

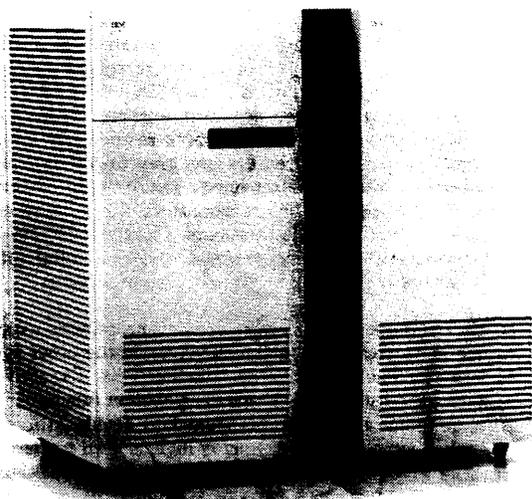
# IBM System/88

## MANAGEMENT SUMMARY

The IBM System/88 is a Stratus-supplied fault tolerant system consisting of three models: the 4575 Model 20B, and the 4576 Models 40 and 60. The system combines a duplexed hardware architecture with logic circuitry that continually checks for errors and provides diagnostics. The System/88's approach to fault tolerance is to detect a failed component, and correct or replace it without data corruption or system downtime. Most of the main components, such as processors, memory, communications controllers, and disks, are duplexed. Each component operates in synchronization with its partner, providing backup so that should one component fail, its partner automatically takes over and continues processing. (The streaming tape device is not a duplexed component.)

The System/88 4575 Model 20B is offered in one standard configuration; features can be added or deleted to alter the system's capabilities and functions. The 4575 Model 20B consists of an enclosure rack with duplexed power supplies, battery backup, and 20 Central Electronic Complex (CEC) attachment slots for memory, processor, and controller boards. The 4575 enclosure cabinet also provides front rack space for two 4580 disk drives and one tape drive, as well as rear rack space for communications adapter chassis, link connectors, and link extenders. The system supports from 4MB to 8MB of duplexed memory, 7GB duplexed disk storage, and up to 128 communications ports.

The 4575 Model 20B contains two identical processor boards, each containing two sets of paired microprocessors capable of executing two instruction streams simultaneously. Each microprocessor has a specialized function; this is unique to the 4575 Model 20B only. In each pair, one ➤



*The System/88 fault tolerant system is shown with the 4577 expansion cabinet. The system is available in three models, and supports up to 16MB of duplexed memory and a maximum of 256 workstations, depending upon the model.*

The IBM System/88 is a 32-bit dual-processor fault tolerant system targeted towards the small-to-large online transaction processing market. The system combines duplexed hardware components with error checking and diagnostic software to provide high availability. Applications areas include finance, retail, manufacturing, distribution, lodging, and cross-industry (accounting, graphics, report writer).

**MODELS:** 4575 Model 20B; 4576 Models 40 and 60.

**MAIN MEMORY:** Up to 16MB duplexed.

**DISK CAPACITY:** Up to 7GB duplexed.

**WORKSTATIONS:** Up to 256.

**PRICE:** \$51,700 to \$132,900 per processor (these processors must be duplexed).

## CHARACTERISTICS

**MANUFACTURER:** International Business Machines Corporation (IBM), Old Orchard Road, Armonk, NY 10504. Contact your local IBM representative.

**CANADIAN ADDRESS:** IBM Canada Limited, Markham, 3500 Steeles Avenue East, Markham, Ontario, L3R 2Z1 Canada. Contact your local IBM representative.

## DATA FORMATS

**BASIC UNIT:** 32-bit word.

**FIXED-POINT OPERAND:** The processor operates on bit data, byte data, double-byte data, and quadruple-byte data.

**FLOATING-POINT OPERAND:** Arithmetic assist for both floating-point and packed-decimal arithmetic functions is available for the 4576 Model 60 only. The math processor is microcoded to handle packed decimal arithmetic, some trigonometric functions, and IEEE double-precision floating-point operations.

**INSTRUCTIONS:** 1,000-plus; there is a version of each basic machine type for each of the four machine data types and each of the addressing modes.

**INTERNAL CODE:** ASCII.

## MAIN STORAGE

**TYPE:** MOS (Metal Oxide Semiconductor).

**CYCLE TIME:** 125 nanoseconds per 2 bytes.

**CAPACITY:** Main memory capacity on the System/88 ranges from 4MB duplexed to 16MB duplexed. The memory is available in either 2MB or 4MB increments. The 2MB memory feature requires two Central Electronic Complex (CEC) slots; the 4MB requires three CEC slots. See Chart A for capacities of specific models.

**CHECKING:** Checking for the System/88 provides memory control, error detection and correction, system bus level ➤

## IBM System/88

### CHART A. SYSTEM COMPARISON

MODEL	4575-20B	4576-40	4576-60
<b>SYSTEM CHARACTERISTICS</b>			
Date of introduction	October 1985	October 1985	October 1985
Date of first delivery	February 1986	February 1986	February 1986
Operating system	VOS	VOS	VOS
Upgradable from	—	—	4576-40
Upgradable to	—	4576-60	—
MIPS	0.90	2.79	7.38
Relative performance (based on a rating of the 4575-20B at 1.0)	1.0	2.5	3.8
<b>MEMORY</b>			
Minimum capacity, bytes	4M duplexed	4M duplexed	4M duplexed
Maximum capacity, bytes	8M duplexed	16M duplexed	16M duplexed
Type	ECC MOS	ECC MOS	ECC MOS
Cache memory	None	None	48KB
Cycle time, nanoseconds	—	—	—
Bytes fetched per cycle	—	—	—
<b>INPUT/OUTPUT CONTROL</b>			
Number of channels	20 slots	40 slots	40 slots
High-speed buses	—	—	—
Low-speed buses	—	—	—
<b>MINIMUM DISK STORAGE</b>			
	142MB duplexed	142MB duplexed	142MB duplexed
<b>MAXIMUM DISK STORAGE</b>			
	7GB duplexed	7GB duplexed	7GB duplexed
<b>NUMBER OF WORKSTATIONS</b>			
	128	256	256
<b>COMMUNICATIONS PROTOCOLS</b>			
	SNA; SDLC; X.25; X.29; Async; Bisync; RJE	SNA; SDLC; X.25; X.29; Async; Bisync; RJE	SNA; SDLC; X.25; X.29; Async; Bisync; RJE

A dash (—) in a column indicates that the information is unavailable from the vendor.

▷ microprocessor executes application instructions, and the other executes operating system instructions. Because all the components on the processor board are duplicated, as the paired microprocessors are executing system and application instructions, another set of paired microprocessors are executing exactly the same instructions. And, because the processor board is duplexed, there are two more pairs of microprocessors also executing the same instructions. The results of the two sets of microprocessors are continuously compared, and if a discrepancy is detected, the entire board is taken out of service and the partner board continues to process in a simplex fashion until the repair has been made.

According to IBM, the 4576 Model 40 performance rate is 2.5 times that of the 4575, and the Model 60 performance rate is 3.8 times that of the 4575, depending on the workload. The Models 40 and 60 provide 40 CEC slots, and support from 4MB to 16MB duplexed memory, up to 256 communications ports, and up to 7GB duplexed disk storage. The 4976 Model 60 also offers a 48KB high-speed cache memory, and separate on-board microprocessors for arithmetic assist for both floating-point and packed-decimal arithmetic functions. The 4576 rack enclosure provides rear cabinet rack space for a communications adapter chassis, link connectors, and link extenders. All disk and tape units must be attached to the 4576 via the 4577 expansion cabinet. The 4976 Model 40 can be field upgraded to the Model 60.

The 4576 duplexed processor boards offer multiple microprocessors that share the processing workload in a nonhierarchical fashion. The 4576 Model 40 processor board contains two sets of four microprocessors capable of executing four instruction streams simultaneously. The

▷ checking, and the management logic required for fault tolerant operation.

**STORAGE PROTECTION:** Information is unavailable from the vendor.

**RESERVED STORAGE:** Information is unavailable from the vendor.

**CACHE MEMORY:** A cache memory of 48KB is supported on the 4576 Model 60 only. Cache is implemented in 55-nanosecond static RAM designed to minimize bus and main memory traffic for data and instructions.

#### CENTRAL PROCESSOR

**GENERAL:** The System/88 CPU contains two identical processor boards, with a peer-to-peer relationship, each of which contains two chips. On the 4575 20B models each chip, holding two microprocessors, executes the same instruction and continuously compares results. Therefore, a total of eight microprocessors are present to execute two instruction streams simultaneously. On the 4576 40 models, each chip holds four microprocessors for a total of 16 executing four instruction streams. On the 4576 60, each chip contains six microprocessors for a total of 24 microprocessors executing six instruction streams.

Within a single chip, one set of microprocessors executes system, or "executive," instructions while the other is performing application, or "user," instructions. Executive, or system, processors handle operating system functions, such as page faults and interrupts from I/O devices, the clock, and other components. Gate array logic is used to distribute interrupts among the logical processors on a board. User, or application, processors execute scheduled user processes and the operating system.

▷ If a comparison results in any kind of discrepancy, the chip takes itself out of service while processing continues on a duplexed twin located on the other board, operating in

## IBM System/88

CHART B. MASS STORAGE

MODEL	4580	4581
Type	Removable	Removable
Controller model	1000	1010
Drives per subsystem/controller	4	8
Formatted capacity per drive, megabytes	142	448
Number of usable surfaces	1,121 cylinders	842 cylinders
Number of sectors or tracks per surface	7 tracks/cylinder, 62 sectors/cylinder	20 tracks/cylinder, 260 sectors/cylinder
Bytes per sector or track	2048/sector	2048/sector
Average seek time	40 ms	18 ms
Average rotational/relay time	9.7 ms	7.5 ms
Average access time	49.7 ms	25.5 ms
Data transfer rate	1.04MB/sec.	1.8MB/sec.
Supported by system models	All System/88s	All System/88s
Comments		

A dash (—) in a column indicates that the information is unavailable from the vendor.

➤ Model 60 processor board contains two sets of six microprocessors and is capable of executing six instruction streams simultaneously. As the primary set of microprocessors are executing, the other set of microprocessors are executing exactly the same instructions and comparing the results for error detection. Like the 4575, if a discrepancy is detected, the entire board is removed from service and the partner board continues to process in a simplex fashion until the repair has been made. All other components on the processor boards are also duplicated.

To further describe the system and data integrity, the error detection functions automatically remove failing components from service. Diagnostics are automatically run on the failing component and if no permanent failure is shown, the component is placed back into service. If the diagnostics determine a hard failure on the component, the System/88 automatically notifies the System/88 Support Center, which then performs a second diagnosis on the component and if required, express ships a replacement component. The same basic duplexed concept extends to memory, mass storage devices, and certain communications components.

The System/88 features what IBM refers to as "hot pluggability." This feature permits System/88 components to be removed, repaired, or replaced during system operation without requiring power shutdown.

The System/88 allows for nondisruptive horizontal growth. Additional System/88 processing modules and their attached resources (memory, DASD, and peripherals) can be added to an existing System/88 system via the System/88 link facility. Once attached, all resources are available to all systems within the link. The System/88 link facility allows systems to be linked at a distance of 750 feet. The link extender allows that distance to be extended to 10 miles.

The 4577 expansion cabinet provides extra rack space and additional power distribution for the System/88. Combinations of disk drives, tape drives, communications chassis, link connectors, and link extenders can be installed in the 4577. Depending on the combination, the 4577 can support up to six disk drives, four tape drives, and 12 communica-

➤ exactly the same fashion. If both chips go out of service, the entire board suspends operation and shifts primary processing responsibility to the duplexed board, which continues to operate in simplex fashion. "Hot pluggability" allows the defective component to be repaired or replaced and resynchronized with its twin while the system continues to operate. This same basic duplexed concept extends to disk storage devices, memory, and certain communications hardware.

The basic 4575 package uses a Stratus P106 CPU board containing four Motorola MC68000 microprocessors. The Motorola MC68000 uses HMOS technology. It has a 16-bit ALU architecture, 16-bit data bus interface, 16-bit internal bus, and a 23-bit address bus. The 4575 20 contains 20 CEC slots for memory, processors, and controllers.

The 4576 40 uses a Stratus G401 CPU board with eight Motorola MC68010 microprocessors.

The 4576 60 system is based around a Stratus G610 processor board with 12 MC68010 microprocessors. The primary difference between the G401 and the G610 is that the G610 includes a 48KB cache and can access a fast arithmetic processor. The 4576 40 and the 4576 60 each contain 40 CEC slots.

The Motorola MC68010 is an enhanced, upward-compatible version of the MC68000 with internal logic for page fault and virtual memory processing. It includes a built-in instruction cache for accelerating small instruction loops such as block data move routines. A hardware memory map is automatically loaded when mapping requests occur. Two additional instructions result in a 58 mnemonic instruction set.

**CONTROL STORAGE:** There are 32KB of control storage in PROM on each circuit board.

**REGISTERS:** There are sixteen 32-bit registers interconnected by 16-bit data paths. Eight of the sixteen registers are for data and eight are for addresses.

**ADDRESSING:** There are five basic addressing modes: register direct and indirect, immediate, absolute, and program counter relative. Post incrementing, predecrementing, offsetting, and indexing, when combined with basic addressing modes, yield 14 addressing modes for over 1,000 instruction variations.

**INTERRUPTS:** There are seven levels of priority interrupt, including nonmaskable with 256 possible interrupt vectors.

**OPERATING ENVIRONMENT:** The System/88 power requirements are 208 VAC or 240 VAC, single phase, 60

## IBM System/88

CHART C. WORKSTATIONS

MODEL	3161	3163
<b>DISPLAY PARAMETERS</b>		
Max. chars./screen	1920	1920
Buffer capacity	7680 char.	7680 char.
Screen size (lines x chars.)	24 x 80	24 x 80
Tilt/swivel screen	Yes	Yes
Symbol formation	8 x 10 dot-matrix	8 x 10 dot-matrix
Character phosphor	Green	Green
Total colors/no. simult. displayed	None	None
<b>KEYBOARD PARAMETERS</b>		
Style	ASCII	ASCII
Character/code set	94	128
Detachable	Yes	—
Program function keys	32	12
<b>TERMINAL INTERFACE</b>		
	RS-232-C	RS-232-C

A dash (—) in a column indicates that the information is unavailable from the vendor.

► tions chassis. Multiple 4577 expansion cabinets can be attached to a Model 4575 or 4576.

Peripherals that can attach to the System/88 include 142MB and 448MB disk drives, an autoload streaming magnetic tape unit, tabletop matrix and floor-standing high-speed printers, and ASCII display stations, as well as the IBM Personal Computer.

The System/88 supports a multiprogramming, multitasking Virtual Operating System (VOS) designed for online transaction processing, interactive processing, networking, batch processing, and online program development. The VOS system supports the duplexed components of a fault tolerant-designed system to provide for high availability. It also maintains file integrity through duplexed disk drives, and provides a diagnostic subsystem for problem analysis and maintenance software for logging and reporting problems. The system can manage the data and services of a complex consisting of one or more System/88 modules connected in a system or a network.

The System/88 supports various communications hardware and software components, which provide for X.25, X.29, Remote Job Entry (RJE), SDLC, asynchronous, and bisynchronous communications capabilities.

The System/88 does not support any automated office functions at this time.

Applications offered on the System/88 include automated teller machine (ATM) transaction processing, point of sale transaction processing, shop floor transaction processing, consumer transaction switch, communications industry customer service, and banking/financial switch.

### COMPETITIVE POSITION

Although IBM is late entering the fault tolerant system market, it should not have much difficulty establishing a customer base simply because of the IBM name and reputation. Also, because the System/88 is a Stratus-supplied system with very minor changes, it is already a technologically tested, industry-approved system, with a reputation ►

► Hz. Each processor cabinet and expansion cabinet requires a separate power connection.

The System/88 systems measure 24 inches wide, 36 inches deep, and 53 inches high. Weight depends upon the configuration.

### INPUT/OUTPUT CONTROL

A duplexed communications controller pair supports one or two communications adapter chassis for input/output control. With two adapter chassis attached, the communications controllers can support up to 16 line adapters. Asynchronous line adapters can support two asynchronous lines. The synchronous line adapters support one synchronous line. Data from each line adapter is input into both communications controllers and is duplexed from that point. All workstations and printers are controlled through either the asynchronous or synchronous lines.

A high-speed bus with a 125-nanosecond cycle time is central to the processing-module organization. The bus has two sets of data and control logic paths. The data path on each bus is 32-bits wide, and data can be put on the bus every bus cycle. This results in a potential bus rate of 32MB per second, although processor/memory boards now run at 16MB per second.

### CONFIGURATION RULES

**GENERAL:** Most of the System/88 components, including processor boards, memory boards, disk drives, and communications controllers, are set in a duplexed configuration. These components execute in synchronization, continually comparing results with their partners to maintain data integrity and to provide a backup in cases of failure. Duplexed disk drives and controllers operate under the control of the operating system. Should any one of these components fail, it is automatically removed from service until proper diagnostics can be done. If the component replacement is required, this can be done without system shutdown.

The System/88 systems are enclosed in a cabinet that includes CEC slots for memory, processors, and controllers; duplexed power supplies; and battery backup. A total of 20 slots are offered on the 4575 20B, two of which are used for the duplexed processors. The 4576 40 has 40 slots; a processor board occupies one slot, and two more slots are reserved for processor boards to provide for upgrades to the Model 60. The 4576 60 also offers 40 CEC slots, three of which are taken up by the processor boards. The 4575 cabinet also contains front rack space for tape and disk units. All tape and disk drives for the 4576 must be mounted in the 4577 ►

## IBM System/88

CHART D. PRINTERS

MODEL	4975	5262
Type	Serial	Line
Speed	40/160 cps	650 lpm
Bidirectional printing	Yes	No
Paper size	Up to 12"	Up to 16"
Character formation	Wire matrix	—
Horizontal character spacing (char./inch)	10; 15	10
Vertical line spacing (char./inch)	6; 8	6; 8
Character set	ASCII	EBCDIC 48; 64; 96
Controller/Interface	RS-232-C	—
No. of printers per controller/interface	1	1
Printer dimensions, in. (h x w x d)	—	—
Graphics capability	No	No
Comments		

A dash (—) in a column indicates that the information is unavailable from the vendor.

▷ all its own. Of course, this does put IBM and Stratus in competition with each other and introduces some interesting aspects. While IBM has the possibility of winning a competitive battle because of name *IBM*, Stratus will also win in a backhanded way because it will be supplying the OEM'ed systems to IBM. One thing the users will note is that they could possibly end up paying a little more for the IBM system than the Stratus system; one reason for this is because IBM has unbundled the software. Both the IBM System/88 and the Stratus/32 systems are aimed towards the online transaction processing market for small-to-large applications.

The System/88 will also face competition from Tandem Computers Inc., although Tandem targets its NonStop systems mainly towards large transaction processing applications. A significant difference between the IBM and Tandem systems is that the System/88 offers hardware-based fault tolerance whereas Tandem's is software-based. However, Tandem does have the advantage of being well-known in the fault tolerant industry, and presently holds the major market share.

Additional competitive fault tolerant systems targeted towards the online transaction processing industry include NoHalt's Reliant, Parallel Computer's 300XR, and AT&T's 3B20D. Others like Autech's Dacmaster and Hewlett-Packard's Systemsafe/1000 target process control and monitoring or industrial automation.

It is difficult to do a one-on-one system comparison of a fault tolerant system because of the differences in system architecture. However, if we were to compare the System/88 with AT&T's 3B20D, we would find the System/88 architecture to be a dual-processing system versus AT&T's hot standby (using two complete and identical systems to perform the same tasks) system. Similarities in the two systems are that both are targeted toward the online transaction processing market; both possess 32-bit processors; and both support 16MB of duplexed memory and 256 workstations. However, the AT&T 3B20D supports 10.5GB of disk storage versus the 7GB supported by the System/88. One significant difference is that AT&T claims the 3B20D is both hardware and software fault tolerant. The AT&T system also supports a Unix operating system. ▷

► expansion unit. Both the 4575 and 4576 provide rear rack space for the communications chassis, link connectors, and link extender components.

The 4577 expansion cabinet provides additional power distribution and rack space for the System/88. It attaches through an air plenum to the System/88 processor or to another 4577 expansion cabinet. Combinations of disk drives, tape drives, communications chassis, link connectors, and link extenders can be installed in a 4577. The 4577 can support up to six 4580 or four 4581 disk drives; and up to 12 communications chassis (link connectors and link extenders can be mounted in place of communications chassis). Tape drives can be mounted in the first and second 4577 from the processor on either side. Multiple 4577s can be attached to a System/88 processor.

A maximum of 32 System/88 processing modules can be interconnected using the System/88 link controller (1300) and the link connector (1400). The link controller receives its power from the System/88 and requires one CEC slot. The link controllers must be ordered as duplexed pairs. Only one link controller pair is required to attach a process module to the System/88 link. The link connector provides the cable connection for up to six link controllers. System/88 processor modules can be located up to 750 feet apart, and this distance can be extended to up to 10 miles through the use of the 4591 link extenders.

The printers, display stations, and PCs connect directly to the System/88 through communications ports. By attaching a 3270 controller to a communications port and using the System/88 3270 Terminal Support, 3270 devices can be attached to the System/88. This allows many 3270 devices to be attached through a single communications port, increasing the number of terminals that can be attached to the System/88.

**WORKSTATIONS:** The System/88 supports the 3161 and 3163 ASCII workstations, as well as the IBM Personal Computer. The 3161 and 3163 attach to the System/88 via an RS-232-C interface. The IBM/PC requires the IBM/PC terminal support software.

**DISK STORAGE:** The System/88 supports two types of disk drives, the 4580 and the 4581. A maximum of 16 duplexed (32) 4580 disk drives are supported by each 4575 processor, and a maximum of 24 duplexed (48) disk drives are supported by each 4576. Two 4580s can be rack mounted in the 4575 processor cabinet (none can be mounted in the 4576 processor cabinet), and up to six can be mounted in a single 4577 expansion cabinet. The 4580 DASD controller (1000) interfaces directly to the 4580 disk drives; each controller requires one CEC slot and supports up to four 4580s. ►

## IBM System/88

**CHART E. MAGNETIC TAPE EQUIPMENT**

MODEL	4968
TYPE	Streaming
FORMAT	
Number of tracks	9
Recording density, bits per inch	1600; 3200
Recording mode	PE
CHARACTERISTICS	
Controller model	1100
Drives per controller	1
Storage capacity, bytes	Up to 80M
Tape speed, inches per second	25/50/100
Data transfer rate, units per second	160K
Streaming technology	Yes
Start/stop mode; speed	Yes; 25
Switch selectable	—

A dash (—) in a column indicates that the information is unavailable from the vendor.

### ▷ ADVANTAGES AND RESTRICTIONS

The basic strength of the System/88 is its fault tolerant architecture, which enables it to operate continuously when a component fails. The hardware components and software work together to detect transient or permanent errors at the point of failure. This prevents proliferation throughout the application or data; protects data from corruption; and maintains system integrity. If there is a system failure, most of the system software contains features to ensure data integrity when processing resumes. Duplicate power supplies and battery backup provide memory retention during short-term power failures. "Hot pluggability" features permit component replacement or repair without disruption of system operation.

Additional attributes of the system include the horizontal growth capability that is accomplished by connecting as many as 32 System/88 processing modules together, a relational database management system, and SNA support.

The most obvious limitation of the System/88 is its incompatibility with other processors in IBM's product line. Users with applications requiring the kind of high availability offered by fault tolerant systems must be willing to undergo a complete processor swap with all the conversion and migration efforts such a move entails.

The amount of software presently available for the System/88 is basically the same as that offered for the Stratus/32. However, IBM is strongly encouraging VARs and other third-party software developers to develop software for the System/88 to increase the offerings.

### USER REACTION

The System/88 was only recently released for general distribution, with first shipments scheduled to begin in February 1986. Therefore, it is necessary to wait until a significant number of systems have been installed and sufficient time has elapsed to provide a valid user reaction. □

▶ Each 4581 disk unit is mounted in the 4577 expansion unit only. It differs from the 4580 in that it must have a DASD director (1011), which provides interface control between the 4581 DASD controller (1010) and the 4581 disk drive. A maximum of 24 physical units on three controllers can be attached to the 4575. A maximum of six duplexed 4581 DASD controller pairs can be attached to a 4576 processor, a maximum of eight 4581 DASD directors can be attached to a 4581 DASD controller, allowing for the attachment of a total of 48 physical 4581 disk drives. Each 4581 DASD controller requires one CEC slot.

Each System/88 processor module must be configured with a minimum of one duplexed pair of disk drives. The 4580 and 4581 Disk Drives are designed to operate in parallel with a partner 4580 or 4581. An unrecoverable error on one unit causes the unit to be automatically removed from service. Processing continues with the partner device without interruption. After repair, the system automatically brings the unit up-to-date in the image of its partner.

**MAGNETIC TAPE:** The 4968 Magnetic Tape Unit attaches to the System/88 through the Streaming Tape Controller (1100). Up to four 4968 tape units can be supported by the 4575 and the 4576. For the 4575, one unit can be mounted in the 4575 cabinet, and up to three additional 4968s can be mounted in the 4577 Expansion Cabinets. For the 4576, up to four units can be mounted in the 4577 Expansion Cabinets. The tape controller is available as a simplex controller only and is not a duplexed component of the System/88.

**PRINTERS:** The 4975 and 5262 Printers attach to the System/88 by means of a line adapter card, which is plugged into a communications chassis. An RS-232-C interface is required for remote use.

### MASS STORAGE

Please refer to Chart B for disk storage devices.

### INPUT/OUTPUT UNITS

See Chart C for workstations, Chart D for printers, and Chart E for magnetic tape devices.

### COMMUNICATIONS CONTROL

**GENERAL:** The communications hardware includes duplexed intelligent communications controllers to support communications chassis and line adapters.

The 4591 *Link Extender* allows an additional 1,500 feet of link cable between it and a System/88 processing module, or another 4591. Multiple 4591s may be connected in series to obtain greater distances (up to ten miles).

The 1200 *Communications Controller* supports up to 16 adapters for asynchronous, bisynchronous, X.25, and SDLC lines. It requires one CEC slot in the system unit, a 1220 communications adapter chassis, and one 120x line adapter. Communications Controllers must be ordered in duplexed pairs. A single duplexed pair is standard on the 4575 20B, with a maximum of four allowed; up to eight are supported on the 4576 processors.

The 1201 *Full Modem Asynchronous Line Adapter* provides two RS-232-C asynchronous line ports with a maximum transmission rate for each port of 9.6K bits per second. The adapter can also be used in conjunction with a crossover cable to provide direct connection of peripheral devices such as terminals and printers. The adapter requires one slot in the communications adapter chassis or expansion chassis. ▶

## IBM System/88

► The *1202 Direct Connect Asynchronous Line Adapter* provides two RS-232-C asynchronous line ports with a transmission rate for each port of 9.6K bits per second. The adapter can be used with direct connect communication cables (1802, 1803, and 1804) providing for local attachment to terminals and printers with a female connector, or it can be used with the direct connect cable for local attachment of IBM PCs.

The *1203 Direct Connect Printer Adapter* provides one port for connection of an IBM 5262 line printer.

The *1204 Remote Support Line/Clock Adapter* provides one line port for the remote system support modem (1300). It also provides a battery high powered system clock.

The *1205 High Performance Full Modem Synchronous Line Adapter* provides one RS-232-C or RS-422 line port; maximum transmission rate is 19.2K bits per second. The adapter supports binary synchronous, SDLC, and X.25 protocols.

The *1206 High Performance Direct Connect Asynchronous Line Adapter* provides two RS-232-C asynchronous line ports; transmission rate for each port is 19.2K bits per second.

The *1207 High Performance Full Modem Asynchronous Line Adapter* provides two RS-232-C asynchronous line ports; maximum transmission rate for each port is 19.2K bits per second. Each port provides the signals required for remote communications via a modem.

The *1220 Communications Adapter Chassis* provides slots for attaching up to eight communications line adapter cards. One chassis connects to a duplexed pair of communications controllers.

The *1230 Communications Adapter Expansion Chassis* allows for the connection of an additional eight communications line adapters.

The *1300 Support Modem* supplies the communication between the system and the remote support facility at the System/88 Support Center. The modem has autodial capabilities, 1200 bps capability, and attaches through normal phone transmission lines.

The *1400 Link Controller* interfaces directly to the link connector and provides control and management of the local intrasystem communication. The controller provides transmit and receive protocol management for the 1.4MB serial interface.

The *1410 Link Connector* provides cable connection points for the interconnection of up to six link controllers on a System/88 link.

## SOFTWARE

**OPERATING SYSTEM:** The System/88 supports a *Virtual Operating System (VOS)* designed for multiprogramming, multiple (linked) processors, and high availability in a fault tolerant environment. The system provides concurrent system usage, including transaction processing, interactive processing, networking, batch processing, and online program development. It dynamically allocates system resources to each user as needed, and provides automatic sharing of resources among users. It provides a hierarchical file system for sequential, relative, or fixed file organization; multikey indexed file access; output spooling; security controls; and a command language. It also maintains file integrity through duplexed disk drives, and provides a diagnostic subsystem for problem analysis and maintenance software for logging and reporting problems.

**DATABASE MANAGEMENT SYSTEM:** The System/88 *Oracle* is a relational database management system that provides an integrated set of tools allowing developers and end users to develop and maintain their own applications. It includes the Structured Query Language (SQL), an English-like language that combines the capabilities of data query, definition, manipulation, and control.

**LANGUAGES:** All languages supported by the System/88 are implemented in an ANSI standard form, and have been enhanced with extensions. The compilers generate compact code using a common optimizer and code generator. Languages supported on the System/88 are Cobol, PL/1, Fortran, Basic, and Pascal.

**COMMUNICATIONS:** System/88 communications software products include networking, device emulation, and terminal connectivity. The System/88 supports ASCII peripherals, the IBM Personal Computer, IBM binary synchronous 3270s, X.25, X.29, and attachment to other IBM systems.

The *Remote Job Entry (RJE)* program allows bisynchronous data transfer between System/88 processors by emulating an IBM 2780, 3780, or IBM HASP multileaving remote workstation.

The *3270 Terminal Support* enables applications programs to read and write to IBM 3270 devices without concern for terminal type or communication protocol. The 3270 devices are supported as standard application devices or as logon devices.

The *3270 Emulator Support* enables System/88 applications programs to communicate with other IBM hosts.

The *X.25 Networking Facility* provides full-duplexed communications between remote application programs. Communications are through either public packet switched networks, or private point-to-point links. The program conforms to the CCITT X.25 Level III standard for computer-to-computer communications.

The *X.29 Networking Facility* provides communications between remote terminals and the System/88 through a packet switched network.

The *SDLC Protocol Support* provides bisynchronous communications software corresponding to the IBM SNA link layer, and can be used to transmit data over communications lines using SDLC protocol.

The *Network Architecture Cluster Controller* allows the System/88 to support SNA communications using SDLC protocols.

The *Network Architecture 3270 Terminal Emulation*, used in conjunction with the SNA Cluster Controller, allows System/88 asynchronous terminals and printers to communicate in an SNA network using SDLC.

**UTILITIES:** The *Symbolic Debugging Aid* is a debugging facility for programs written in any of the languages supported by the System/88.

The *Text Editor* provides an interactive, full-screen editor for entry and modification of text data and application programs.

The *Transaction Processing Services* provide tools and structures to assist in developing online transaction processing applications. Features include control for multiple terminals from a single user program, access to multiple applications from the same terminal, distribution of work load across multiple System/88 processors, and commands that enhance file integrity if a transaction fails to complete. ►

## IBM System/88

► The *Forms Management System* is designed to simplify the creation and modification of video display formats.

The *IBM PC Terminal Support* executes in an IBM Personal Computer connected to a System/88 and allows the PC to appear as an ASCII terminal to the System/88 application. IBM PC models supported include the IBM Personal Computer and IBM Personal Computer XT.

**OFFICE AUTOMATION:** The System/88 does not support any office automation software at this time.

**APPLICATIONS:** Applications offered on the System/88 include the following:

- Automated teller machine (ATM) transaction processing
- Point of sale transaction processing
- Shop floor transaction processing
- Consumer transaction switch
- Communications industry customer service
- Banking/financial switch

### PRICING

**POLICY:** The IBM System/88 is available for purchase only. Volume discounts are allowed. A three-month warranty period is provided. The System/88 is also eligible for the IBM Credit Corporation term lease and installment payment plans. Preinstallation testing allowances are 75 hours for the 4575 20B, 85 hours for the 4576 40, and 95 hours for the 4576 60.

The software is offered unbundled from the hardware. All software is eligible for Volume License Amendments (VLAs). The 15 percent educational allowance cannot be added to other discounts or allowances. A separate license is required for each designated machine; no usage licenses are offered.

**SUPPORT:** Installation and service is provided by the IBM National Service Division (NSD). Ongoing maintenance is managed through the System/88 Support Center using Customer Problem Analysis and Resolution (CPAR) techniques. The customer supplies the data link for electronic request for fault diagnosis by the support center, or voice communications via an 800 number to NSD's Regional Administrative Support Center. Hours are weekdays from 8:00 a.m. to 8:00 p.m. Eastern time; emergency assistance is provided upon request.

All software is supported for six months following availability of next subsequent release. Problems causing system restarts are reported automatically through the Remote Support Network; the center interrogates error log data sets and performs debugging analysis on system dump data sets.

Because of the continuous self-checking, the System/88 Support Center is notified automatically of any problems and performs further diagnostics. Needed parts are automatically ordered. All duplexed components and most other components can be removed, replaced, or repaired while the System/88 continues operation.

**TRAINING:** IBM offers two courses for System/88 training, the System/88 Basic Usage course and the System/88 Application Programmer course. The Basic Usage course is designed for systems administrators and application programmers using the system. The Application Programmer course is designed for programmers who will be writing applications programs on a System/88.

**TYPICAL CONFIGURATIONS:** Sample configurations for the IBM System/88 are shown below.

#### System/88 4975 Model 20B Configuration

4575	2-4575 Model 20B microprocessors, paired	\$103,400
1500	2MB memory, duplexed	34,600
1000	2 4580 DASD controllers	12,260
4580	2 142MB disk drives	25,500
1100	1 streaming tape controller	5,610
4968	1 streaming magnetic tape unit	8,800
1200	2 communications controllers	14,300
1202	3 direct connect async line adapters	1,530
1203	1 direct connect printer adapter	3,000
4975	1 Model 01L tabletop printer	2,860
3163	6-1920 char. display stations	6,540
1220	communications adapter chassis	1,480
1300	support modem	NC
1204	remote support line/clock adapt.	870

**TOTAL PURCHASE PRICE** \$221,850

#### System/88 4976 Model 40 Configuration

4576	2-4576 Model 40 microprocessors, paired	\$184,200
1510	4MB memory, duplexed	57,200
1010	2-4581 DASD controllers	18,360
4581	2-448MB disk drives	51,000
1100	1 streaming tape controller	5,610
4968	1 streaming magnetic tape unit	8,800
1200	2 communications controllers	14,300
1201	2 full modem async line adapters	1,020
1202	2 direct connect async line adapters	1,020
1203	1 direct connect printer adapter	3,000
4575	1 Model 02L tabletop printer	4,175
5262	1 line printer	13,500
1819	5262 to direct connect printer adapter cable	120
3163	10-1920 char. display stations	10,950
1220	communications adapter chassis	1,480
4577	expansion cabinet	3,060
1300	support modem	NC
1204	remote support line/clock adapt.	870

**TOTAL PURCHASE PRICE** \$379,665

#### System/88 4976 Model 60 Configuration

4576	2-4576 Model 60 microprocessors, paired	\$275,800
1510	8MB memory, duplexed	114,400
1010	2-4581 DASD controllers	18,360
4581	4-448MB disk drives	102,000
1100	1 streaming tape controller	5,610
4968	1 streaming magnetic tape unit	8,800
1200	2 communications controllers	14,300
1201	4 full modem async line adapters	2,040
1202	4 direct connect async line adapters	2,040
1203	1 direct connect printer adapter	3,000
1819	5262 to direct connect printer adapter cable	120
4575	3 Model 02L tabletop printer	12,525
5262	1 line printer	13,500
5150	12 IBM PCs	15,180
1220	communications adapter chassis	1,480
4577	expansion cabinet	3,060
1300	support modem	NC
1204	remote support line/clock adapt.	870

**TOTAL PURCHASE PRICE** \$592,045

NC—No charge.

IBM System/88

EQUIPMENT PRICES

		<u>Purchase Price (\$)</u>	<u>Monthly Maint. (\$)</u>
<b>PROCESSORS</b>			
4575	Model 20B System/88 Processor	51,700	836
4576	Model 040 System/88 Processor	92,100	256
	Model 060 System/88 Processor	132,900	315
<b>MEMORY</b>			
1500	2 Megabyte Memory, with controller	13,000	106
1510	4 Megabyte Memory, with controller	24,000	188
<b>UPGRADES</b>			
4576	Upgrade Model 40 to Model 60	65,000	—
<b>OPTIONS</b>			
4577	Expansion Cabinet	3,060	23
4951	Link Extender	2,040	7
<b>MASS STORAGE</b>			
4580	142MB Disk Drive	12,750	112
1000	4580 DASD Controller	6,630	27
4581	448MB Disk Drive	25,500	155
1010	4581 DASD Controller	9,180	37
1011	4581 DASD Director	5,100	21
<b>MAGNETIC TAPE EQUIPMENT</b>			
4968	Autoload Streaming Magnetic Tape Unit	8,800	23
1100	Streaming Tape Controller	5,610	48
<b>PRINTERS</b>			
4975	01L 80 cps Local Printer, tabletop	2,860	31
	01R 80 cps Remote Printer, tabletop	2,860	38
	02L 40/160 cps Local Printer, tabletop	4,175	38
	02L 40/160 cps Remote Printer	4,175	38
5262	001 650 lpm High-speed Printer, floor-standing	13,500	154
<b>WORKSTATIONS</b>			
3161	Model 011 1920 char. Display Station	695	—
	Model 012 1920 char. Display Station	774	—
3163	Model 011 1920 char. Display Station	1,095	—
	Model 012 1920 char. Display Station	1,174	—
5150	Model 104 PC System Unit/Keyboard	1,265	—
5151	Model 001 Monochrome Display	275	—
<b>COMMUNICATIONS FEATURES</b>			
1100	Communications Controller	5,610	48
1200	Communications Controller	7,650	31
1201	Full Modem Async Line Adapter	510	6
1202	Direct Connect Printer Adapter	3,000	15
1204	Remote Support Line/Clock Adapter	870	9
1205	High Performance Full Modem Sync Line Adapter	1,020	16
1206	High Performance Direct Connect Async Line Adapter	1,020	19
1207	High Performance Full Modem Async Line Adapter	1,020	19
1220	Communications Adapter Chassis	1,480	12
1230	Communications Adapter Expansion Chassis	1,480	17
1300	Support Modem	NC	NC
1400	Link Controller	5,100	21
1410	Link Connector	1,580	12

NC—No charge.

## IBM System/88

### SOFTWARE PRICES

	<u>Onetime Charge (\$)</u>
<b>OPERATING SYSTEM</b>	
5732-001 System/88 VOS Operating System	11,800
<b>DATABASE MANAGEMENT SYSTEM</b>	
5732-024 Oracle	27,000
<b>LANGUAGES</b>	
5732-011 Cobol	5,900
5732-012 Basic	5,900
5732-013 PL/1	5,900
5732-014 Fortran	5,900
5732-015 Pascal	5,900
<b>UTILITIES</b>	
5732-006 Transaction Processing Service	6,140
5732-007 Forms Management System	4,370
5732-016 Text Editor	2,360
5732-017 Symbolic Debugging Aid	1,660
<b>COMMUNICATIONS SUPPORT</b>	
5732-002 Network Support	7,550
5732-003 Remote Job Entry	3,540
5732-004 3270 Terminal Support	4,370
5732-005 3270 Emulation Support	5,900
5732-008 X.25 Networking Facility	5,430
5732-009 X.29 Networking Facility	1,770
5732-010 SDLC Protocol Support	3,300
5732-019 IBM/PC Terminal Support	100
5732-020 SNA 3270 Terminal Emulation	2,200
5732-021 SNA Cluster Controller Support	8,100 ■