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

MANAGEMENT SUMMARY

UPDATE: *NCR has started delivery of the new V-8800 Systems consisting of seven models. These include the uniprocessor V-8835 and the dyadic V-8845, and the V-8855 through V-8895 models, loosely coupled systems which include various combinations of the V-8835 and/or V-8845 processors. The V-8800 Systems are similar in most respects, including program compatibility, to the V-8600, the systems they will replace. The V-8600 Systems cannot be upgraded to V-8800 Systems. The V-8500 and V-8600 Systems represent a mature product line and no enhancements to the systems have been made. NCR has reduced prices for the V-8600 to make the system a more attractive upgrade option for System V-8500 users.*

NCR's V-8500, V-8600 and V-8800 line of mainframe computers are designed to operate in batch, on-line transaction, remote job entry (RJE), and distributed processing environments. All systems use the VRX virtual operating system which supports multiprogramming, and tightly and loosely coupled multiprocessing.

The V-8500-II five-model product line includes three uniprocessor systems, the V-8545-II, V-8555-II, and V-8565-II; and two dyadic or dual-processor systems, the V-8575-II and V-8595-II. The three uniprocessor models cannot be field upgraded to the dyadic systems since a swapout of CPUs is required. The V-8500-II system architecture employs multi-position, plug-in modules each with its own set of tasks. This modular architecture allows expansion of the base by incorporating additional subsystems. These subsystems can include two processors joined in a tightly coupled multiprocessing environment that functions as a single system to operators, programmers, and application software.

The V-8500, V-8600, and V-8800 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.

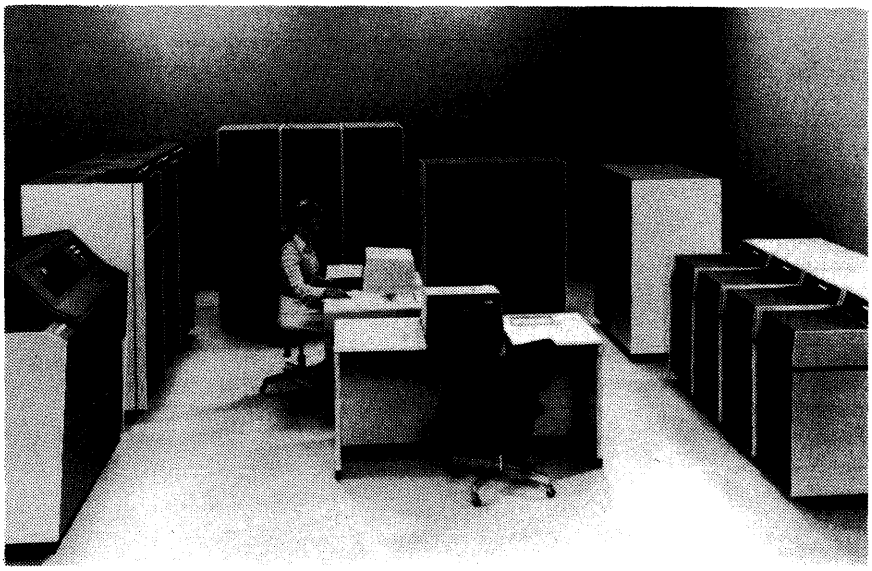
MODELS: V-8545-II, V-8555-II, V-8565-II, V-8575-II, and V-8595-II; V-8635, V-8645, V-8655, V-8665, V-8675, V-8685, and V-8695; V-8835, V-8845, V-8855, V-8865, V-8875, V-8885, and V-8895.
CONFIGURATION: Depending on product line, one to eight CPUs, 1 to 64 megabytes of memory, and a wide assortment of I/O devices are available.
COMPETITION: Honeywell DPS 7 and DPS 8 Series; IBM System/38 and 4300 Systems; Unisys (Burroughs) A 3 and A 5 Series, (Sperry) System 1100/60, and 1100/70 Series.
PRICE: Purchase prices range from $41,500 (V-8545-II E) to $3,011,000 (V-8895).

CHARACTERISTICS

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

MODELS:

NCR V-8545-II, V-8555-II, V-8565-II, V-8575-II, V-8595-II; V-8635, V-8645, V-8655, V-8665, V-8675,



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.

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

TABLE 1. SYSTEM COMPARISON

MODEL	V-8545-II	V-8555-II	V-8565-II	V-8575-II	V-8595-II
SYSTEM CHARACTERISTICS					
Date announced	—	—	—	—	—
Date first delivered	April 1983	April 1983	April 1983	April 1983	April 1983
Field upgradable to	V-855-II	V-8565-II	—	V-8595-II	—
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	64K MOS	64K MOS	64K MOS	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

The V-8800 is very similar in architecture to the V-8600 and both systems have identical configurations, main memory and cache capacities, and input/output control.

The V-8600 and V-8800 Systems comprise seven models each; the uniprocessor models V-8635/V-8835 with 4 to 16 megabytes of main memory and the V-8645/V-8845 which are tightly coupled dyadics with 4 to 16 megabytes of main memory. A unique combination of both tight and loose coupling is achieved when a V-8635/V-8835 and a V-6645/V8845 are configured together. The V-8655/V-8855, with 8 to 32 megabytes of main memory, consist of two V-8635/V-8835 processors. The V-8665/V-8865, configured with one V-8635/V-8835 single and one V-8645/V-8845 dyadic processor, have a main memory capacity of 8 to 32 megabytes. The V-8675/V-8875 are configured with two V-8645/V-8845 dyadic processors, and 8 to 64 megabytes of main memory. The V-8685/V-8885 have three V-8645/V-8845 dyadic processors and from 12 to 48 megabytes of main memory. The top of the line models V-8695/V-8895 are configured with four V-8645/V-8845 dyadic processors and a main memory capacity of 16 to 64 megabytes.

The V-8500-II E, V-8600, and V-8800 Series processors are microcode based and make extensive use of Large Scale Integration (LSI) logic and 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 70 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 RAM chips. Memory cycle times range from 440 to 336 nanoseconds, and all, except the three V-8500-II uniprocessors, feature data interleaving. All memory subsystems have single-bit error correction and double-bit error detection. A high-speed cache memory is used in all V-8600 and V-8800 Systems. I/O devices can be attached to the V-8685, V-8695; V-8835, V-8845, V-8855, V-8865, V-8875, V-8885, V-8895.

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.

INTERNAL CODE: 8-bit EBCDIC is standard.

MAIN MEMORY

The memory subsystem consists of the interface, timing and control logic permitting it to function independent of other subsystems. When multiple memory subsystems are present on the same system the memory interleaving feature is used. Data in main memory is interleaved with up to four contiguous words located in separate modules. Interleaving allows two or four 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.

STORAGE TYPE: 64K-bit RAM Metal Oxide Semiconductor (MOS).

CAPACITY: See Table 1.

CYCLE TIME: See Table 1.

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 the number one mainframe vendor in 1986, not in size, but in what really counts, earnings. NCR has proved that with skillfull marketing in well defined market niches, mainframes are selling very well and with a healthy 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, V-8600, and V-8800 Systems

a 2-megabyte memory capacity and .38 MIPS rating. Prices are $39,600 for the 4361, and $225,000 for the V-8635.

ADVANTAGES AND RESTRICTIONS

The new V-8800 Systems are aimed primarily at V-8500 and V-8600 Systems users who need additional processing capacity. The V-8800 can provide up to 50 percent more power than a comparable V-8600 System. This power is achieved through an additional hardware component in the V-8800 to speed up the execution of NEAT virtual commands. The V-8600 cannot be upgraded to a V-8800 because this component cannot be added to the V-8600 System. The V-8800 is completely program compatible with V-8500 and V-8600 Systems and offers users of these systems an excellent growth path and protection of their software investment.

The V-8600 and V-8800 Systems are identical in most respects. Both systems have 38-nanosecond processor cycle time; a standard Instruction Storage Unit ranging from 96K to 768K bytes; and a 32K- to 512K-byte high-speed cache memory which acts as a buffer between the processor and main memory. 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) is double the size of the V-8500 DAT, and the V-8800 also features the Dynamic Address Translation Assist Unit (DAU) to perform virtual/real and real/virtual address translation. 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 V-8600 and V-8800 have a high system availability using 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.

To realize maximum performance improvements VRX Cobol programs will have to be recompiled using the VRX/E Cobol Compiler and VRX Release 12. Neither VRX Release 12 nor the VRX/E Compiler have been released yet. When available the VRX/E Cobol Compiler can only be used on the V-8800, V-8600, V-8565-II, and V-8595-II systems. The use of the VRX/E Cobol Compiler therefore restricts V-8800/V-8500 loose coupling to the V-8565-II and V-8595-II systems only.

USER REACTION

Datapro received a total of 178 NCR user responses in our 1986 survey of mainframe computer users. The user population consisted of a variety of business types with banking/finance institutions (34 percent), manufacturing facilities (12 percent), and retail/wholesale establishments (15 percent) represented most frequently. The primary applications were accounting/billing operations (59 percent),

V-8645 and V-8845. The remaining V-8655, V-8665, V-8675, V-8685, V-8695, and the V-8855, V-8865, V-8875, V-8885, V-8895 models are made up of multiple configurations of the base models and are termed the "processor complex" models. The V-8655 consists of two V-8635 processors; the V-8665 consists of one V-8635 uniprocessor and one V-8645 dyadic processor; the V-8675 consists of two 8645 dyadic processors; the V-8685 consists of three 8645 dyadic processors; and the V-8695 consists of four 8645 dyadic processors. The dyadic 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. Similar to the V-8600 systems, the V-8855 through V-8895 "processor complex" models are configured by using various combinations of the V-8835 and/or V-8845 "base models".

Of the two basic system instruction sets available the V-8500 Base Virtual Machine uses the 71-instruction set. 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.

The Time of Day Clock is 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.

SPECIAL FEATURES: Two special features are, the NEAT Assist Unit (NAU) to speed up the execution of the most commonly used NEAT virtual commands and the Dynamic Address Translation Unit (DAU), a hardware component to perform the calculations of virtual/real and real/virtual address translation. NEAT is NCR's proprietary programming language.

CONFIGURATION RULES

The V-8500-II family comprises five models, three in the uniprocessor series and two in the dyadic series. The V-8545 II, V-8555 II, and the V-8565 II uniprocessors each 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 communications subsystem with 1 to 20 integrated lines, and a CRT console. The dyadic models V-8575-II and V-8595-II 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 communications 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 the dyadic series is not possible. The dyadic model V-8575-II can be field upgraded to the V-8595-II.

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

TABLE 2. MASS STORAGE

MODEL	6540	6543
Cabinets per subsystem	1 or 4	1 or 4
Disk packs/HDAs per cabinet	2 to 4	2 to 4
Capacity	135M to 540M	415 to 1.6GB
Tracks/segments per drive unit	—	711
Average seek time, msec.	21.7	20
Average access time, msec.	30	28.33
Average rotational delay, msec.	8.3	8.3
Data transfer rate	1.2MB	1.2MB
Controller model	6539	6099
Comments	6539 IOLA	Units can be stacked

payroll/personnel (57 percent), and check processing (36 percent), although many others were mentioned. About 72 percent of the respondents purchased their equipment from NCR, 14 percent rented the equipment from NCR, and about 14 percent leased the equipment through a third party. Most users developed their applications programs in-house (86 percent), and 56 percent of the users purchased NCR developed programs. Fifty-seven percent have a disaster recovery plan in place, and 25 percent have established an information center. User responses for both the V-8500 and V-8600 systems are presented in the following chart. Because first customer shipments of the V-8800 Systems did not take place until October 1986 no user ratings are available for these systems.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	68	97	13	0	3.31
Reliability of mainframe	88	80	8	2	3.39
Reliability of peripherals	71	95	16	2	3.32
Maintenance service:					
Responsiveness	88	68	15	6	3.34
Effectiveness	67	83	22	5	3.20
Technical support:					
Troubleshooting	33	81	54	9	2.78
Education	40	102	27	8	2.98
Documentation	26	92	49	9	2.77
Manufacturers software:					
Operating system	66	98	12	2	3.28
Compiler & assemblers	39	117	20	2	3.08
Application programs	16	76	48	20	2.55
Ease of programming	23	123	29	1	2.95
Ease of conversion	57	82	32	4	3.10
Overall satisfaction	36	120	20	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 expansion	107	57	9	3	3.52
Compatibility of hardware carried over from other systems	89	54	19	11	3.28
Compatibility of programs/data carried over from other systems	94	51	15	12	3.32
Power/energy efficiency	23	125	21	4	2.97
Productivity aids help keep programming costs low	17	88	60	11	2.63
Software/support promised by vendor	12	79	59	26	2.44

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

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

The V-8800 System also comprises seven models, one uniprocessor (V-8835), one dyadic (V-8845), and five multiprocessor models (V-8855, V-8865, V-8875, V-8885, and 8895). Configuration rules for the V-8800 Systems are identical to the V-8600 Systems.

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 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, used on the V-8500-II, is based on three elements: the I/O Link Controller, I/O Links, and the I/O Link Adapter. The I/O Link Controller

NCR V-8500, V-8600, and V-8800 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.
6376-0201	9	1600	PE/GCR	200	320K to 1250K
6376-0202	9	1600	PE/GCR	200	320K to 1250K
6373-0101	9	1600	PE/GCR	25/75	40K to 469K
6373-0102	9	1600	PE/GCR	25/75	40K to 469K
6325-0101	9	800	NRZI	45	36K to 72K
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.
6420-2601	1440 lpm	132	10	6 or 8	Industry std.
6480-0101	103 ppm	—	to 20	to 24	Industry std.

NCR users were asked two final questions: "Did the system measure up to your expectations?" and, "Would you recommend it to another user?" Almost 95 percent of the V-8500 and V-8600 users felt their systems performed as they had expected. Less than 2 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 5 percent of the users answered "no" to this question. □

(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-II, 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 (CCP) in the V-8600 and V-8800 I/O Subsystem 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, and two more are optional. Up to four are optional on the V-8555-II E through V-8595-II E models. On the V-8635, V-8645, V-8835, and V-8835 models 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 and V-8800 "processor complex" models in place of the DCX. The DCD offers additional I/O capabilities that provide the intersystem communications 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, V-8600, and V-8800 systems, refer to Table 2.

INPUT/OUTPUT UNITS

Refer to Table 3 for information on tape units and printers.

TERMINALS

Terminals used with the V-8500, V-8600, and V-8800 Systems are listed in Table 4.

COMMUNICATIONS

The *Integrated Communications Subsystem (ICS)* 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 E, V-8555-II E, and V-8565-II E.

Communications hardware for the V-8600 and V-8800 systems includes synchronous, asynchronous, and bit-oriented Data Link Control (DLC) adapters, multiplexers, integrated and freestanding modems, and communications processors that can be configured to handle any on-line, realtime net-

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

work requirements. Front-end communications processors are also available to handle all network control functions so that telecommunications are transparent to host processors and application programs.

The use of the *612 Communications Multiplexer* on V-8600 or V-8800 processor complex models requires a *Trunk Channel Control Processor (TCCP).* The TCCP includes a low-speed common trunk, with another low-speed or high-speed trunk available as an option. A *Multiplexer Channel Control Processor (MCCP)* may be required to increase the low-speed trunk bandwidth to 40K bytes to accommodate medium- to high-speed 612 multiplexer activity. The MCCP should only be added if really necessary because it occupies one CCP position and may restrict growth in the I/O subsystem.

The *721 Communications Processor* serves as a front-end processor, a remote communications concentrator, a message-switching system, or as a unit performing combinations of these functions for up to 62 full-duplex or 95 half-duplex lines.

The *5620 Communications Processor* is designed for local or remote network configurations requiring up to 32 duplex communications lines.

The *3650 Communications Processor* is designed for network configurations at local or remote locations requiring up to 128 duplex communications lines.

SOFTWARE

OPERATING SYSTEM: NCR offers a virtual operating system for the V-8500. V-8600, and V-8800 Systems. The *Virtual Resource Executive (VRX)* is a group of software modules that utilize the VS1, VS2, VS6, or VS8 firmware to make up a flexible operating system with multiprocessing, virtual-machine, and virtual-storage capabilities. VRX supports multiple-processor systems and treats processing elements in the system as assignable resources. The current level of VRX is Release 12 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 (JCL)* 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, provides an interface for the virtual-storage software, while the 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 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 information is entered into the log and the job is removed from the system.

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

TABLE 4. TERMINALS

MODEL	7930	7910	7950
DISPLAY PARAMETERS			
Max. chars./screen	2000, 3300	1920, 2560	2000
Screen size (lines x chars.)	25x80	25x80/132	24x80
Symbol formation	7x9 dot matrix	7x9, 5x9 dot matrix	7x9 dot matrix
Character phosphor	Green P31	Amber	Green P31
Total colors/no. simult. displayed	—	—	—
KEYBOARD PARAMETERS			
Style	Typewriter	Typewriter, data	Typewriter
Character/code set	128 ASCII	128 ASCII	96 ASCII, EBCDIC
Detachable	Standard	Standard	Standard
Program function keys	12/24	—	24
OTHER FEATURES			
Buffer capacity	256 characters	12K	—
Tilt/swivel	Standard	Standard	Standard
Graphics capability	125 symbols	32 symbols	—
TERMINAL INTERFACE	RS-232-C	RS-232-C, RS-422	RS-232-C

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 (REINIT)* system 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 Management Facility (IHMF)* (Inter Host Communication IHC, V-8500 and V-8600 Systems) is responsible for the communications between base processors in loosely coupled configurations. The two components which make up the IHMF 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 IHMF. It is a necessary element to detect failure and to activate automatic recovery.

The *InstantReady* mode uses two hosts for critical on-line applications. One host handles all on-line acivity with the required files opened, while the second host has the same on-line applications (InstantReady) loaded and the same files opened, but in a suspended state waiting for transaction input. When a failure in the first host is detected the InstantReady job is automatically activated by VRX and, with automatic switchovers, assumes the entire transaction load.

Inter-host *File Sharing* is designed to facilitate the InstantReady concept in incremental processing without precluding the ability to run in a shared workload mode. A file may be shared by more than one host if it resides on an inter-host shared disk and declared open for inter-host sharing by its users. The file types that can be shared under InstantReady are B-Series input or I/O files, CAM sequential and relative input or I/O files.

The VRX incorporates facilities for handling sequential, indexed sequential, and NCR random 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.

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 6540, and 6543 with the capability of accessing greater than 64K-byte 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.

PROGRAMMING LANGUAGES: The high-level languages supported by the V-8500, V-8600, and 8800 Systems are Basic, Cobol 74, Cobol 68, Fortran IV, Fortran E, NEAT/3, NEAT/VS, and NCR RPG.

DATA BASE MANAGEMENT: The *NCR-Total* data base management system is a licensed software product running under the VRX operating system and is available in two versions. *Total Basic* is single-threaded with a copy of Total bound to each active task. *Total Central* is multithreaded and is located in its own job region. The structured *Data Base Definition Language* provides for the initial generation of a Total data base description module, and all subsequent modifications. The *Data Management Language* interfaces to the operating system and the application program for all communications with the Total data base. File Sharing under Total Basic uses file locks when an update to a data set is to occur. Total Central uses a combination of File Sharing options and a record-locking facility to protect files to be updated.

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

DATA MANAGEMENT: The *NCR-DMS* data management system for the VRX environment includes several software tools that provide resource control, system documentation, applications development aids, and end-user information access.

The *DMS/Directory* is an integrated dictionary/directory that simplifies documentation and control of data bases, files, records, data elements, software, hardware and networks. *DMS/Data Entry* is an on-line, source-data entry system for batch processing allowing batches of data to be entered at the originating point of the transaction. 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. *DMS/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 applications program requirements. It is designed for users with large network and data base requirements. The *DMS-Query* interactive query language is 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. The *DMS/Reporter* is an off-line report writer for batch generation of large reports with extensive data manipulation and sorting.

DATA COMMUNICATIONS: VRX provides communications 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 (MCS)* 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. The *Network Description Language (NDL)* defines a communications network and the queue arrangement to be used by an on-line program. The *Network Description Language Processor (NDLP)* reads NDL statements, processes them, and creates the tables necessary for on-line operation. The tables are subsequently combined with programs at load time by the Link Editor.

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.

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 Telecommunications software provides NCR/DLC, SDLC, BSC, X.25, TTY, or ISO asynchronous 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).

PROGRAM DEVELOPMENT: *VRX-IVS* includes facilities for on-line, interactive program development, testing, and debugging. Programmers at remote locations can create, modify, and run source programs through interactive terminals. This includes text editing, file library maintenance, and program execution. Source programs are entered directly into the system and can pass through the test and debug cycles without interfering with regular system operation.

UTILITIES: The *System Performance Utility* monitors the entire system's performance levels and produces data-related copy, print, and sort; interactive file-related copy, print, compare, backup, and delete. It also performs system maintenance and program debug; CAM file handling, time-ordered index CAM file handling, and program development.

OTHER SOFTWARE: NCR offers software packages to handle key applications in manufacturing, retailing, schools, financial institutions, hospitals, and public safety.

PRICING & SUPPORT

POLICY: 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 onetime fees range up to about $36,000. Specific software prices were not provided by the vendor.

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. 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%

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.

TYPICAL CONFIGURATION: The following configurations illustrate the V-8545-II, V-8665, and V-8895 systems. The quoted prices include all necessary hardware components, but no software.
Model V-8545-II:

One central processor with 1024K bytes of main memory, 1 CRT console, 10 communications lines, 1 I/O Link Controller	$ 41,500
1 6540 disk subsystem (540MB)	33,200
1 6420 band printer 1,440 lpm	31,370
10 7910 terminals	19,950
TOTAL PURCHASE PRICE:	$126,020

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

Model V-8665:

One V-8635 uniprocessor, 1 V-8645 dyadic processor, 8M bytes of memory, 160K cache memory, 4 Channel Control Processors, 16 I/O channels, 2 CRT consoles, 1 System Control Unit, 1 Control Processor	$1,325,000
1 6549 IOLA (I/O Link Adapter) Exp.	3,392
1 6540 disk subsystem (540MB)	33,200
2 6543 disk drives (415.2MB)	38,000
1 6379 IOLA	29,130
4 6376 magnetic tape units (200 ips)	198,040
2 6420 IOLAs	5,560
2 6420-06 band printers 1440 lpm	62,740
2 6420-K019 print bands	700
1 6770 MICR Reader/Sorter 1400 dpm	114,700
20 7910 terminals	39,900
TOTAL PURCHASE PRICE:	$1,850,362

Model V-8895:

Four V-8845 dyadic processors with 16M bytes of memory, 512K bytes cache memory, 8 Channel Control Processors, 1 System-to-System Adapter, an 8x32 Dynamic Channel Director, 2 CRT consoles, 1 System Control Unit, 1 Control Processor	$3,011,000
1 6549 IOLA Expansion	3,392
2 6540 disk subsystems (540MB)	66,200
4 6543 disk drives (415.2MB)	76,000
1 6379 IOLA	29,130
4 6376 magnetic tape units (200 ips)	198,040
3 6420 IOLAs	8,340
3 6420-06 band printers 1440 lpm	94,110
3 6420-K019 print bands	1,050
1 6770 MICR Reader/Sorter 1400 dpm	114,700
40 7910 terminals	79,800
TOTAL PURCHASE PRICE:	$3,681,762

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
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	Virtual Memory Processor System; includes a CRT console, 2048K bytes of memory	70,000	7,608	8,255
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
8575 PROCESSOR AND MAIN MEMORY				
V-8575-II	Virtual Memory Multiprocessor System; includes a CRT console, 4096K bytes of memory	123,300	11,352	10,475
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

**Includes maintenance.*
***Three-year rental only.*
NC—No charge.

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

		Purchase Price ($)	Annual Maint. ($)	One-Year Rental* ($)
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	195	136
AK 56XO-PX41	Medium-Speed Trunk	5,380	281	205
AK 56XO-PX42	Very High-Speed Trunk	8,094	403	305
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	368	342
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	12,500	1,440	990
AK 5600-P796	V-8555-II to V-8565-II	16,000	3,389	2,593
AK 5600-P781	V-8575-II to V-8595-II	46,700	5,822	7,780
AK 5600-P782	V-8585-II to V-8595-II	16,000	2,522	2,478

		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
	VRX Mode for V-8565-II	548
	N Mode for V-8565-II	858
	VRX Mode for V-8575-II	712
	VRX Mode for V-8595-II	1,096

		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.	225,000	20,625	**14,100
AK 5710-P370	V-8635-V-8645 Upgrade	215,000	1,875	**9,270

Includes maintenance.
***Three-year rental only.*
NC—No charge.

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

		Purchase Price ($)	Annual Maint. ($)	One-Year Rental* ($)
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	440,000	222,500	**21,750
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)	835,000	33,750	**36,365
Additional Memory for V-8655:				
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
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)	1,040,000	38,815	**36,365
Additional Memory for V-8665:				
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
	4-megabyte increment (up to 2)	64,800	4,032	3,220
8675 PROCESSOR AND MAIN MEMORY				
V-8675	System includes two V-8645 Dual-Processor Systems (see V-8645 above for description)	1,250,000	40,500	**43,250
Additional Memory for V-8675:				
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
	4-megabyte increment (up to 4)	64,800	4,032	**43,250
8685 PROCESSOR AND MAIN MEMORY				
V-8685	System includes three V-8645 Dual-Processor Systems (see V-8645 above for description)	1,870,000	60,750	**64,940
Additional Memory for V-8685:				
AK 5710-P523	12,288K to 16,384K bytes	64.800	4,032	3,220
	4-megabyte increments (up to 8)	64,800	4,032	3,220
8695 PROCESSOR AND MAIN MEMORY				
V-8695	System includes four V-8645 Dual-Processor Systems (see V-8645 above for description)	2,460,000	81,000	**81,630
Additional Memory for V-8695:				
	4-megabyte increment (up to 12)	64,800	4,032	3,220
8835 PROCESSOR AND MAIN MEMORY				
V-8835	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, one System Control Unit with one Control Processor, and DCX or DCD interface	480,000	20,625	**16,720
AU 8835-8845	V-8835-V-8845 Upgrade	321,000	1,875	**10,190

**Includes maintenance.*
***Three-year rental only.*
NC—No charge.

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

		Purchase Price ($)	Annual Maint. ($)	One-Year Rental* ($)
Additional Memory for V-8835:				
AK 5710-P520	4M to 8M bytes	64,800	4,032	3,220
8845 PROCESSOR AND MAIN MEMORY				
V-8845	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, one System Control Unit with two Control Processor, and a DCX/DCD interface	733,000	22,500	**24,780
Additional Memory for V-8845 thru V-8895				
AK 5710-P522	8M to 12M bytes	64,800	4,032	3,220
AK 5710-P523	12M to 16M bytes	64,800	4,032	3,220
8855 PROCESSOR AND MAIN MEMORY				
V-8855	System includes two V-8835 Virtual Memory Uniprocessor Systems (see V-8835 above for description) and a System-to-System Adapter	1,003,000	33,750	**34,160
8865 PROCESSOR AND MAIN MEMORY				
V-8865	System includes one V-8835 Uniprocessor and one V-8845 Dual-Processor (see V-8835 and V-8845 above for descriptions) and a System-to-System Adapter	1,258,000	38,815	**42,550
8875 PROCESSOR AND MAIN MEMORY				
V-8875	System includes two V-8845 Dual-Processor Systems (see V-8845 above for description) and a System-to-System Adapter	1,512,000	40,500	**50,625
8885 PROCESSOR AND MAIN MEMORY				
V-8885	System includes three V-8845 Dual-Processor Systems (see V-8845 above for description) and a System-to-System Adapter	2,277,000	60,750	**76,220
8895 PROCESSOR AND MAIN MEMORY				
V-8895	System includes four V-8845 Dual-Processor Systems (see V-8845 above for description)	3,011,000	81,000	**100,840
I/O CONTROL OPTIONS				
AK 5710-P537	Channel Control Processor with DCX interface for 8 I/O channels	9,000	635	454
AK 5710-P538	Channel Control Processor with DCD interface	9,000	635	454
AK 5710-P539	Channel Control Processor Upgrade; DCX to DCD	2,225	152	110
AK 5710-P541	Trunk Channel Control Processor and 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-P584	Multiplexer Channel Control Processor	6,775	600	450
AK 5710-P045	Control Processor Upgrade	4,850	161	230
AK 5720-P046	Filter 400 Hz	800	26	40
AK 5720-P050	Expanded High-Speed Link	2,225	75	105
AU 6032-0707	Auxiliary Cabinet for System-to-System Adapter	1,500	—	55
AC 1401-C128	Cable; BSL 50 ft.	130	—	—
AC 1401-C128	Cable; BSL 100 ft.	140	—	—

	Monthly License Fee ($)
Firmware Options:	
V-8635/V-8835 Firmware	700
V-8645/V-8845 Firmware	900
V-8655/V-8855 Firmware	1,400
V-8665/V-8865 Firmware	1,600
V-8675/V-8875 Firmware	1,800
V-8685/V-8885 Firmware	2,700
V-8695/V-8895 Firmware	3,600

**Includes maintenance.*
***Three-year rental only.*
NC—No charge.

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

		Purchase Price ($)	Annual Maint. ($)	One-Year Rental* ($)
MASS STORAGE				
AU 6099-5103	Disk Subsystem; 415.2 megabytes	29,035	1,296	1,390
AU 6099-5203	Disk Subsystem; 830.4 megabytes	44,260	1,788	2,105
AU 6099-5403	Disk Subsystem; 1.6 gigabytes	80,095	3,276	3,810
AU 6543-7404	Disk Drive; 415.2 megabytes	19,000	660	865
AK 6099-K004	Kit; 6099/6543 stacking	350	—	—
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
MAGNETIC TAPE				
AU 6376-0101	Magnetic Tape Unit; 25/75 ips, 9-track, PE/GCR, 40/469KB, primary unit	25,990	2,988	1,350
AU 6376-0102	Magnetic Tape Unit; 25/75 ips, 9-track, PE/GCR, 40/469KB, secondary unit	17,745	2,280	945
AU 6376-0201	Magnetic Tape Unit; 200 ips, 9-track, PE/GCR, 320/1250KB, primary unit	49,510	5,050	2,505
AU 6376-0202	Magnetic Tape Unit; 200 ips, 9-track, PE/GCR, 320/1250KB, secondary unit	23,190	2,950	1,230
BU 6325-0101	Magnetic Tape Unit with Controller; 9-track, 45 ips, 80KB	14,400	958	792
PRINTERS				
2,388 238 108				
BU 6471-0201	Band Printer; 2000 lpm, 64-character band, controller	46,790	4,800	2,482
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 6420-2601	Band Printer; 1440 lpm, requires at least one print band	31,370	4,225	1,686
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
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; 720 lpm, interface for 64 character band, RS-232 interface	13,995	1,500	725
AU 6430-0202-7190	Band Printer; 72 lpm, system printer	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
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
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				
AU 7910-0201	CRT, 7900-1 and -4 compatible	1,995	—	—
BU 7958-2044	CRT; Model 7950, synchronous	1,395	150	85
BU 7930-0102	CRT; green, 7900-1/7901 compatiblely	995	191	—

**Includes maintenance.*
***Three-year rental only.*
NC—No charge. ■