Amdahl 580 Systems

MANAGEMENT SUMMARY

UPDATE: *Although it was long in coming, Amdahl finally launched an expected IBM counterattack in October 1985 with the announcement of the new 5890 top-end mainframes, built to compete against IBM's new 3090 generation of mainframes. Amdahl then responded to IBM's February 1986 announcement of additional 3090 mainframes and mainframe price reductions with mainframe price reductions of its own. Last February 22, Amdahl announced mainframe purchase price reductions and lease price adjustments. The three new Amdahl 5890 models include the dual-processor Model 200, scheduled for a first-quarter 1987 delivery; the dual-processor Model 300, delivered earlier this year; and the four-processor Model 600, planned for a fourth quarter 1987 delivery. At the time of the 5890 announcement, Amdahl also announced a smattering of significant enhancements to all of its existing 580 models. Enhancements included expanded main memories and channel capacities, a new 580/Expanded Storage feature, the extension of the High-Speed, Floating-Point feature to more processors, and other features. Amdahl peripheral products announced include new 6000 Series storage devices. On the software side, Amdahl introduced a new Unix version that can run on Amdahl mainframes in native operating system mode.*

Amdahl's entry in the extreme high end of the IBM plug-compatible market, the 5890, now joins the seven existing 580 models, a large-scale processor line first announced in 1980. The new three-model 5890 Series is said to offer

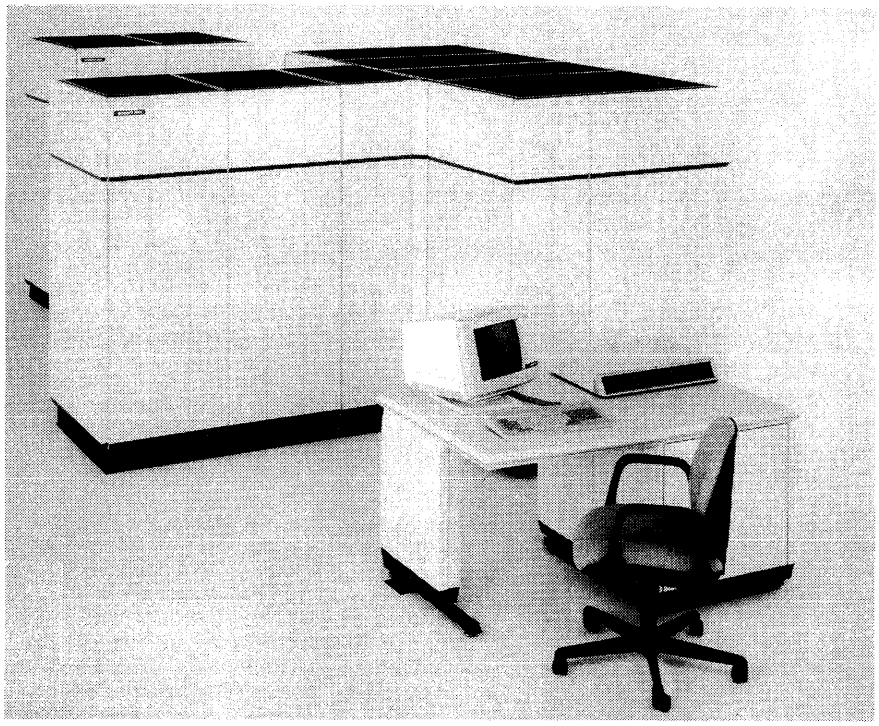
Amdahl Corporation's 10-member 580 Series is fully compatible with all IBM hardware and software and has an improved price/performance ratio over its IBM counterparts, according to the vendor.

MODELS: 5840, 5850, 5860, 5867, 5868, 5870, 5880, and 5890-200, -300, -600.
CONFIGURATION: One, two, or four CPUs, up to 512MB of main memory, and up to 128 I/O channels.
COMPETITION: IBM 4381 Group 3, IBM 308X, IBM 3090, NAS AS/8000, AS/9000, and AS/XL Series.
PRICE: Prices range from $1,270,000 to $12,220,000.

CHARACTERISTICS

MANUFACTURER: Amdahl Corporation, 1250 East Arques Avenue, Sunnyvale, California 94086. Telephone (408) 746-6000. In Canada: One First Canadian Place, Suite 3940, P.O. Box 123, Toronto, Ontario, Canada M5X 184. Telephone (416) 862-7479.

MODELS: Amdahl 5840, 5850, and 5860 single processors; 5867, 5870, 5890-200, and -300 dual processors; 5868, 5880 two-way multiprocessors; and the 5890-600 four-way multiprocessor.



The Amdahl Model 5890-300 is a dual tightly coupled processor which can be configured with up to 256 megabytes of main memory and 64 I/O channels. The 580/Expanded Storage feature is standard and the 580/Multiple Domain Feature is optional.

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Amdahl 580 Systems

TABLE 1. SYSTEM COMPARISON

MODEL	5840	5850	5860	5867	5868
SYSTEM CHARACTERISTICS					
Date announced	June 1983	May 1983	November 1980	March 1984	March 1984
Date first delivered	Fourth Quarter 1983	Third Quarter 1983	Third Quarter 1983	Third Quarter 1982	Second Quarter 1985
Field upgradable to	5850, 5860, 5867, 5868, 5870, 5880	5860, 5867, 5868, 5870, 5880	5870, 5880	5868, 5870, 5880	5880
Relative performance	1.20*	1.75*	2.00*	2.70*	2.70*
Number of processors	1	1	1	2	2
Cycle time, nanoseconds	23.25	23.25	23.25	23.25	23.25
Word size, bits	32	32	32	32	32
Operating systems	MVS/370, MVS/XA, VM/SP HPO	MVS/370, MVS/XA, VM/SP HPO	MVS/370, MVS/XA, VM/SP HPO	MVS/370, MVS/XA, VM/SP HPO	MVS/SP, MVS/XA, VM/SP HPO
MAIN MEMORY					
Type	Dynamic NMOS	Dynamic NMOS	Dynamic NMOS	Dynamic NMOS	Dynamic NMOS
Minimum capacity, bytes	16MB	16MB	16MB	24MB	32MB
Maximum capacity, bytes	128MB	128MB	128MB	128MB	256MB
Increment size, bytes	8MB, 16MB, 32MB	8MB, 16MB, 32MB	8MB, 16MB, 32MB	8MB, 16MB, 32MB	16MB, 32MB, 64MB
Cycle time, nanoseconds	280	280	280	280	280
BUFFER STORAGE					
Minimum capacity	64KB	64KB	64KB	64KB	64KB
Maximum capacity	64KB	64KB	64KB	64KB	64KB
Increment size	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels:					
Byte multiplexer	1 to 4	1 to 4	1 to 4	1 to 4	2 to 8
Block multiplexer	15 to 31	15 to 31	15 to 31	15 to 31	30 to 46
Word	—	—	—	—	—
Other	—	—	—	—	—

*Relative performance based on Amdahl Model 470V/8 equaling 1.0.

better price/performance than comparable IBM products. The processors feature a better cycle time and greater maximum memory and channel capacities than the IBM 3090 mainframes. Machine cycle time for all three 5890 processors is 15 nanoseconds. Memory capacity for the 5980 Models 200 and 300 ranges from 64 megabytes to 256 megabytes. Memory for the top-end Model 600 ranges from 128 megabytes to 512 megabytes. By comparison, the IBM 3090 features an 18.5 nanosecond cycle time and a maximum main memory of 128 megabytes. In addition, the Models 200 and 300 can support up to 64 channels, while the Model 600 can support up to 128 channels, exceeding the maximum channel capacity of the IBM 3090.

All three 5890 models feature two high-speed buffers per CPU, a 64K-byte buffer for operands and a 32K-byte buffer for instructions.

A 5890 Model 300 dual processor is said to have 1.7 to 1.9 times the throughput capacity of an Amdahl 5870 dual processor. The 5890 Model 200 is said to have 0.75 times the throughput capacity of the Model 300. The Model 600 is said to have 1.7 to 1.9 times the instruction execution rate of the Model 300 dual processor operating in single-image mode. The four-way Model 600 approximates the performance of a Model 300 on each side when operating in partitioned mode.

The three 5890 processors can operate in either System/370 or 370-XA mode and support the current releases of MVS/SP Versions 1 and 2: VM/SP High Performance Option (VM/SP HPO), and VM/XA Systems Facility (VM/XA SF). The Model 600 supports VM/XA SF when operating in partitioned mode.

DATA FORMATS

All data formats, instruction formats, and other architectural features are compatible with IBM System/370 architecture and System/370 Extended Architecture.

BASIC UNIT: Eight-bit bytes. Each byte can represent one alphanumeric character, two BCD digits, or eight binary bits. Two consecutive bytes form a half word of 16 bits, while four consecutive bytes form a 32-bit word.

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; one half word (16 bits) or one word (32 bits) in binary mode.

FLOATING-POINT OPERANDS: One word, consisting of 24-bit fraction and seven-bit hexadecimal exponent in short format; two words, consisting of 56-bit fraction and seven-bit hexadecimal exponent in long format; or four words in extended-precision format.

INSTRUCTIONS: Two, four, or six bytes in length, which usually specify zero, one, or two memory addresses, respectively.

INTERNAL CODE: EBCDIC (Extended Binary-Coded Decimal Interchange Code).

MAIN MEMORY

The Amdahl 580 Main Storage Unit (MSU), on all models except for the top-end 5890 mainframes, uses four-way line interleaving and four-way quarterline (each quarterline is eight bytes in length) multiplexing to provide up to 256 megabytes of storage. The data bus paths are 72 bits (double word) wide, and transfer eight-byte messages, plus parity, between the MSU and the Memory Bus Controller (MBC) every cycle. The most common data bus transactions are MSU data fetches, an activity for which the 580 bus system has been optimized to support.

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TABLE 1. SYSTEM COMPARISON

MODEL	5870	5880	5890-200	5890-300	5890-600
SYSTEM CHARACTERISTICS					
Date announced	October 1981	November 1980	October 1985	October 1985	October 1985
Date first delivered	Fourth Quarter 1983	Second Quarter 1985	First Quarter 1987	Second Quarter 1986	Fourth Quarter 1987
Field upgradable to	5880	—	5890-300 or 5890-600	5890-600	—
Relative performance	3.40*	3.50*	1.2 to 1.4**	1.7 to 1.9**	2.9 to 3.6**
Number of processors	2	2	2	2	4
Cycle time, nanoseconds	23.25	23.25	15	15	15
Word size, bits	32	32	64	64	64
Operating systems	MVS/SP, MVS/XA, VM/SP HPO	MVS/SP, MVS/XA, VM/SP HPO	MVS/370, MVS/XA, VM/SP HPO, VM/XA	MVS/370, MVS/XA, VM/SP HPO, VM/XA	MVS/370, MVS/XA, VM/SP HPO, VM/XA
MAIN MEMORY					
Type	Dynamic NMOS	Dynamic NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS
Minimum capacity, bytes	32MB	32MB	64MB	64MB	128MB
Maximum capacity, bytes	128MB	256MB	256MB	256MB	512MB
Increment size, bytes	16MB, 32MB	16MB, 32MB, 64MB	32MB, 64MB	32MB, 64MB	64MB, 128MB
Cycle time, nanoseconds	280	280	—	—	—
BUFFER STORAGE					
Minimum capacity	64KB	64KB	96KB	96KB	96KB
Maximum capacity	64KB	64KB	96KB	96KB	96KB
Increment size	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels:					
Byte multiplexer	1 to 4	2 to 8	0 to 16	0 to 16	0 to 32
Block multiplexer	15 to 31	30 to 46	32 to 64	32 to 64	64 to 128
Word	—	—	—	—	—
Other	—	—	—	—	—

*Relative performance based on Amdahl Model 470V/8 equaling 1.0.
**Relative performance based on Amdahl Model 5870 equaling 1.0

Other 5890 features now common to all other 580 mainframes are 580/Expanded Storage (580/ES) and the optional 580/Multiple Domain Feature. The 580/Expanded Storage feature lets 580 users set aside a portion of main memory for expanded storage. Similar to the IBM expanded storage feature available with the 3090, the 580/ES is designed to improve system throughput by reducing the paging and swapping load to channel-attached devices in storage-constrained and heavy paging environments. The Amdahl expanded storage feature moves 4K pages between expanded storage and main memory to cut back on direct access storage device paging. Amdahl believes the new 580/Expanded Storage option will be particularly beneficial to users who need additional memory but whose operating systems or systems facilities, such as VM/SP HPO and IMS Virtual Fetch, cannot use regular main memory greater than 64 megabytes. The expanded storage option is available either from the plant or as a field upgrade and will be available during fourth-quarter 1986.

The 580/Multiple Domain Feature (580/MDF) lets users consolidate multiple computer systems into a single processing complex, and operate multiple System Control Programs (SCPs) on a single processor.

In addition to the 5890 announcement, Amdahl also announced the following enhancements for the existing 580 processors:

- Larger main memory options
- 580/Expanded Storage feature
- Extension of the High-Speed, Floating-Point feature to the 5840 and 5850 single processors, and the 5867 and 5868 dual processors

The main storage unit on 5890-200 and 5890-300 models uses eight-way interleaving and contains data and key storage arrays for up to 256 megabytes of main memory. The 5890-600 has a 512-megabyte capacity.

Mainframes can also be configured with the 580/Expanded Storage feature. Users can allocate a portion of main memory as 580/Expanded Storage at initialization time to reduce the paging and swapping load to channel-attached paging and swapping devices. Expanded storage is specified in four-megabyte increments.

STORAGE TYPE: Dynamic NMOS; 64K-bit chips or 256K-bit chips.

CAPACITY: Please refer to Table 1.

CYCLE TIME: Amdahl specifies a memory cycle time of 280 nanoseconds for all 580 models. Cycle time for 5890 models has not been disclosed.

CHECKING: Error checking and correction (ECC) circuitry in main memory performs automatic correction of all single-bit errors and detection of all double-bit and most other multiple-bit memory errors.

RESERVED STORAGE: The 580 processors reserve an area in lower memory for such purposes as interrupt handling routines, CPU ID, channel ID, and machine-check logouts. Storage protection facilities are comparable to those implemented in the IBM System/370.

CENTRAL PROCESSOR

The 580 makes extensive use of large-scale integration (LSI) chips, using high-performance emitter-coupled logic (ECL) circuitry. Up to 400 of these circuits can be contained on a single LSI chip, compared to only 100 circuits per chip on the older technology 470 Series. In spite of an increased packing density, a 580 chip generates only slightly more heat than a 470 chip. This allows the 580, like the older 470, to be air-cooled.

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- New 40-channel option for multiprocessor configurations
- Up to eight byte multiplexer channels on multiprocessors
- The Multiprocessing Coupling feature
- Dual Power Distribution Unit for multiprocessor configurations
- 580/VM Performance Assist feature

Maximum main memories on single processors and the 5867 and 5870 dual processors were increased from 64 megabytes to 128 megabytes. Maximum main memories on the 5868 and 5880 two-way multiprocessors were increased from 128 megabytes to 256 megabytes. Memory options are available directly from the plant or as a field upgrade. The 128-megabyte expansions first became available during fourth quarter 1985 and the 256-megabyte expansion option became available first-quarter 1986.

Amdahl is also offering a 40-channel configuration option on multiprocessors. This is a cost-saving feature directed at users who don't need full 48-channel configurations. Additionally, Amdahl increased the number of possible byte multiplexer channels on multiprocessors from four to eight in single-image mode and up to four on each side in partition mode. This enhancement is directed at users who need more than four byte multiplexer channels, particularly when running in partitioned mode. The new channel feature is available from the factory or as a field upgrade. It first became available first-quarter 1986.

Amdahl added the Multiprocessor Coupling feature in response to users who have told Amdahl they would like to couple two identical 580 single-processor models to make it possible to eliminate redundant software licenses and reduce software costs. Users can now couple two 5850s to form one 5868 multiprocessor or two 5860s to form one 5880 multiprocessor. The feature makes it possible to operate in single image and partition mode, making it practical for users to run larger system work loads and experience faster throughput. The feature is available as a field upgrade and was first available fourth-quarter 1985.

The optional Dual Power Distribution Unit (PDU) feature distributes power independently to each side of the 5868 and 5880 dual processors to ensure higher system availability. Under such a configuration, at least one side of each system will be available should one PDU fail. The feature is available as a field upgrade or directly from the plant. First shipments were scheduled for fourth-quarter 1985.

The VM Performance Assist feature (580/VMPA), now a standard feature on all 580 models, supersedes Amdahl's VM/Software Assist. The 580/VMPA feature improves the performance for both VM/CMS and preferred real machine environments. The feature is available directly from the plant or as a field upgrade and first became available earlier this year.

High-speed, 4K-bit and 16K-bit RAM modules were developed by Amdahl to handle such functions as Distributed Microcode control storage, high-speed buffer (HSB) storage, and system registers.

Amdahl combines up to 121 RAM, logic, and register chips on a Multiple Chip Carrier (MCC). This increased packing density, with almost three times the number of chips per MCC as the 470 Series, permits the implementation of an entire system function on a single MCC. Each system MCC is arranged in three-dimensional stacks. Each stack can contain 13 to 15 MCCs. The MCCs are interconnected through 12-layer printed circuit board side walls. Single-processor systems contain one stack, two-processor and two-way multiprocessor systems contain two stacks, and four-way multiprocessors contain four stacks.

Combining all functional units together are two data buses, the A-Bus and B-Bus. Each bus moves unidirectionally and has a 72-bit-wide data path. The two buses are integral parts of the stack side walls. They provide shorter data paths and simplified physical connections, while reducing the number of connections required among functional units. In 580 systems other than the 5890 models, the A-Bus transports data from the Console, I/O Processor (IOP), and CPU to the Memory Bus Controller (MBC). The B-Bus returns data to these units from the MBC. In 5890 systems, the A- and B-buses carry data among the External Director, the Input/Output Processors, and the System Support Processor. These 580 and 5890 components are described fully in succeeding paragraphs.

The Amdahl 580 CPU has two instruction functions continuously performed in parallel: Instruction Fetch (I-Fetch) and Instruction Execution.

The I-Fetch component provides a double word of instruction flow and holds it in the Instruction Word Buffer (IWB) in the I-Unit until needed for execution. With each cycle, instructions are moved in and out of the IWB at the rate of one, two, or three halfwords of instruction data.

The I-Unit controls instruction execution and processes system interrupts. Specific functions of the I-Unit include:

- **Instruction fetching, decoding, and buffering**
- **Determining effective operand addresses**
- **Providing register access for operands**
- **Maintaining overlapped pipeline processing technique via control of Storage Unit (S-Unit), Execution Unit (E-Unit), and I/O Processors (IOPs)**

After an instruction is fetched, a five-phase pipeline operation takes over. The pipeline concept permits the I-Unit to have several instructions in various phases of execution simultaneously. With each processor cycle, another instruction enters the pipeline from the IWB. The instruction preceding it moves into the next phase of execution. By the fifth processor cycle, at maximum execution rate, five instructions are in the pipeline simultaneously in different execution phases. Since instruction flow involves five basic steps at the maximum execution rate, the result is an effective rate of one instruction per machine cycle. For comparison, the older 470 Series executed at a maximum rate of one instruction per two cycles. This increased execution rate permits the 580 to execute twice as fast as Amdahl's previous top-end system, the 470V/8.

Extensive parity checking is performed throughout the I-Unit. All incoming instructions are checked for parity, and the results are checked again after completion of execution. All control registers and the program status word are

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In addition to new mainframe products and enhancements, Amdahl has been upgrading its storage products. Last December 1985, Amdahl announced a new top-end double-capacity disk product, the 6380E Models AE4 and BE4. Each cabinet contains four sealed disk enclosures with a total capacity of 5.04 gigabytes. Field upgrades to the new "E" models are available to users who have 6380 AA4 devices with serial numbers greater than 6410000, B4 models with serial numbers greater than 6510000, and M4 models with serial numbers greater than 6520000. The 6380E models will be available during fourth-quarter 1986. Field upgrades will be available by first-quarter 1987.

Last January 1986, Amdahl announced new 6280 disk storage products for its UTS/580 operating system users. The new 6280 Models AU4, AUF, BU4, and BUF each contain four sealed disk elements (DE) per cabinet. A DE can hold 446 megabytes of memory for a total of 1.78 gigabytes per unit. The models attach to the 6880-A2 Storage Control Unit, which contains two directors. Up to two 6280 AU4 or AUF units and six BU4 or BUF units can be attached per director. These new models are now currently available.

In April 1986, Amdahl announced the 6680 Electronic Direct Access Storage Product, a solidstate semiconductor memory consisting of the Models S2 or S2E Storage Control Unit and the 6680 Electronic Storage Unit. An optional 6681 battery unit provides power backup to the Electronic Storage Unit in the event of power failure. The 6680 uses 256K-bit dynamic RAM chips and is said to be 80 times faster than rotating magnetic disk units. Depending on configuration, storage can range from 64 megabytes to 512 megabytes.

On the software front, Amdahl announced a new release of its UTS/580 operating system, based on Unix System V. In January 1986, Amdahl announced UTS/580 Version 1.1, a product Amdahl calls the first standalone Unix implementation to be made commercially available for large System/370 architecture processors. UTS/580 can run as a system control program on an Amdahl 580 Series processor, can operate in a domain under Amdahl's 580/Multiple Domain Feature, or can run as a guest under VM/SP or VM/SP HPO.

COMPETITIVE POSITION

With the announcement of the IBM 3090 mainframes, 1985 and 1986 have surely been critical years for PCMs who must coax IBM customers into the PCM fold with claims of superior price/performance.

Both NAS and Amdahl have responded to the 3090 introduction with comparable plug-compatible offerings and both apparently held on to their market share during 1985, according to a market analysis from International Data Corporation (IDC), a Massachusetts market research firm. IDC analysts figure the PCMs benefited largely from user confusion about the true performance potential of the IBM 3090 processors. Observers believe IBM created much of this confusion by deliberately underselling the true perfor-

checked each time they are used. In addition, parity is checked for the timer and the address generation function, and parity is also maintained for all program-referrable data.

The 580 I-Unit is compatible with the IBM System/370 Principles of Operation opcodes. These elements are implemented within the CPU by a mixture of hardware, microcode, and a new class of firmware called Macrocode. Critical system functions are implemented in hardware for fastest execution, while other less critical functions can be implemented in microcode resident on the MCC used by the I-Unit.

All I-Unit data requests are processed by the S-Unit. Virtual-to-absolute address translations are performed in the S-Unit, which includes a Translation Lookaside Buffer (TLB) to facilitate rapid virtual-to-absolute translations. Data traffic between the CPU data buffers and main memory is controlled by the S-Unit. It also provides the bus interface between the CPU and the rest of the 580.

A double word of data is accessed each cycle by the S-Unit from its high-speed buffers (HSB). The four storage arrays in the S-Unit (the data array, the data select array, the tag array, and the TLB array), are accessed simultaneously during this activity. The data array has 512 thirty-two-byte lines organized within its primary and alternate partitions, and contains the actual data lines. The tag array mirrors the data array in organization, and contains TLB pointers that indicate the pages to which the data lines belong. The data select array facilitates the virtual address selection process. The TLB array contains the virtual-to-absolute address translations.

Since the 580 processes I-Fetch and execution functions separately, two high-speed buffers (HSB) for instructions and operands are provided. Both the Instruction Buffer (I-Buffer) and the Operand Buffer (O-Buffer) have 32K bytes of storage (5890 systems have a 64K-byte O-Buffer and 32K-byte I-Buffer), are two-way, set-associative, and are organized into primary and alternate partitions of 512 thirty-two-byte lines. If a line of requested data is not present within an HSB, the S-Unit sends a message to main memory requesting the desired line.

The high-speed TLB has 512 entries organized into primary and alternate partitions of 256 translations to speed virtual-to-absolute address translations. Within each TLB entry is Segment Table Origin (STO) information which eliminates the need for a separate STO stack as in the 470. Address translations conform to the System/370 structure.

The E-Unit executes the arithmetic and logical instructions contained in the 580's instruction set. Operands and opcodes are received from and returned to either the O-Buffer or the I-Unit Register Facility as required by the specific instruction. Performance is enhanced within the instruction pipeline via concurrent activity on two separate instructions by the E-Unit Logic Unit and Checker (LUCK) and the various execution-cycle processes (multiply, add, shift, pack, and decimal correct). LUCK and execution phase operations require one processor cycle. In addition, the 580 uses an eight-byte-wide data path, compared to a four-byte wide path in the 470. Amdahl has optimized certain logic algorithms used with frequently executed instructions to improve execution speeds.

The primary data traffic manager within the 580 is the Memory Bus Controller (MBC). In 5890 systems, similar functions are performed by the System Director and External Director.

The MBC, a key element in the instruction execution process of the 580, receives requests from the CPU, I/O Proces-

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TABLE 2. MASS STORAGE

MODEL	6280 Models AA4, AAF, B4, B4F	6280 Models AU4, AUF, BU4, and BUF	6380 Models AA4, M4, B4	6380E AE4 and BE4
Cabinets per subsystem	1 to 4	1 to 16	1 to 4	4 to 8
Disk packs/HDAs per cabinet	4	4	4	4
Capacity	1.27GB per unit	1.78GB per unit	2.52GB per unit	5.04GB per unit
Tracks/segments per drive unit	16,650	16,660	13,275	—
Average seek time, msec.	18	18	15	17
Average access time, msec.	25.6	25.6	23.3	25.3
Average rotational delay, msec.	7.6	7.6	8.3	8.3
Data transfer rate	1.52 or 1.86MB per sec.	1.86MB per sec.	3.0MB per sec.	3.0MB per sec.
Controller model	6880-A2	6880-A2	6880-G2 or 6880-G2E	6880 Model G2 or G2E
Comments	6880-A2 Cache controller is available with up to 20GB of cache storage, a two- or four-channel switch, and remote enable/disable.	6880-A2 is available with two-channel switch pair and two storage directors	6880-G2/G2E Cache controller is available with up to 40GB of cache storage, a two-, four-, or eight-channel switch, and remote enable/disable.	6880-G2/G2E Cache Controller Unit can be added to the 6880 Control Unit in either 8, 16, 24, or 32MB configurations

mance of the 3090. Apparently, IBM feared a new and improved mainframe product would hurt 308X sales. A surprisingly soft mainframe market, however, forced IBM to reduce prices for both the 3090 and 308X Series and accelerate delivery of the 3090 Model 400, IBM's most powerful mainframe. IBM now plans to deliver the Model 400 four-way processor by October of this year.

While IBM contended with product transition problems in a soft mainframe market, Amdahl was contending with problems of its own. The PCM has been criticized for waiting eight months to respond to the IBM 3090 announcement. Then, when Amdahl did announce a product, the three-model 5890 Series, it announced its top-end product, the four-way Model 600, would not be delivered until fourth-quarter 1987, well after IBM plans to deliver the comparable 3090 Model 400 four-way processor. Additionally, Amdahl plans to deliver the two-processor Model 200 by first-quarter 1987. The dual-processor Model 300 was first delivered second-quarter 1986.

Meanwhile, NAS, Amdahl's PCM rival, began delivering its IBM plug-compatible Alliance Series by second-quarter 1986.

Even with the introduction of a new mainframe generation, activity within the new and used 308X market remained busy during 1985, according to IDC. IBM continued to stimulate business here with fire sale 308X price reductions last February. The PCMs have responded to the 308X market with their own price reductions and price/performance enhancements particularly within the memory and channel capacity areas. Amdahl, in particular, reduced mainframe prices after IBM reduced hardware prices in February. Earlier, Amdahl increased main memories on all its existing 580 processors, added the 580/Expanded Storage feature to all models, extended the High-Speed, Floating-Point feature to more models, and added a Multiprocessor Coupling feature that makes it possible to link existing single processors and turn them into multiprocessor, or console over the A-Bus. The MBC includes the following components:

- **Data Integrity Unit, which assures that copies of a currently accessed data line which also exist in other system elements, such as the MSU and the two HSBs, contain the same data**
- **Interrupt Router, which directs external system interrupts to the CPU**
- **Timer Complex, which provides System/370 timing facilities such as the time-of-day clock, clock comparator, CPU timer, and interval timer**
- **I/O Router, which translates logical channel addresses to real addresses, formats them for IOP or console action, and facilitates channel reconfiguration**
- **Main Storage Controller (MSC), which provides the correct control signals for MSU memory requests, and generates error checking and correction (ECC) codes**

Once a request has entered the MSU from the MBC, the MSU accesses four quarterlines from one of the four interleaves present and latches them within the Main Storage Data-Out Register. The quarterlines (actually a 32-bit data line) are then routed over the B-Bus (move-in data path) to the appropriate component, such as the S-Unit, IOP, or console.

The System Director in 5890 systems controls and monitors, but does not execute, all requests for data and access to main memory and all storage protect key functions to insure data integrity. The External Director in 5890 systems provides a logical and physical interface between CPUs, System Director, and Main Storage Unit, and the Input/Output Processors and System Support Processor. The External Director handles I/O interrupt routing, 370-XA I/O path selection, and message routing from the CPUs.

The Amdahl 580 operates in the Extended Control (EC) mode. In the EC mode, the Program Status Word (PSW) and the layout of the permanently assigned lower main storage area are altered to support Dynamic Address Translation (DAT) and other new system control functions; therefore, virtual-storage-oriented operating systems must be used.

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cessors. Maximum main memories on Amdahl 580 processors from the entry-level 5840 to the 5880 now range from 128 megabytes to 256 megabytes.

IBM, on the other hand, has brought out few enhancements for the 308X Series within the last year, leading most observers to agree the 308X Series is a technologically mature product line. Maximum main memory on 308X processors continues to range from 32 megabytes to 128 megabytes.

In the wake of 308X price reductions, a basic entry-level IBM 3083 CX single processor with 16 megabytes of memory, 16 channels, and other required hardware sells for roughly $993,010. A comparable Amdahl 5840 with 16 megabytes of main memory and 16 channels sells for $1,270,000. A basic IBM 3081 Model GX dual processor with 32 megabytes of memory, 24 channels, and other required hardware sells for roughly $2,730,515. An Amdahl 5868 two-way processor with 32 megabytes of memory and 32 channels sells for $2,850,000. An IBM 3084 QX four-way processor with 128 megabytes of memory, 48 channels, and other required hardware sells for roughly $6,693,515. A comparable Amdahl 5880 two-way processor with 128 megabytes of memory and 48 channels sells for $4,352,000. It should also be noted Amdahl 580 systems have a slightly better CPU cycle time than the IBM 308X Series.

Despite competitive price/performance, most customers who buy plug-compatible mainframes are more interested in a good price and less interested in better performance, according to an IDC study. Of 409 users responding to an 1985 IDC survey, 57 percent said they bought PCM equipment to save money, while 20 percent said they bought it to obtain better performance.

Finally, the availability of the new 6380E disk with a total capacity of 5.04 gigabytes per cabinet now makes Amdahl competitive with IBM, NAS, and other vendors who have brought out disk products of comparable capacity.

ADVANTAGES AND RESTRICTIONS

With the announcement of new 5890 top-end mainframes and price/performance enhancements for existing 580 processors, Amdahl has extended the growth path for its customers, has made larger configurations possible on existing 580 mainframes, and has augmented savings in the operating systems software area.

The announcement of the three 5890 processors gives the mainframe user community a price/performance alternative to IBM. Just the same, existing Amdahl users who plan to migrate to the 5890 will be faced with a processor swapout, since no field upgrade is possible between existing 580 processors and the new 5890 Series. It is possible, however, to field upgrade the seven existing 580 processors from the entry-level 5840 to the 5880.

Besides the new top-end systems, Amdahl has made it possible for existing 580 users to expand processing power and processing flexibility. The optional 580/Multiple Do-

The 580 can also operate in the Extended Architecture (XA) mode. This capability supports 31-bit addressing with real and virtual address sizes of 2 billion bytes. Normal EC mode supports 24-bit addressing with a maximum of 16 million bytes of real and virtual address space per user program. The 580 supports a dynamic channel subsystem and bimodal operation, which permits user programs with 24- and 31-bit addresses to execute concurrently.

Sixteen 32-bit general registers are used for indexing, base addressing, and as accumulators. Other program-visible registers are the same as in the System/370. Machine-dependent registers contained in the 580 processors are not visible to the user and may differ from the System/370.

The Amdahl 580 instruction set consists of the complete System/370 Universal Instruction Set, including the five System/370 instructions for Dynamic Address Translation.

The Console Complex is the command center of the 580, and provides an operator's console interface. It is the primary means of conducting both local and remote system diagnostics. The Console Complex and its associated components are implemented in microcode and contained in a single MCC.

The Console Complex includes the following:

- **Microcoded System Support Processor with two megabytes of memory, capable of executing a subset of the Amdahl 580 instruction set**
- **An I/O channel, associated with one hard disk and two diskettes**
- **Up to three remote CRT keyboard units, comparable to IBM 3277s**
- **A system scanning facility**
- **Modem control facilities for access to Amdahl Diagnostic Assistance Center (AMDAC)**
- **A Bus Handler for attachment to the system's A-Bus and B-Bus**

In 5890 systems, the console subsystem consists of operator consoles, a System Support Processor, Console Support Processor, and System Activity Monitor. Operator consoles include a system console to handle system control functions and monitoring; an operator console to handle controlling and monitoring functions that involve the System Control Program; a maintenance console to monitor system functions and to diagnose problems, and an AMDAC console for communicating between dual-processor systems and the AMDAC.

The System Support Processor (SSP) handles system initialization and reset, monitoring, diagnostic, and system recovery and repair functions. The SSP includes a processor, a hard disk, two diskette drives, up to four terminals at the operator consoles, and a modem for connection to the AMDAC.

The System Activity Monitor displays system status information, such as CPU busy or channel busy. The monitor formats data in rows, columns, and graphs. Up to 18 horizontal graphs together with titles and headings can be displayed.

SPECIAL FEATURES: Other features of the System/370 found in the Amdahl 580 processors include control registers, direct addressing, double word buffer, machine check handling, multiple bus architecture, channel command retry, channel indirect addressing, byte-oriented operand fea-

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main Feature (580/MDF), now extended to all processors, lets users consolidate multiple computer systems on a single processing complex and operate multiple System Control Programs (SCPs) on a single processor.

Amdahl now offers a 40-channel configuration option on multiprocessors for users who don't need full 48-channel configurations. Additionally, users who need more than four byte multiplexer channels can now allocate up to eight possible byte multiplexer channels on multiprocessors. The new 580/Expanded Storage option, now available for all Amdahl processors, will be particularly beneficial to users who need additional memory but whose operating systems or systems facilities, such as VM/SP HPO and IMS Virtual Fetch, cannot use regular main memory greater than 64 megabytes.

The Multiprocessor Coupling feature lets users couple two identical 580 single-processor models to make it possible to eliminate redundant software licenses and reduce software costs. The feature also makes it possible to operate in single image and partition mode, making it practical for users to run larger system work loads and experience faster throughput.

A new hardware/firmware product called Macrocode supports the machine-check and channel-check capabilities of the 580. Macrocode along with hardware and microcode is used on the Amdahl 580 to implement System/370 Extended Architecture.

USER REACTION

Datapro's 1986 survey of mainframe users drew responses from 17 users of Amdahl 580 Series systems. Of the 17 systems rated, four were 5840s, four were 5860s, three were 5850s, three were 5870s, and two were 5880s, and one was a 5867. The average age of these installed systems was 29.50 months at the time the survey was taken. Some 47.06 percent of the respondents said they purchased their systems from Amdahl, while 23.53 leased the equipment and 29.41 percent purchased it from a third party.

Amdahl sites surveyed were concentrated in manufacturing (five), government (three), utilities (three), insurance (three), and one each in banking and finance, health care and medical, and transportation. Principal applications respondents cited most often were accounting and billing (82.35 percent) and payroll and personnel (70.59 percent). Other major applications listed in order of times cited were engineering/scientific, order processing and inventory, and process control (all cited by 47.06 percent). These were followed by purchasing (41.18 percent), sales and distribution (41.18 percent), insurance (35.29 percent), manufacturing (29.41 percent), and education (23.53 percent). Others mentioned less frequently were construction (17.65 percent), banking (11.76 percent), health and medical care, mathematics and statistics, and petroleum/fuel analysis. These last three categories were all mentioned by 11.76 percent of the respondents. The relatively high percentage citing engineering/scientific applications suggests this area

ture, console audible alarm, remote console, remote data link, console file, extended control mode, program event recording, VM Performance Assist, and 580/Expanded Storage.

- **Machine check handling analyzes errors and attempts recovery by retrying the failed instruction if possible. If retry is unsuccessful, it attempts to correct the malfunction or to isolate the affected task. Channels have the capability to perform channel command retry, a channel and control unit procedure that causes a command to be retried without requiring an I/O interruption. Channel Indirect Addressing (CIA) is a companion feature to dynamic address translation, providing data addresses for I/O operations. CIA permits a single channel command word to control the transmission of data that crosses noncontiguous pages in real main storage. If CIA is not indicated, then channel one-level (direct) addressing is employed. The byte-oriented operand feature permits storage operands of most nonprivileged operations to appear on any byte boundary. Instructions must appear on even byte addresses. The console audible alarm is a device activated when predetermined events occur that require operator attention or intervention for system operation. Remote consoles are available in addition to the standard console. The remote data link allows establishment of communications with a technical data center to remotely diagnose system malfunctions. The console file is the basic microprogram loading device for the system, containing a read-only file device. The media read by this device contains all the microcode for field engineering device diagnostics, basic system features, and any optional system features. The extended control mode (EC) is a mode in which all features of the System/370 computing system, including dynamic address translation, are operational. Program event recording is a hardware feature used to assist in debugging programs by detecting and recording program events.**

- **The optional Channel-to-Channel Adapter (CCA) permits direct communications between an Amdahl 580 and an IBM System/370, 303X, or 308X via a standard I/O channel. It can be attached to a block multiplexer channel and uses one control unit position on either channel. In an interconnection between an Amdahl 580 and an IBM processor, either system can be equipped with the Channel-to-Channel Adapter, and it is required on only one of the interconnected channels. Up to two CCAs can be implemented in a system.**

- **The Two-Byte Interface, with up to four available per IOP, doubles the bandwidth of the data path between the channel and the control units which support this option.**

- **The 580/Multiple Domain Feature (580/MDF) lets users consolidate multiple computer systems into a single processing complex, and operate multiple System Control Programs (SCPs) on a single processor. Each SCP resides in a domain, which has all the resources necessary to operate the SCP. The 580/MDF supports up to four domains on any model and up to eight domains on partitioned multiprocessors. Features include concurrent native support of S/370 and 370-XA; performance of at least 95 percent of native mode; no additional SCPs or software modifications required; hardware isolation and protection for each domain; dynamic allocation and redistribution of CPU time; flexible allocation of main memory and channels from a resource pool; full-screen menus; and predefined domain characteristics. The characteristics of the domain (architectural mode, amount of main storage, channels, and CPU time allocation) are specified during domain definition, and are entered at the 580/MDF master console. The domain console is identified during domain definition, and can either be a Main Operator Console (MOC) or a 580 Remote Operator Console (ROC).**

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has become increasingly important in the mainframe world.

Terminal and memory configurations cited suggest the Amdahl sites surveyed maintain fairly large centralized operations. Some 83.35 percent said they had more than 60 local terminals and 88.24 percent had more than 60 remote terminals. Some 35.29 percent installed 16 megabytes to less than 32 megabytes of main memory; 29.41 percent installed between 32 megabytes and 64 megabytes; and 29.41 percent had more than 64 megabytes of main memory. Some 82.35 percent also had disk space capacity equal to or greater than 10 gigabytes.

For all of the users surveyed, the major source of applications programs originated with in-house personnel (100 percent). Another 70.59 percent obtained packaged programs from the manufacturer, 64.71 percent used contract programming, and 41.18 percent obtained some of the programs from independent suppliers. The major programming language was Cobol, while Assembler was a distant second.

As part of system expansions planned for the year, 52.94 percent said they planned to obtain additional software from the manufacturer, and 82.35 percent planned to obtain proprietary software from other suppliers. Only 11.76 percent said they planned to install a Unix-based operating system. Interestingly, Amdahl offers Unix-based systems and is a major Unix proponent in the mainframe world. On the hardware side, 88.24 percent said they planned to add to their present hardware, and 94.12 percent said they planned to expand data communications facilities.

In other survey categories, 58.82 percent said they now have an information center, and 82.35 had a disaster recovery plan, while 5.88 percent said they planned to implement a plan this year.

As part of the survey, users were asked to rate their Amdahl equipment from excellent to poor. As the results show, Amdahl received some of its highest marks in maintenance service responsiveness, reliability of the mainframe, and in technical troubleshooting. Lowest rated areas centered around software-related categories and ease of conversion. This last area is especially critical to a plug-compatible vendor trying to lure customers away from the IBM world.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	8	9	0	0	3.47
Reliability of system	13	3	0	1	3.65
Reliability of peripherals	9	6	1	0	3.50
Maintenance service:					
Responsiveness	13	3	1	0	3.71
Effectiveness	11	5	0	1	3.53
Technical support:					
Troubleshooting	11	5	1	0	3.59
Education	7	5	5	0	3.12
Documentation	6	9	2	0	3.24
Manufacturers software:					
Operating system	1	9	0	0	3.10
Compiler & assemblers	0	7	1	0	2.88
Application programs	0	6	1	0	2.86

The MOC may be used for both the 580/MDF master console and the domain console functions, but Amdahl recommends that the 580/MDF master console be assigned to the MOC and each domain console be assigned to a separate ROC. Main storage is allocated to each domain in multiples of 64K bytes. The 580/MDF provides support for only MVS/370, MVS/XA, and VM/SP HPO software environments. If the 580/MDF feature is removed, the system is restored to its original configuration. The 580/MDF makes it possible to test SCPs and applications during prime shift without the need for separate processors. It also lets users convert from one SCP to another, or to convert subsystems and applications. Finally, the feature lets users combine operations running on multiple systems to a single system. By doing this, Amdahl contends, users may be able to reduce operating and software costs.

- **The 580/Accelerator provides users of Amdahl's 5840 and 5850 with the ability to mimic a more powerful processor during periods of increased demand. Depending on the installed processor and desired performance level, the user can select one of three options: 5840 accelerated to 5850 level, 5850 accelerated to 5860 level, and 5840 accelerated to 5860 level.**

- **The 580/Conversion Feature assists users of systems converting from IBM MVS/370 to the MVS/XA operating environment. This feature combines 580 hardware circuitry with macrocode to split the 580 system into two logical systems with MVS/370 operating in one environment and MVS/XA operating in another.**

- **The High-Speed, Floating-Point feature is designed for use by large-system users with significant scientific processing needs. The feature provides additional computational capabilities that let 5840, 5850, 5860, 5867, 5868, 5870, and 5880 processors make use of the floating-point instruction set.**

- **580/VM Performance Assist, a standard feature on all 580 systems, is said to enhance VM performance.**

- **580/Expanded Storage, a standard feature on all 580 mainframes, lets users allocate a portion of main storage to expanded storage to reduce the paging and swapping load to channel-attached paging and swapping devices. Users can specify the size of expanded storage at system initialization time in four-megabyte increments.**

PHYSICAL SPECIFICATIONS: Environmental conditions for 580 processors are included in the following table:

Temperature Range	**60° to 90° F (16° to 32° C)**
Underfloor Temperature	**50° to 66° F (10° to 19° C)**
Relative Humidity Range (noncondensing)	**50% to 80%**
Maximum Wet Bulb Temperature	**78° F (26° C)**
Heat Output (Btus/hr)	**51,500**
Power Consumption	**6.0 to 16.4 kVA at 60 Hz**
	7.4 to 17.6 kVA at 50 Hz
	13.1 to 55 kVA at 400 Hz
Power Source	**200V, 60 Hz, three phase**
	208V, 60 Hz, three phase
	220V, 60 Hz, three phase
	240V, 60 Hz, three phase
	380V, 60 Hz, three phase
	200V, 50 Hz, three phase
	220V, 50 Hz, three phase
	240V, 50 Hz, three phase
	380V, 50 Hz, three phase
	415V, 50 Hz, three phase
	208V, 400 Hz

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	Excellent	Good	Fair	Poor	WA*
Ease of programming	0	10	1	0	2.91
Ease of conversion	0	6	4	0	2.60
Overall satisfaction	0	11	0	0	3.00

*Weighted Average on a scale of 4.0 for Excellent.

To obtain additional comments, Datapro contacted three Amdahl users who all installed 5840s. One system was installed at a New York, NY government site two years ago, one was installed at a Virginia government-related location, and the third was placed at a Pennsylvania manufacturing location. Users at all three sites said they like their systems and had few major complaints.

The New York site installed an Amdahl system when it outgrew an IBM 4341. To obtain a replacement system, by law, the government agency was required to solicit bids. IBM, NAS, and Amdahl submitted bids and Amdahl's bid came in the lowest. Since installing the Amdahl system, the user said he has been pleased with Amdahl's support during the conversion process. "The suppport was excellent." The actual conversion from an IBM to an Amdahl system was accomplished over a single weekend. The new Amdahl system was up and running the following Monday morning. He added that his agency did experience some negative feelings from IBM, which continues to be a major agency vendor. These hurt feelings were soothed somewhat when agency officials told IBM personnel they were required by law to accept the lowest bidder's offer.

The Pennsylvania-based user said his firm selected Amdahl two years ago after receiving unsatisfactory support from IBM. He said he is now pleased with the support he's receiving from Amdahl. He would be even more pleased with Amdahl if the plug-compatible vendor expanded its peripheral line. Currently, the firm only offers several storage product lines, but no tape drives or printers. "They ought to offer a line of peripherals," he said.

The Virginia-based user said his site purchased an Amdahl two years ago because it was competitively priced and offered adequate computing capacity and features. He was particularly pleased with the air cooling feature. He said field service has been good and the machine has been reliable. Downtime has been minimal. His only major complaint involved computer operation. Because of all the microcode, firmware, and operational software, it can take up to 10 minutes to IPL the system.

When asked whether their systems did what they expected them to do, 15 respondents (94.12 percent) said "Yes," and one respondent (5.88 percent) said "No." When asked whether they would recommend their systems to others, the answers were identical. □

The dimensions and weights for Amdahl mainframes are listed in the following chart:

	Width (in.)	Ht. (in.)	Depth (in.)	Wt. (lb.)
Amdahl Mainframes				
Models 5840/5850/5860 (Covers in place)	147	70.5	36	3,833
Models 5867/5868 (Covers in place)	196	70.5	36	5,252
Models 5890-200/-300 (Covers in place)	153.8	70.5	104	6,482

CONFIGURATION RULES

The Amdahl 580 is built from several interrelated components. Each element is implemented in a Multiple Chip Carrier (MCC), which contains all logic and circuitry required in a compact package. All functions are housed within the 580 mainframe and include the following:

- **Instruction Unit (I-Unit), which processes instructions and controls the CPU**
- **Execution Unit (E-Unit), which performs the required computations**
- **Storage Unit (S-Unit), which manages the system's storage and retrieval activities**
- **Instruction Buffer (I-Buffer), which provides high-speed buffer storage for instruction streams**
- **Operand Buffer (O-Buffer), which provides similar storage capabilities for operand data**

These components make up the Central Processor Unit (CPU). For 580 processors other than the 5890 models, additional elements include:

- **Input/Output Processor (IOP), which manages I/O requests and provides up to 16 channels**
- **Console Processor, which monitors CPU functions, provides maintenance and diagnostic routines via the System Support Processor (SSP)**
- **Memory Bus Controller (MBC), which controls data accesses to the Main Storage Unit (MSU), data bus transfers, and provides overall system coordination and timing facilities**

An additional IOP can be configured, giving the 580 a maximum of 31 block multiplexer channels per CPU (48 per system). Up to 128 channels are ultimately possible in 5890 systems.

Major 5890 mainframe components include the Processor Unit (PRU), Main Storage Unit (MSU), System Support Unit (SSU), and Power Supply Unit (PSU). An optional Channel Extension Unit (CEU) may also be configured in systems with more than 32 channels, or more than two Channel-to-Channel Adapters. Additional 5890 system components include a power distribution unit, main operator console, and up to three optional remote consoles. In addition to identical central processing units and a main storage unit, 5890 systems also include these other functional units:

- **Channel Subsystem containing two, three, or four integrated I/O Processors, each containing 16 I/O channels**
- **System Director, which controls data transfers between the MSU, the CPUs, and the External Director**
- **External Director, which is the logical and physical interface between internal system elements, such as the CPU,**

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System Director, and MSU, and external elements, such as the IOPs and the System Support Processor

The 580 Series features the Models 5840, 5850, and 5860 uniprocessors; the Models 5867, 5870, 5890-200, and 5890-300 dual processors; the Models 5868 and 5880 two-way multiprocessors; and the Model 5890-600 four-way multiprocessor complex. Multicomputer complexes are all tightly-coupled, sharing main memory, channels, and a single copy of the operating system.

The 5840, 5850, 5860 single processors feature 16 megabytes of main memory expandable to 128 megabytes, 16 I/O channels expandable to 32 channels, a Main Operator Console, and a Power Distribution Unit. Up to two optional Channel-to-Channel Adapters and three Remote Operator Consoles are available.

The 5867 dual processor features 24 megabytes of main memory expandable to 128 megabytes, 16 I/O channels, expandable to 32 channels, a Main Operator Console, and a Power Distribution Unit. Up to two Channel-to-Channel Adapters and three Remote Operator Consoles are available.

The 5868 and 5880 two-way multiprocessors feature 32 megabytes of main memory expandable to 256 megabytes, 32 I/O channels expandable to 48 channels, two Main Operator Consoles, and a Power Distribution Unit, expandable to two. Up to four optional Channel-to-Channel Adapters and up to six Remote Operator Consoles are available.

The 5870 dual processor features 32 megabytes of main memory expandable to 128 megabytes, 16 I/O channels expandable to 32 channels, one Main Operator Console, and one Power Distribution Unit. Up to two optional Channel-to-Channel Adapters and three Remote Operator Consoles are available.

The 5890-200 and -300 dual processors feature 64 megabytes of main memory expandable to a maximum of 256 megabytes, 32 I/O channels expandable to a maximum of 64 channels, one Main Operator Console, and one Power Distribution Unit. Up to four optional Channel-to-Channel Adapters and three Remote Operator Consoles are available.

The 5890-600 four-way processor features 128 megabytes of main memory expandable to a maximum of 512 megabytes, 64 channels expandable to a maximum of 128 channels, two Main Operator Consoles, and two Power Distribution Units. Up to eight optional Channel-to-Channel Adapters and up to six Remote Operator Consoles are available.

INPUT/OUTPUT CONTROL

The 580 Input/Output Processor (IOP) handles I/O operations. The IOP consists of three components, the I/O Controller (IOC), the Bus Handler, and the Interface Handlers associated with the channels. An IOP can support up to 16 I/O channels and each channel can have up to 256 subchannels. Channels may be configured as either byte multiplexer or block multiplexer channels. A block multiplexer channel can operate in either interlock mode or data streaming mode. Channel data rates in interlock mode are 1.86 megabytes per second, and channel rates in data streaming mode are 3 megabytes per second. In addition to block multiplexers, users can optionally configure up to four channels per IOP as byte multiplexer channels. On 5868 and 5880 multiprocessors, users can now allocate up to eight byte multiplexers in single image mode and up to four on each side of the partition in partition mode. Byte multiplexer channels can transfer data in byte interleave mode at a maximum rate of 40K bytes per second, or in burst mode at a maximum data rate of 200K bytes per second. Refer to Table 1 for specific byte and block multiplexer combinations per model.

Data flowing in and out of the IOP moves over the 580's A- and B-buses. These buses are a connecting link for the major system components. The Bus Handler is the interface to the A-Bus and B-Bus for the IOP, and provides data buffering when needed. The IOC provides the processing capabilities of the IOP, and manages the Bus Handler and the Interface Handlers. The Interface Handlers provide a logical and electrical link to the peripheral device control units. They perform data transfer functions, including channel bus and tag manipulation and data buffering.

MASS STORAGE

Amdahl offers the 6000 Series of Disk Storage Units (DSU) for the Amdahl 580 Series. The logical and physical characteristics of the 6000 Series are listed in Table 2.

The Amdahl 580 Series can also use all IBM System/370, 303X, and 30XX input/output and mass storage devices as well as their plug-compatible counterparts from independent vendors. Please refer to Volume 2 of DATAPRO 70 for detailed coverage of many of these peripherals.

INPUT/OUTPUT UNITS

Amdahl does not offer tape units or printers.

TERMINALS

Amdahl does not offer terminals.

COMMUNICATIONS

Amdahl has two communications processors, the 4705E and the 4705T. The 4705E was announced in April 1983 and the 4705T in February 1985. Both models are communications software-compatible with the IBM 3705-II and the IBM 3725 systems based on System/370 and System/370 XA. The 4705E and 4705T have approximately 2.4 times the power of the 3705-II, and can be configured with 256K to 1024K bytes of memory in 256K-byte increments. Up to 160 communications lines can be connected to the basic frame. Up to two 96-line expansion frames are available for a total of up to 352 communications lines. The host channels can be byte or block multiplexer, or selector channel. The access methods can be BTAM, QTAM, TCAM, or VTAM. The communications software supported is EP, PEP, NCP, and ACF/NCP, and the network architecture is SNA. The communications facilities supported on the 4705 Series can be half- or full-duplex, private, leased, or switched lines; EIA RS-232-C; CCIT V.24; CCIT V.35; and X.21. Transmission speed for both models is 64,000 bps. With the high-speed attachment, channel speeds of 4800 bps to 768,000 bps, and synchronous trunk speeds up to 2,048,000 bps are possible. Start/stop, BSC, and SDLC protocols are supported. The 4705E and 4705T models are compatible with IBM 3705 communications software and access methods.

SOFTWARE

OPERATING SYSTEMS: Amdahl offers complete functional compatibility with IBM 360/370/303X/30XX software. Operating systems supported include MVS, MVS/SP1, MVS/SP2, VM/SP HPO, VM/SP, ACP, and ACP/TPF. Support is included for such major IBM subsystems as TSO, TCAM, JES2, JES3, VTAM, RSCS, CMS, and IPCS.

Universal Timesharing System (UTS): This product provides a Unix-based timesharing system for use on System/370 architecture processors.

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580/Multiple Domain Feature (580/MDF): This hardware feature allows the concurrent native support of S/370 and 370/XA.

PROGRAMMING LANGAUGES: Amdahl Systems run IBM language and compilers. Please refer to IBM 3090 and 308X reports for details about packages and products under this category

DATA BASE MANAGEMENT: Amdahl Systems run IBM data base management packages. Please refer to IBM 3090 and 308X reports for details about packages and products under this category

DATA MANAGEMENT: Amdahl systems run IBM data management systems. Please refer to IBM 3090 and 308X reports for details about packages and products under this category .

DATA COMMUNICATIONS: Amdahl systems handle IBM communications products. Please refer to IBM 3090 and 308X reports for details about packages and products under this category.

UTILITIES: Please refer to IBM 3090 and 308X reports for details about packages and products under this category.

OTHER SOFTWARE: Amdahl supplies two performance tools called Modeling and Analysis Package (MAP) and System Utilization and Reporting Facility/IMS (SURF/IMS).

PRICING & SUPPORT

POLICY: The Amdahl 580 Series models are offered for purchase or for lease under monthly rental terms. Specific multiple-year lease plans should be worked out with Amdahl. Purchase credits are available at a rate of 20 percent of each monthly rental payment to a maximum aggregate credit of 50 percent of the purchase price. The purchase credit applies either to the original lessee or the current lessee.

SUPPORT: Monthly maintenance charges are not included in lease charges. Maintenance is provided for 24 hours per day and 7 days per week.

EDUCATION: Amdahl offers courses and consulting services through its Education and Professional Services Division. Amdahl currently offers more than 50 Systems Education courses covering such areas as MVS, VM, Communications Systems, and Data Systems. Amdahl's Systems Consulting Services provides consulting for DP managers and staff. In addition to consulting services, Consulting Services also offers seminars and workshops.

TYPICAL CONFIGURATION: Except for disk storage products, Amdahl does not offer its own terminals, printers, tape drives, and other supporting devices, making it impractical to suggest a typical configuration cost.

EQUIPMENT PRICES

PROCESSORS AND MAIN MEMORY		Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5840	CPU Complex; includes two 32K-byte buffer storage units, one byte multiplexer channel, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below			
	With 16 megabytes of main memory and:			
	16 channels	1,270,000	8,200	108,330
	24 channels	1,400,000	8,400	119,170
	32 channels	1,530,000	8,600	130,000
	With 24 megabytes of main memory and:			
	16 channels	1,354,000	8,600	116,670
	24 channels	1,484,000	8,800	127,500
	32 channels	1,614,000	9,000	138,330
	With 32 megabytes of main memory and:			
	16 channels	1,438,000	9,000	125,000
	24 channels	1,568,000	9,200	135,830
	32 channels	1,698,000	9,400	146,670
	With 48 megabytes of main memory and:			
	16 channels	1,606,000	9,800	141,670
	24 channels	1,736,000	10,000	152,500
	32 channels	1,866,000	10,200	163,330
	With 64 megabytes of main memory and:			
	16 channels	1,774,000	10,600	158,330
	24 channels	1,904,000	10,800	169,170
	32 channels	2,034,000	11,000	180,000
	With 96 megabytes of main memory and:			
	16 channels	2,062,000	12,200	182,330
	24 channels	2,192,000	12,400	193,170
	32 channels	2,322,000	12,600	204,000
	With 128 megabytes of main memory and:			
	16 channels	2,350,000	13,800	206,330
	24 channels	2,480,000	14,000	217,170
	32 channels	2,610,000	14,200	228,000

**Includes 24-hour/7-day service; applies to both purchased and leased systems.*
NC—No charge.
NA—Not Available.

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Amdahl 580 Systems

PROCESSORS AND MAIN MEMORY (Continued)	Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5850 CPU Complex; includes two 32K-byte buffer storage units, one byte multiplexer channel, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 16 megabytes of main memory and:			
16 channels	1,450,000	9,350	129,170
24 channels	1,580,000	9,550	140,000
32 channels	1,710,000	9,750	150,830
With 24 megabytes of main memory and:			
16 channels	1,534,000	9,750	137,500
24 channels	1,664,000	9,950	148,330
32 channels	1,794,000	10,150	159,170
With 32 megabytes of main memory and:			
16 channels	1,618,000	10,150	145,830
24 channels	1,748,000	10,350	156,670
32 channels	1,878,000	10,550	167,500
With 48 megabytes of main memory and:			
16 channels	1,786,000	10,950	162,500
24 channels	1,916,000	11,150	173,330
32 channels	2,046,000	11,350	184,170
With 64 megabytes of main memory and:			
16 channels	1,954,000	11,750	179,170
24 channels	2,084,000	11,950	190,000
32 channels	2,214,000	12,150	200,830
With 96 megabytes of main memory and:			
16 channels	2,242,000	13,350	203,170
24 channels	2,372,000	13,550	214,000
32 channels	2,502,000	13,750	224,830
With 128 megabytes of main memory and:			
16 channels	2,530,000	14,950	277,170
24 channels	2,660,000	15,150	238,000
32 channels	2,790,000	15,350	248,830
Model 5860 CPU Complex; includes two 32K-byte buffer storage units, one byte multiplexer channel, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 16 megabytes of main memory and:			
16 channels	1,630,000	9,850	150,000
24 channels	1,760,000	10,050	160,830
32 channels	1,890,000	10,250	171,670
With 24 megabytes of main memory and:			
16 channels	1,714,000	10,250	158,330
24 channels	1,844,000	10,450	169,170
32 channels	1,974,000	10,650	180,000
With 32 megabytes of main memory and:			
16 channels	1,798,000	10,650	166,670
24 channels	1,928,000	10,850	177,500
32 channels	2,058,000	11,050	188,330
With 48 megabytes of main memory and:			
16 channels	1,966,000	11,450	183,330
24 channels	2,096,000	11,650	194,170
32 channels	2,226,000	11,850	205,000
With 64 megabytes of main memory and:			
16 channels	2,134,000	12,250	200,000
24 channels	2,264,000	12,450	210,830
32 channels	2,394,000	12,650	221,670
With 96 megabytes of main memory and:			
16 channels	2,422,000	13,850	224,000
24 channels	2,552,000	14,050	234,830
32 channels	2,682,000	14,250	245,670
With 128 megabytes of main memory and:			
16 channels	2,710,000	15,450	248,000
24 channels	2,840,000	15,650	258,830
32 channels	2,970,000	15,850	269,670

**Includes 24-hour/7-day service; applies to both purchased and leased systems.*
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Amdahl 580 Systems

PROCESSORS AND MAIN MEMORY (Continued)	Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5867 Attached CPU Complex consists of a 580 CPU tightly coupled to a 5850 CPU Complex; includes two 32K-byte buffer storage units per CPU, one byte multiplexer channel, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 24 megabytes of main memory and:			
16 channels	2,474,000	12,500	214,170
24 channels	2,520,000	12,700	225,000
32 channels	2,650,000	12,900	235,830
With 32 megabytes of main memory and:			
16 channels	2,474,000	12,900	222,500
24 channels	2,604,000	13,100	233,330
32 channels	2,734,000	13,300	244,170
With 48 megabytes of main memory and:			
16 channels	2,642,000	13,700	239,170
24 channels	2,772,000	13,900	250,000
32 channels	2,902,000	14,100	260,830
With 64 megabytes of main memory and:			
16 channels	2,810,000	14,500	255,830
24 channels	2,940,000	14,700	266,670
32 channels	3,070,000	14,900	277,500
With 96 megabytes of main memory and:			
16 channels	3,098,000	16,100	279,830
24 channels	3,228,000	16,300	290,670
32 channels	3,358,000	16,500	301,500
With 128 megabytes of main memory and:			
16 channels	3,386,000	17,700	303,830
24 channels	3,516,000	17,900	314,670
32 channels	3,646,000	18,100	325,500
Model 5868 Dual CPU Complex; includes two 32K-byte buffer storage units, two byte multiplexer channels, two consoles, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 32 megabytes of main memory and:			
32 channels	2,850,000	13,950	252,500
40 channels	2,980,000	14,150	263,330
48 channels	3,110,000	14,350	274,170
With 48 megabytes of main memory and:			
32 channels	3,081,000	14,750	269,170
40 channels	3,148,000	14,950	280,000
48 channels	3,278,000	15,150	290,830
With 64 megabytes of main memory and:			
32 channels	3,186,000	15,550	285,830
40 channels	3,316,000	15,750	296,670
48 channels	3,446,000	15,950	307,500
With 96 megabytes of main memory and:			
32 channels	3,474,000	17,150	309,830
40 channels	3,604,000	17,350	320,670
48 channels	3,734,000	17,550	331,500
With 128 megabytes of main memory and:			
32 channels	3,762,000	18,750	333,830
40 channels	3,892,000	18,950	344,670
48 channels	4,022,000	19,150	355,500
With 192 megabytes of main memory and:			
32 channels	4,242,000	21,950	373,830
40 channels	4,372,000	22,150	384,670
48 channels	4,502,000	22,350	395,500
With 256 megabytes of main memory and:			
32 channels	4,722,000	25,150	413,830
40 channels	4,852,000	25,350	424,670
48 channels	4,982,000	25,550	435,500

**Includes 24-hour/7-day service; applies to both purchased and leased systems.*
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Amdahl 580 Systems

▸ PROCESSORS AND MAIN MEMORY (Continued)		Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5870	Attached CPU Complex consists of a 580 CPU tightly coupled to a 5860 CPU Complex; includes two 32K-byte buffer storage units per CPU, one byte multiplexer channel, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
	With 32 megabytes of main memory and:			
	16 channels	2,770,000	16,300	255,830
	24 channels	2,900,000	16,500	266,670
	32 channels	3,030,000	16,700	277,500
	With 48 megabytes of main memory and:			
	16 channels	2,938,000	17,100	272,500
	24 channels	3,068,000	17,300	283,330
	32 channels	3,198,000	17,500	294,170
	With 64 megabytes of main memory and:			
	16 channels	3,106,000	17,900	289,170
	24 channels	3,236,000	18,100	300,000
	32 channels	3,366,000	18,300	310,830
	With 96 megabytes of main memory and:			
	16 channels	3,394,000	19,500	313,170
	24 channels	3,524,000	19,700	324,000
	32 channels	3,654,000	19,900	334,830
	With 128 megabytes of main memory and:			
	16 channels	3,682,000	21,100	337,170
	24 channels	3,812,000	21,300	348,000
	32 channels	3,942,000	21,500	358,830
Model 5880	Dual CPU Complex; includes two 32K-byte buffer storage units, two byte multiplexer channels, two consoles, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
	With 32 megabytes of main memory and:			
	32 channels	3,180,000	17,600	294,170
	40 channels	3,310,000	17,800	305,000
	48 channels	3,440,000	18,000	315,830
	With 48 megabytes of main memory and:			
	32 channels	3,348,000	18,400	310,830
	40 channels	3,478,000	18,600	321,670
	48 channels	3,608,000	18,800	332,500
	With 64 megabytes of main memory and:			
	32 channels	3,516,000	19,200	327,500
	40 channels	3,646,000	19,400	338,330
	48 channels	3,776,000	19,600	349,170
	With 96 megabytes of main memory and:			
	32 channels	3,804,000	20,800	351,500
	40 channels	3,934,000	21,000	362,330
	48 channels	4,064,000	21,200	373,170
	With 128 megabytes of main memory and:			
	32 channels	4,092,000	22,400	375,500
	40 channels	4,222,000	22,600	386,330
	48 channels	4,352,000	22,800	397,170
	With 192 megabytes of main memory and:			
	32 channels	4,572,000	25,600	415,500
	40 channels	4,702,000	25,800	426,330
	48 channels	4,832,000	26,000	437,170
	With 256 megabytes of main memory and:			
	32 channels	5,052,000	28,800	455,500
	40 channels	5,182,000	29,000	466,330
	48 channels	5,312,000	29,200	477,170
Model 5890-200	CPU Complex; includes one 64K-byte and one 32K-byte buffer per CPU, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
	With 64 megabytes of main memory and:			
	32 channels	3,825,000	15,250	354,170
	40 channels	3,955,000	15,450	365,000
	48 channels	4,085,000	15,650	357,830
	64 channels	4,345,000	16,050	397,500

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Amdahl 580 Systems

PROCESSORS AND MAIN MEMORY (Continued)	Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5890-200 (Continued)			
With 96 megabytes of main memory and:			
32 channels	4,095,000	15,575	378,170
40 channels	4,225,000	16,775	389,000
48 channels	4,355,000	15,975	399,830
64 channels	4,615,000	16,375	421,500
With 128 megabytes of main memory and:			
32 channels	4,365,000	15,900	402,170
40 channels	4,495,000	16,100	413,000
48 channels	4,625,000	16,300	423,830
64 channels	4,885,000	16,700	445,500
With 192 megabytes of main memory and:			
32 channels	4,765,000	16,550	442,170
40 channels	4,895,000	16,750	453,000
48 channels	5,025,000	16,950	463,830
64 channels	5,285,000	17,350	485,500
With 256 megabytes of main memory and:			
32 channels	5,165,000	17,200	482,170
40 channels	5,295,000	17,400	493,000
48 channels	5,425,000	17,600	503,830
64 channels	5,685,000	18,000	525,500
Model 5890-300 CPU Complex; includes one 64K-byte and one 32K-byte buffer per CPU, console, power distribution unit, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 64 megabytes of main memory and:			
32 channels	4,500,000	16,350	416,670
40 channels	4,630,000	16,550	427,500
48 channels	4,760,000	16,750	438,330
64 channels	5,020,000	17,150	460,000
With 96 megabytes of main memory and:			
32 channels	4,770,000	16,675	440,670
40 channels	4,900,000	16,875	451,500
48 channels	5,030,000	17,075	462,330
64 channels	5,290,000	17,475	484,000
With 128 megabytes of main memory and:			
32 channels	5,040,000	17,000	464,670
40 channels	5,170,000	17,200	475,500
48 channels	5,300,000	17,400	486,330
64 channels	5,560,000	17,800	508,000
With 192 megabytes of main memory and:			
32 channels	5,440,000	17,650	504,670
40 channels	5,570,000	17,850	515,500
48 channels	5,700,000	18,050	526,330
64 channels	5,960,000	18,450	548,000
With 256 megabytes of main memory and:			
32 channels	5,840,000	18,300	544,670
40 channels	5,970,000	18,500	555,500
48 channels	6,100,000	18,700	566,330
64 channels	6,360,000	19,100	588,000
Model 5890-600 CPU Complex; includes one 64K-byte and one 32K-byte buffer per CPU, two consoles, two power distribution units, 580/Expanded Storage, and 580/VM Performance Assist; main memory and channels as listed below.			
With 128 megabytes of main memory and:			
64 channels	8,500,000	27,400	777,500
80 channels	8,760,000	27,800	799,170
96 channels	9,020,000	28,200	820,830
128 channels	9,540,000	29,000	864,170
With 192 megabytes of main memory and:			
64 channels	9,040,000	28,050	825,500
80 channels	9,300,000	28,450	847,170
96 channels	9,560,000	28,850	868,830
128 channels	10,080,000	29,650	912,170

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Amdahl 580 Systems

PROCESSORS AND MAIN MEMORY (Continued)	Purchase Price ($)	Monthly Maint.* ($)	Monthly Rental ($)
Model 5890-600 (Continued)			
With 256 megabytes of main memory and:			
64 channels	9,580,000	28,700	873,500
80 channels	9,840,000	29,100	895,170
96 channels	10,100,000	29,500	916,830
128 channels	10,620,000	30,300	960,170
With 384 megabytes of main memory and:			
64 channels	10,380,000	30,000	953,500
80 channels	10,640,000	30,400	975,170
96 channels	10,900,000	30,800	996,830
128 channels	11,420,000	31,600	1,040,170
With 512 megabytes of main memory and:			
64 channels	11,180,000	31,300	1,033,500
80 channels	11,440,000	31,700	1,055,170
96 channels	11,700,000	32,100	1,076,830
128 channels	12,220,000	32,900	1,120,170

FIELD UPGRADES

What follows are selected field upgrade purchase prices. Purchase prices for models, main storage, and channels equal the difference between any two given configurations. Prices listed here were all derived from basic configurations.

5840 to 5850	180,000	—	—
5850 to 5860	180,000	—	—
5850 to 5867	940,000	—	—
5850 to 5868	1,400,000	—	—
5860 to 5870	1,140,000	—	—
5860 to 5880	1,550,000	—	—
5870 to 5880	410,000	—	—
5890-200 to 5890-300	675,000	—	—
5890-200 to 5890-600	4,675,000	—	—
5890-300 to 5890-600	4,000,000	—	—

PROCESSOR FEATURES

Channel-to-Channel Adapter; maximum of two on 5840, 5850, 5860, 5867, and 5870; maximum of four on 5868, 5880, 5890-200 and -300; maximum of eight on the 5890-600	15,000	NC	1,250
Dual Power Distribution Unit feature; Models 5868 and 5880 only	50,000	175	NA
580/Accelerator; factory installation is $2,500; field installation is $3,000. Option 1: 5840 to 5850, $200/hour; Option 2: 5850 to 5860, $275/hour; Option 3; 5840 to 5860, $475/hour	—	—	NA
580/Multiple Domain Feature (580/MDF) is available only on a monthly lease basis. The installation charge and lease rate are both based on processor category and are listed as follows:			
Category A includes the Model 5840; installation charge is $10,000	—	—	3,000
Category B includes Models 5850 and 5860; installation charge is $10,000	—	—	4,000
Category C includes Models 5867, 5868, 5870, 5880; installation charge is $10,000	—	—	6,000
Category D includes Models 5890-200 and -300; installation charge is $15,000	—	—	8,000
Category E includes the Model 5890-600; installation charge is $15,000	—	—	10,000
High-Speed Floating Point feature (HSFP); Models 5867, 5868, 5870, and 5880 require two HSFPs	90,000	500	NA
Multiprocessing Coupling Feature; available as a field installation for Models 5868 and 5880 only. Removed or replaced parts become the property of Amdahl	175,000	NC	NA
Remote Operator Console: maximum of three Models 5840, 5850, 5860, 5867, 5870, 5890-200 and -300; maximum of six on Models 5868, 5880, and 5890-600	10,000	50	835
Hardware Monitor Attachment Feature (HMAF); price is per processor complex. Processor complexes 5867, 5868, 5870, 5880, 5890-200, or 5890-300 require two HMAFs The 5890-600 requires four. For leased processors there is a onetime lease rate of $4,000 per processor conplex	4,000	—	—
Two-byte Interface; not available on Models 5890-200, -300, or -600	1,400	NC	NA

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MASS STORAGE		Purchase Price ($)	Monthly* Maint. ($)	1-Year Lease ($)
6280 Series and Features				
6280-AA4	1.27GB Disk Storage Unit with associated controls	41,900	155	1,893
6280-AAF	1.27GB Disk Storage Unit with fixed heads and associated controls	58,900	260	2,699
6280-B4	1.27GB Disk Storage Unit	30,430	120	1,366
6280-B4F	1.27GB Disk Storage Unit with fixed heads	47,430	225	2,172
6880-A2	Storage Control Unit for 6280 Series with standard two-channel switch pair	65,700	175	3,338
8005	Additional two channel switch pair	12,750	45	672
8208	8MB Cache Controller Feature	52,125	385	2,295
3005	B4/B4F channel speed kit; 1.52 megabytes per second to 1.86 megabytes per second	15,000	—	—
3006	AA4/AAF channel speed kit; 1.52 megabytes per second to 1.86 megabytes per second	15,000	—	—
3008	B4/B4F channel speed kit; 1.86 megabytes per second to 1.52 megabytes per second	15,000	—	—
3009	AA4/AAF channel speed kit; 1.86 megabytes per second to 1.52 megabytes per second	15,000	—	—
6380 Series				
6380-AA4	2.52GB Disk Storage Unit with associated controls	71,200	300	**3,130
6380-M4	2.52GB Disk Storage Unit with associated controls	38,950	75	**1,835
6380-B4	2.52GB Disk Storage Unit	48,700	220	**2,299
6880-G2	Storage Control Unit for 6380 Series with standard two-channel switch pair	58,970	183	**2,724
6880-G2E	Storage Control Unit for 6380 Series, with standard eight-channel switch pair includes 8005 and 8006 features	134,480	370	**6,220
8001	Four-Channel Remote Switch; onetime field change charge is $800 per unit	800		
8003	Additional Four-Channel Remote Switch; onetime field charge is $800 per unit	800		
8005	Additional Two-Channel Switch Pair	14,730	36	**691
8006	Eight-channel switch allows attachment of up to eight channels, shared between two storage directors. Dual Frame Control is a prerequisite for the eight-channel switch on models with the Cache Controller Feature	20,260	50	**935
8008	Dual Frame Control; onetime field change charge is $800 per unit. The field change charge applies only in those instances where Feature 8008 is to be installed on two previously installed 6880-G2s or -G2Es	NC	—	—
8308	8MB Cache Controller Feature	54,900	387	**2,680
8316	16MB Cache Controller Feature	90,900	414	**4,430
8324	24MB Cache Controller Feature	126,900	441	**6,180
8332	32MB Cache Controller Feature	162,900	468	**7,930
6380 Upgrades				
	6380-AA4 to 6380-AE4	40,000	—	—
	6380-B4 to 6380-BE4	40,000	—	—
	6380-M4 to 6380-B4	9,750	—	—
6380E Series				
6380-AE4	5.04-gigabyte Disk Storage Unit	104,110	300	**4,575
6380-BE4	5.04 gigabyte Disk Storage Unit	78,510	220	**3,705

**Maintenance prices are for 11 hours per day, 5 days per week.*
***Two-Year Lease*
NC—No charge.
NA—Not available.

4705 SERIES COMMUNICATIONS PROCESSORS		Purchase Price ($)	Monthly* Maint. ($)	2-Year Lease ($)	4-Year Lease ($)
	4705E Communications Processor with 256K bytes of memory	27,000	330	1,225	730
	4705T Communications Processor with 256K-bytes of memory, and high-speed voice and data attachment; includes redundant multiplexer, power supply, and trunk interface module, expansion cabinet, 3 synchronous I/O modules, network console with async interface, and associated cables.	42,000	430	1,905	1,135
4705E and 4750T Series Features					
EXPE	Expansion Unit	12,000	50	545	320
ILSE	Integrated Line Switch	4,000	—	180	105
MS3E	256K-byte Memory Module	6,000	30	270	160
CA4E	Channel Adapter	4,000	15	180	105
RIPLE	Remote IPL	2,000	—	90	50

**Includes 24-hour/7-day service*

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		Purchase Price ($)	Monthly* Maint. ($)	2-Year Lease ($)	4-Year Lease ($)
4705E and 4750T Series Features (Continued)					
TCSE	Two-Channel Switch	1,750	15	80	45
CS2E	Type 2 Communications Scanner	6,000	30	270	160
CS3E	Type 3 Communications Scanner	16,000	70	725	430
SS2E	Single Scanner Attachment, Base Type 2	5,000	—	225	135
SS3E	Single Scanner Attachment, Base Type 3	8,000	—	360	215
LIB1E	Line Interface Base	1,000	—	45	25
LIB2E	Line Interface Base for high-speed asynchronous line speeds up to 9.6K bps.	2,000	—	90	45
HD1E	Analog Line Set, half-duplex, V.24, 4 lines	2,400	—	110	65
HD1LE	Analog Line Set, half-duplex, V.24, 4 lines, LPDA	2,500	—	115	70
FD1E	Analog Line Set, full-duplex, V.24, 2 lines	1,200	—	45	30
FD1LE	Analog Line Set, full-duplex, V.24, 2 lines, LPDA	1,300	—	50	35
HD1GE	Analog Line Set, wideband, half-duplex, Bell 300, 2 lines	4,000	—	180	105
FD1TE	Analog Line Set, wideband, full-duplex, Bell 303, 1 line	2,000	—	90	50
HD2E	Digital Line Set, half-duplex, V.35, 2 lines	5,000	—	225	135
FD2E	Digital Line Set, full-duplex, V.35, 1 line	3,000	—	135	80
NC1E	Analog Line Set, auto-dial, half-duplex, RS366, 2 lines	1,200	—	55	30
LA1C	Analog Line Set, low-speed asynchronous, local attachment, half-duplex, 4 lines	2,400	—	105	65
4750T High Speed Features					
HS20	Synchronous I/O Module, 2 lines	1,000	—	50	25
HS40	Asynchronous I/O Module, 1 line	680	—	30	15
HS45	Voice I/O Module, 2 lines	1,430	—	70	50
HS30	Integrated Limited Distance Data Set, 1.2K bps to 64K bps, speed specified by customer	880	—	40	25
HS34	Integrated Limited Distance Data Set, 600 bps to 9.6K bps, combines up to four synchronous channels	1,300	—	65	35

**Includes 24-hour/7-day service*

SOFTWARE PRICES

		Monthly License Fee ($)	Monthly DSLO *(1)* ($)	Annual License Fee ($)	Annual DSLO *(1)* ($)	Initial Charge ($)
MVS Product:						
4PZ0-C3-U	MVS/SP Assist (MVS/SPA)	385	300	—	—	—
VM Products						
4PV0-P1	VM/Performance Enhancement (VM/PE); a VM/Performance Enhancement installation workshop is required before installation at all sites at a onetime cost of $2,000	2,200	1,650	—	—	—
4PV1-P2	VM/Software Assist (VM/SA)	635	480	—	—	—
UTS Products*						
4SU1-PA	UTS/580					
4SU1-PA	Category A; includes Model 5840	4,000	3,600	—	—	20,000
4SU1-PB	Category B; includes Model 5850 and 5860	6,000	5,400	—	—	20,000
4SU1-PC	Catagory C; includes Models 5867, 5868, 5870, and 5880	10,500	9,450	—	—	20,000
4SU1-PD	Category D; includes Models 5890-200 and -300	14,000	12,600	—	—	20,000
4SU1-PE	Category E; includes Model 5890-600	20,000	18,000	—	—	20,000
UTS/580 and 580/MDF package**						
4SU1-P1	Category A; includes Model 5840	5,000	—	—	—	25,000
4SU1-P2	Category B; includes Models 5850 and 5860	7,000	—	—	—	25,000
4SU1-P3	Category C; includes Models 5867, 5868, 5870, and 5880	13,000	—	—	—	25,000
4SU1-P4	Category D; includes Models 5890-200 and -300	17,000	—	—	—	30,000
4SU1-P5	Category E; includes Model 5890-600	25,000	—	—	—	30,000
5PU0-F1-F	UTS/F	275	250	—	—	—
Performance Tools:						
4UZ0-M2-1	Modeling and Analysis Package (MAP)	—	—	12,000	9,000	—
4UZ0-M1-1	System Utilization Reporting Facility/IMS (SURF/IMS)	—	—	8,000	6,000	—

(1) The Amdahl Distributed System License Option (DSLO) allows the user to license additional, unsupported copies of an Amdahl licensed program product for a reduced fee.
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***580/MDF and UTS/580 are available as a package. The monthly charge varies with the processor. A separate 580/MDF lease agreement must be executed for 580/MDF, and an Amdahl Software License Agreement must be executed for UTS/580. Maintenance for 580/MDF is included as part of the lease agreement for 580/MDF. Concurrent installation of 580/MDF and UTS/580 will have a combined installation charge as previously outlined. This combined installation charge is in lieu of the installation charge for 580/MDF and the initial license fee for UTS/580.* ■

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