems to others. About 9 percent of the users answered "no" to this question. □

▶ **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.

CONFIGURATION RULES

The V-8500-II E family comprises five models, three in the uniprocessor series and two in the dyadic series. The V-8545, V-8555, and the V-8565 uniprocessors consist of one central processor, one memory subsystem with one to eight megabytes of memory, one I/O subsystem with one to eight I/O link controllers, one communication subsystem with 1 to 20 integrated lines, and a CRT console. The dyadic models V-8575-II E and V-8595-II E consist of two central processors in a single cabinet, one memory subsystem with 4 to 16 megabytes of memory, one I/O subsystem with six I/O link controllers, one communication subsystem with 1 to 253 freestanding lines, and one CRT console.

Uniprocessors are field upgradable to the next higher level model. Upgrading from the uniprocessor series to dyadic series is not possible. The dyadic model V-8575-II E can be field upgraded to the V-8595-II E.

The V-8600 family comprises seven models, one uniprocessor, two dyadic, and four multiprocessor models. The uniprocessor model V-8635 consists of one central processor, four megabytes of main memory, 32K bytes of cache memory, two channel control processors with 16 I/O channels, two CRT consoles, and one system control unit with one control processor. The two dyadic models V-8645 and V-8655 consist of two central processors, four to eight megabytes of main memory, 64K to 128K bytes of cache memory, four channel control processors with 16 I/O channels, two CRT consoles, and a system control unit with one control processor. The four multiprocessor models V-8665, V-8675, V-8685, and V-8695 have from three to eight central processors, 8 to 16 megabytes of main memory, 160K to 512K bytes of cache memory, four to eight channel control processors with 16 to 32 I/O channels, two CRT consoles, and a system control unit with one control processor.

INPUT/OUTPUT CONTROL

Input/output control within the V-8500 systems is provided through three types of subsystems: Common Trunk 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 ▶

NCR V-8500 and V-8600 Systems

TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed Inches/Sec.	Transfer Rate, Bytes/Sec.
6370-0402	9	1600	PE/GCR	75	120K to 140K
6370-0401	9	1600	PE/GCR	75	120K to 470K
6370-0601	9	1600	PE/GCR	125	200K to 780K
6370-0801	9	1600	PE/GCR	200	320K to 1250K
Printers	Printing Speed	Print Positions	Horizontal Spacing, Chars./Inch	Vertical Spacing, Lines/Inch	Form Size, Inches
6471-0201	2000 lpm	132	10	6 or 8	Industry std.
6430-0101	360 lpm	132	10	6 or 8	Industry std.
6430-0201	720 lpm	132	10	6 or 8	Industry std.
6420-2301	1130 lpm	132	10	6 or 8	Industry std.
6420-0601	1440 lpm	132	10	6 or 8	Industry std.
6480-0101	103 ppm	—	—	24	8½ x 11

► 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 E and V-8555-II E and up to eight in the V-8565-II E, V-8575-II E, and V-8595-II E. 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 85XS-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 E through V-8595-II E 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 solidstate 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 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.

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 and printers.

TERMINALS

For information on terminals used with the V-8500 and V-8600 Systems, refer to Table 4.

COMMUNICATION CONTROL

INTEGRATED COMMUNICATIONS SUBSYSTEM:
The Integrated Communications Subsystem provides up to

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► 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 micro-processors (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 E, V-8555-II E and V-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 per second, and synchronous devices at speeds ranging from 600 to 50,000 bits per second. 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 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.

SOFTWARE

OPERATING SYSTEM: NCR offers a virtual operating system (VRX) for the V-8500 and V-8600 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).

Instant Ready 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 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

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TABLE 4. TERMINALS

MODEL	7900 Model 1	7900 Model 3	7901	7910	7950
DISPLAY PARAMETERS					
Max. chars./screen	2000	2000	1920	2000, 3300	1920, 2560
Screen size (lines x chars.)	25x80	25x80	24x80	25x80/132	24/32x80
Symbol formation	7x7 dot matrix	7x7 dot matrix	5x7 dot matrix	7x9, 5x9 dot matrix	7x9 dot matrix
Character phosphor	Amber	Green P31	Green P31	Amber	Green P31
Total colors/no. simult. displayed	—	—	—	—	—
KEYBOARD PARAMETERS					
Style	Typewriter	Typewriter	Typewriter	Typewriter	Typewriter, data entry
Character/code set	128 ASCII	128 ASCII	96 ASCII	128 ASCII	96 ASCII, EBCDIC
Detachable	Optional	Optional	Standard	Standard	Standard
Program function keys	1	—	—	—	24
OTHER FEATURES					
Buffer capacity	—	—	—	12K	—
Tilt/swivel	Standard	Standard	Standard	Standard	Standard
Graphics capability	—	—	—	32 symbols	—
TERMINAL INTERFACE	RS-232-C	RS-232-C	RS-232-C	RS-232-C, RS-422	RS-232-C

► 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 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 system, which uses CAM utilities to restore CAM files if an error occurs. There is also a batch recovery system, 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-byte disk sectors, perform general housekeeping functions, provide system performance data, analyze ►

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- 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. For a description of TOTAL refer to Page 70E-153MY-101 in Volume 3.

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 database manager to limit specific user access to data at the field level by assigning passwords or access codes.

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.

FORTTRAN: 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.

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.

EQUIPMENT

The following configurations illustrate the V-8545-II, V-8565-II E 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 Controller; 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 ►

NCR V-8500 and V-8600 Systems

► 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 a onetime licensing fee. The monthly charge ranges up to slightly over \$1,000 and one-time fees range up to about \$36,000.

SUPPORT: NCR has a Software Maintenance plan with a toll-free telephone number to call for assistance. If the problem cannot be resolved over the telephone, on-site fault isolation activity and software updates are supplied at the current hourly rate.

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 8 a.m. and 5 p.m. on Monday through Friday. Charges for maintenance coverage beyond this period are calculated by adding a percentage premium to the basic maintenance 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%	6%	7%	10%	10%
Sunday & Holiday	7%	8%	9%	12%	12%

EQUIPMENT PRICES

8545 PROCESSOR AND MAIN MEMORY

		Purchase Price (\$)	Annual Maint. (\$)	One-Year Rental* (\$)
V-8545-II E	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 E	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

8565 PROCESSOR AND MAIN MEMORY

V-8565-II E	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-II:				
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

*Includes maintenance.

**No new sale.

NC—No charge.

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		Purchase Price (\$)	Annual Maint. (\$)	One-Year Rental* (\$)
8575 PROCESSOR AND MAIN MEMORY				
V-8575-II E	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 E	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	118	141
AK 5600-P971	Second CLC; requires ICS Light Display	1,130	118	141
AK 5600-P972	Third CLC; requires ICS Light Display	1,130	118	141
AK 5600-P973	Fourth CLC; requires ICS Light Display	1,130	118	141
AK 5600-P959	ICS Light Display	—	—	—
AK 5600-P978	MLA Upgrade for AK 5600-P970 through P973	1,530	69	134
Processor Performance Upgrade (Requires same memory configuration on both systems):				
AK 5600-P815	V-8545-II to V-8555-II E	12,500	1,450	990
AK 5600-P796	V-8555-II to V-8565-II E	16,000	3,228	2,580
AK 5600-P780	V-8575-II to V-8585-II E	**82,500	3,694	6,072
AK 5600-P781	V-8575-II to V-8595-II E	49,760	5,822	7,780
AK 5600-P782	V-8585-II to V-8595-II E	16,000	2,402	2,468

	Monthly License Fee (\$)
Firmware Options:	
VRX Mode for V-8545-II E	302
N Mode for V-8545-II E	485
VRX Mode for V-8555-II E	403
N Mode for V-8555-II E	660
MP Option for V-8555-II E	683
VRX Mode for V-8565-II E	548
N Mode for V-8565-II E	858
MP Option for V-8565-II E	933

*Includes maintenance.
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NCR V-8500 and V-8600 Systems

			<u>Monthly License Fee (\$)</u>	
Firmware Options (Continued):				
	VRX Mode for V-8575-II E			712
	MP Option for V-8575-II E			1,210
	VRX Mode for V-8595-II E			1,096
	MP Option for V-8585-II E			2,236
		<u>Purchase Price (\$)</u>	<u>Annual Maint. (\$)</u>	<u>One-Year Rental* (\$)</u>
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
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	—	—

*Includes maintenance.

**No new sale.

NC—No charge.

NCR V-8500 and V-8600 Systems

		Purchase Price (\$)	Annual Maint. (\$)	One-Year Rental* (\$)
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 4-megabyte increments (up to 8)	88,000 80,000	4,032 —	3,216 —
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
BU 6559-0101	I/O Link Adapter for 6550	18,630	492	765
AU 6550-0101	Fixed Disk Drive; 1092MB; 1st unit	50,560	2,203	1,906
AU 6550-0201	Fixed 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
AU 6370-0402	Magnetic Tape Unit; 75 ips, 9-track, PE/GCR, 120/140KB, secondary drive	17,070	3,084	886
AU 6370-0601	Magnetic Tape Unit; 125 ips, 9-track, PE/GCR, 200/780KB, I/O Link Adapter	47,303	5,316	2,411
AU 6370-0602	Magnetic Tape Unit; 125 ips, 9-track, PE/GCR 200/780KB, secondary drive	19,620	3,189	999
AU 6370-0801	Magnetic Tape Unit; 200 ips, 9-track, PE/GCR, 320/1250KB	27,795	3,279	1,217
BU 6379-0801	I/O Link Adapter for up to four 6370-0801 magnetic tape units	29,103	2,468	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

*Includes maintenance.
**No new sale.
NC—No charge.

NCR V-8500 and V-8600 Systems

		Purchase Price (\$)	Annual Maint. (\$)	One-Year Rental* (\$)
PRINTERS				
BU 0647-0201	Train Printer; 2000 lpm, 132 positions, power stacker; includes controller	**64,722	9,325	3,117
AK 0647-P001	I/O Link Adapter for BU 0647-0201	2,388	238	108
BU 6471-0201	Band Printer; 2000 lpm, 64-character band, controller	54,500	5,280	2,825
AK 6471-K004	Hour Meter	230	—	10
AK 6471-K005	Static Eliminator	820	—	35
AK6471-K006	Audio Alarm	230	—	10
AK 6471-K401	Print Band; 48 characters	500	—	—
AK 6471-K601	Print Band; 64 characters	500	—	—
AK 6471-K901	Print Band; 96 characters	500	—	—
AU 6471-007-7190	Dual Interface SIA/SPA	6,550	360	315
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
AK 6420-P001	I/O Link Adapter; required for 6420-21301 and 3202 printers	2,780	202	100
AK 6420-P002	I/O Link Adapter; required for 6420-0601 printer	2,780	385	184
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 ASCII, 1403, 10 cpi	350	—	27
AK 6420-K024	Quietized Cabinet	583	—	38
BU 6430-0101-0232	Band Printer; 360 lpm, and interface for 64 character band	8,750	977	449
AK 6430-K010	Print Band; 64 characters	350	—	27
AK 6430-K020	Print Band; 64 characters, CP, 15 cpi	350	—	27
AK 6430-K002	Print Band; 48 characters	350	—	27
AK 6430-K019	Print Band; 96 characters	350	—	27
BU 6430-0201-7100	Band Printer; 72 lpm, interface for 64 character band	13,995	1,500	725
BU 6480-0101-0682	Laser Printer; includes Photoconductor Drum, software driver, utilities, and two character sets	210,430	6,720	9,500
D002-03XX	Various Software for 6480-0101: 64 & 96 character sets, 10, 12, 15, and 20 pitch, Gothic, US, Italics, and OCR-A	NC	NC	NC
D002-05XX	Various Software for 6480-0101: graphic element 64-character set, 10, 12, 15, and 20 pitch	NC	NC	NC
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-6831-0203	Card Reader; 600 cpm, with I/O link adapter	12,140	727	414
AU 6831-0201	Card Reader; 600 cpm	**9,580	643	396
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	Auxiliary Cage	7,950	138	136
AU 0690-0103	On-Line Auxiliary Bay	8,480	68	177

*Includes maintenance.

**No new sale.

NC—No charge.

NCR V-8500 and V-8600 Systems

		Purchase Price (\$)	Annual Maint. (\$)	One-Year Rental* (\$)
COMMUNICATIONS (Continued)				
AU 0692-0600	Dual Asynchronous Adapter	3,000	245	122
AU 0693-0600	Dual Synchronous Adapter	4,500	275	173
AU 0694-0800	C.C. DLC Adapter	2,275	191	93
AU 0695-0600	On-Line Auto Dialer	995	175	57
TERMINALS				
BU 7900-1301	CRT; 7900 Model 1, asynchronous	1,500	—	—
BU 7900-1303	CRT; 7900 Model 3, asynchronous	3,500	453	178
BU 7900	CRT; Model 7901, asynchronous	850	—	—
BU 7900	CRT; Model 7910, asynchronous, TTY	1,995	—	—
BU 7900	CRT; Model 7950, synchronous	1,395	—	—
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

SOFTWARE PRICES

		One-Time License Fee (\$)	Monthly License Fee (\$)
VS1 Basic System Software			
	VRX Operating System	—	—
	VRX Cobol 74 Compiler	—	132
	VRX COBUG	—	12
	VRX Fortran 77 Compiler	—	100
	VRX NEAT/VS Compiler	—	158
	VRX SORT/MERGE	—	121
	VRX TRAN-PRO	10,000	334
VS1 On-Line System Software			
	Terminal Communications Processor	—	60
	Network Definition Language Processor	—	36
	Remote Job Entry	—	72
	VRX Telecommunications	—	22
	DMS Data Entry System	2,000	67
VS1 Data Management System Software			
	VRX Utilities	—	35
	VRX File Conversion Utility	—	48
	VRX Total—V-8500 Series	38,500	1,430
	VRX DMS Tools	10,000	334

*Includes maintenance.

**No new sale.

NC—No charge. ■