BTI 8000

MANAGEMENT SUMMARY

The BTI 8000 is marketed as a multiprocessor packaged system designed to handle the workload requirements of large multiuser interactive and multistream batch processing application environments. Recent enhancements to the 8000 system include: refinements to the VRM operating system to further improve user response time in large system configurations; upgrading of the file management system to increase transaction processing speed, and to provide greater flexibility in multiuser updating of database files while maintaining data integrity; improvements to existing utilities and the addition of new utilities; a reduction in memory prices, made possible by new memory and controller designs; and expansion of the number of peripherals available, including a new series of fixed and removable storage 8-inch disk drives, a higher speed magnetic tape drive, and higher speed line printers.

The BTI 8000 is based on a 32-bit, 67-nanosecond bus serving multiple processors, controllers for main memory modules, a System Services Unit, and peripheral processors which in turn control I/O device controllers, an approach which BTI calls "Variable Resource Architecture." Computational Processing Units (CPUs), Memory Control Units (MCUs), Peripheral Processing Units (PPUs), and System Services Units (SSUs) can be plugged into the bus in any mix to match the requirements of the application. A minimum configuration requires at least one of each. The system's computational power, memory, and I/O resources are automatically pooled for efficient processing of the overall workload. If an application subsequently requires more computational power, memory, or I/O capacity, additional modules can be plugged into the bus. Conventional manual regeneration of the operating sytem (sysgen) is not required when changing the hardware configuration—the system does it automatically under control of one front-panel switch. The 8000's hardware ▷

The BTI 8000 is a 32-bit, multiprocessor, multiuser, multilanguage, and multifunction system. Modular in configuration, the 8000 is designed around a central bus with a 32-bit wide data path and 16 slots for plug-in attachment of system resource modules. The system is capable of supporting as many as 200 interactive users, and provides a high-level of security for users in a time-sharing environment.

MODEL: 8000.
MEMORY: 1M to 16M bytes.
DISK CAPACITY: Up to 8G bytes.
WORKSTATIONS: Up to 200 (interactive).
PRICE: Basic system package—$110,000.

CHARACTERISTICS

MANUFACTURER: BTI Computer Systems, 870 West Maude Avenue, Sunnyvale, California 94086. Telephone (408) 733-1122.

CANADIAN ADDRESS: BTI does not currently have an office in Canada.

BTI Computer Systems started in the San Francisco Bay area in 1968 as a timesharing service company under the name Basic Timesharing, Inc., and took its present name in 1978. From this time-sharing experience, the company developed a series of interactive systems initially based on a modified Hewlett-Packard minicomputer. Today, the company manufactures three product lines: two 16-bit single-processor systems, capable of supporting up to 32 users, and a 32-bit, modular, multiprocessor system which can support as many as 200 active users. BTI also has a European subsidiary, BTI Computer Systems (U.K.), Ltd., in Birmingham, England. ▶

The BTI 8000 supports a number of peripheral devices and terminals. The BTI 8000 configuration shown here includes four terminals, two disk-pack drives, a reel-to-reel magnetic tape unit, and a line printer. This 32-bit system can support up to 200 interactive users in a multilanguage, multifunction environment.

BTI 8000

CHART A. SYSTEM COMPARISON

MODEL	8000	
SYSTEM CHARACTERISTICS		
Date of introduction	May 1980	
Date of first delivery	June 1981	
Operating system	8000-VRM	
Upgradable from	—*	
Upgradable to	—	
MIPS	—	
Relative performance	—	
MEMORY		
Minimum capacity, bytes	1M	
Maximum capacity, bytes	16M	
Type	ECC-MOS	
Cache memory	None	
Cycle time, nanoseconds	670	
Bytes fetched per cycle	4	
INPUT/OUTPUT CONTROL		
Number of channels	Max. 32	
High-speed buses	32-bit	
Low-speed buses	—	
MINIMUM DISK STORAGE	64MB	
MAXIMUM DISK STORAGE	8GB	
NUMBER OF WORKSTATIONS	200	
COMMUNICATIONS PROTOCOLS	RS–232–C asynchronous	

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

configuration is totally isolated from the user software, preserving a user's software investment as the system grows.

The BTI 8000's operating system creates private virtual machine environments for each process, independent of and isolated from the hardware configuration. Users may therefore develop application programs without reference to the specific system's hardware, and reprogramming is unnecessary as a system is expanded or otherwise changed in configuration.

BTI's Variable Resource Architecture also makes the 8000 system "fail-soft." In a multimode configuration, the loss of a processor or memory bank merely reduces the resource pool. The operator removes or replaces the faulty module—identified by built-in diagnostics—and resumes system operation with a one-button restart.

The BTI 8000's bus provides a 32-bit wide data path and uses distributed logic to achieve a data transfer rate between resource modules of 60M bytes per second. Up to 16 resource modules can be plugged into the bus. In addition to the CPU, MCU, and PPU modules, the system requires one System Services Unit (SSU), a microprogrammed processor that provides system control.

The SSU includes the system's operator control panel, with pushbuttons for various system operations and a 10-character alphanumeric display. The display informs the operator of normal and exception status conditions and the results of self-test diagnostics. Each resource module automatically runs a self-test at system start-up (bootstrap). On completion of the self-tests, the SSU continues "bootstrap," which, if all modules are operative, configures the operating system. Any module not in working order is identified by the SSU display. The operating system also checks the resource modules present and, if the hardware

DATA FORMATS

BASIC UNIT: 32-bit word and 8-bit byte.

FIXED-POINT OPERAND: Operands can be single or double words, a character, or a field of from 1 to 32 bits.

FLOATING-POINT OPERAND: Sixteen floating-point instructions deal with 64-bit, double-word operands, which include 11-bit biased exponents (10^{-154} to 10^{154}) and 52-bit mantissas (over 15 decimal digits).

INSTRUCTIONS: Machine instructions are all one word in length and reside on memory word boundaries. There are 174 machine instructions available to the user. The lowest 22 bits of most instructions specify an operand, while the next 3 higher bits are sometimes used to specify a register. Different methods of referencing operands are provided by the "address mode" field and 21 addressing modes. Indirect addressing further involves special one-word structures called pointers, which themselves contain address mode fields and parameters for operand specification.

Instructions provided for subroutine-linkage check entry points and provide parameter-type checking for the subroutine. The calling sequence and the entry sequence are executed part by part, passing one parameter at a time with the pass parameter instructions on the calling side and corresponding store parameter instructions on the subprogram side. The instructions specify the parameter type, whether the parameter is being passed by location or value, and whether this is the last parameter in the protocol.

INTERNAL CODE: ASCII.

MAIN STORAGE

TYPE: ECC–MOS RAM.

CYCLE TIME: Read access time is 867 nanoseconds, including two bus transfers (read request and response) and byte parity check. Write time is 667 nanoseconds.

CAPACITY: Minimum memory is 1M bytes, and is increased in 1M-byte increments to a maximum of 16M bytes. For cross-vendor comparative information on BTI 8000

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CHART B. MASS STORAGE

MODEL	8230	8232	8234	8215	8225
Type	8" fixed	8" removable	8" fixed	14" removable	14" removable
Controller model	8205	8205	8205	8205	8205
Drives per subsystem/ controller	1 to 4	1 to 4	1 to 4	1 to 4	1 to 4
Formatted capacity per drive, megabytes	67	67	135	67	254
Number of usable surfaces	5	5	10	5	19
Number of sectors or tracks per surface	3292 tracks	3292 tracks	3292 tracks	3292 tracks	3292 tracks
Bytes per sector or track	4096 per track	4096 per track	4096 per track	4096 per track	4096 per track
Average seek time	35 ms	30 ms	30 ms	30 ms	30 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms	8.3 ms	8.3 ms
Average access time	43.3 ms	38.3 ms	38.3 ms	38.3 ms	38.3 ms
Data transfer rate	1.2MB per sec.	1.2MB per sec.	1.2MB per sec.	1.2MB per sec.	1.2MB per sec.
Supported by system models	8000	8000	8000	8000	8000
Comments	—	—	—	—	—

▷ configuration has been expanded or reduced by the operator since the previous start-up, automatically reconfigures the operating system to match the resources available. The SSU contains a program-accessible system ID, a permanently assigned number which identifies the system in which the SSU is installed, which permits vendors of proprietary software packages control of what systems can run their packages by checking the system ID before executing.

The Computational Processing Unit is a microprogrammed processor which uses 32-bit architecture throughout. Integer arithmetic is 32 or 64 bits; floating-point arithmetic is 64 bits. Twenty-one addressing modes directly support compiler data structures, including stack, queue, array, and linked-list structures, with arbitrary size data elements. System computation is performed by one or more Computational Processing Units, operating concurrently. To gain more computational power, additional CPUs are plugged into the bus. The operating system software assigns tasks equally among available CPUs to achieve true concurrent processing. As an indication of the CPUs' speed, a fully-configured, multiple-CPU system performs floating-point multiplication with 64-bit operands in an average time of approximately three microseconds. Hardware address mapping in the CPU converts virtual memory addresses to physical memory addresses in parallel with instruction execution.

The BTI 8000 uses MOS (metal oxide semiconductor) memory with ECC (error-correcting code) and features a 670-nanosecond full cycle time (including Memory Control Unit operation). Read access time is under 900 nanoseconds. Memory is furnished in 1M-byte increments and is interfaced to the system via the MCUs. Minimum memory is 1M bytes, and the system will support up to 16M bytes of main memory. All memory present is treated by the system as an entity (even if interfaced through more than one MCU) organized in pages of 4096 bytes. In the event of a memory malfunction, the system eliminates the bad area on a page basis and reconfigures the available memory.

Mass storage for the BTI 8000 is provided by disk drives in formatted capacities from 67 to 254 megabytes. Drives are ▷

▶ system capacities, please refer to Chart A, System Comparison Chart.

CHECKING: The memory incorporates automatic checking of single- and double-bit errors, and correction of single-bit errors.

STORAGE PROTECTION: The memory management logic divides memory present into 4096-byte pages, while treating memory as an entity. Assignment of pages of physical memory to satisfy virtual memory page requests is controlled by the memory manager. Pages of memory exhibiting hard errors are automatically deleted from the pool of memory pages available. Battery backup supports memory for up to two hours.

RESERVED STORAGE: The system reserves approximately 10 to 30 pages (40K- to 120K-byte), depending on the system configuration, for memory management and other system operations.

CENTRAL PROCESSOR

GENERAL: The major resource modules and all peripheral controllers are special-purpose microprogrammed processors, which in turn use microcomputer-based submodules for many service functions. The foundation of the system is the Variable Resource Architecture (VRA) bus, a distributed-logic, passive, synchronous bus with a 32-bit wide data path and 16 slots for the attachment of major modules. All data transfers between major modules take place through the VRA bus at 67 nanoseconds per 32-bit word (15 million words per second or 60 million bytes per second).

The four major modules are the System Services Unit (SSU), the Computational Processing Unit (CPU), the Memory Control Unit (MCU), and the Peripheral Processing Unit (PPU). A system must include at least one of each, but no more than one System Services Unit is required. Additional CPUs, MCUs, and PPUs can be configured to the system to increase throughput and to provide fail-soft operation.

All resource modules automatically carry out self-tests at system start-up. On completion of its self-test, the SSU completes system start-up. If all modules are operative, the operating system is automatically configured to match the resources present. Faulty resource modules are identified with the aid of a front panel display. In multimodule configurations, faulty modules can be removed and the system restarted (one-button bootstrap).

The System Services Unit is internally cabled to the operator's panel. The panel contains a readout of 10 alphanumeric characters for reporting system status and exception conditions, an alarm light, and eight rocker switches. The switches include the main power switch, a switch to disable ▶

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CHART D. PRINTERS

MODEL	8420	8422	8425	8427
Type	Band	Band	Band	Band
Speed	300 lpm	220 lpm	600 lpm	440 lpm
Bidirectional printing	Not applicable	Not applicable	Not applicable	Not applicable
Paper size	Up to 15"	Up to 15"	Up to 15"	Up to 15"
Character formation	Full char.	Full char.	Full char.	Full char.
Horizontal character spacing (char./inch)	10	10	10	10
Vertical line spacing (lines/inch)	6 or 8	6 or 8	6 or 8	6 or 8
Character set	64	96	64	96
Controller/Interface	8415	8415	8415	8415
No. of printers per controller/interface	1	1	1	1
Printer dimensions, in. (h x w x d)	44.5 x 34 x 24"	44.5 x 34 x 24"	44.5 x 34 x 24"	44.5 x 34 x 24"
Graphics capability	None	None	None	None
Comments	—	—	—	—

▷ of both fixed and removable storage types. One disk controller can control up to four drives in any mix and can provide for overlapping seeks to minimize access times. A special error-correction technique substantially reduces the risk of data loss in the event of disk read problems. Mass storage data transfers take place one page at a time, and each page occupies one "block" of disk capacity. Blocks are stored on disk in a number of segments in such a way that an entire block can be reconstructed even if a segment becomes totally unreadable. The system "remembers" bad areas and dynamically reassigns block placements to work around them.

All system peripherals, including disk drives, are controlled by device controllers. Each Peripheral Processing Unit can support up to four controllers. Peripherals currently available for the BTI 8000 include serial magnetic tape cartridge drives, 9-track open-reel magnetic tape drives, and four line printers with print rates from 300 to 1200 lines per minute.

Terminals and modems are interfaced to the BTI 8000 through an Asynchronous Communications Controller (ACC), which is in turn controlled through a PPU channel. One PPU can control up to four ACCs, and each ACC can control up to 64 ports in increments of 8 ports. BTI considers a practical maximum for the 8000 system to be 200 ports. Any or all ports can be used at rates up to 19,200 bps. To allow users flexibility in the type of asynchronous terminal or other asynchronous device to be used with the system, user programs have full control over interface pins, selection of terminating characters, and input and output buffers.

Security mechanisms have been designed into the 8000 system, including its hardware, to enable the system to operate in a secure, multiuser, on-line environment. The account structure is closed and secure, in that all operations and data remain private within account boundaries, unless explicit action to grant foreign access is taken. All passwords required are stored in encrypted form only, and BTI claims there is no way to decrypt stored passwords. Users can share files on a read-only basis, can limit writing privileges to "append-only," or can grant full access to a file. On-line disk packs are not encrypted. A special recording format is used to provide security. ▷

▶ BTI remote maintenance access, a switch to select between normal start-up and dedicated diagnostic start-up, the run/halt switch, and four switches to select from 16 variations of start-up or diagnostic operation.

CONTROL STORAGE: Although the BTI 8000 CPU is microprogrammed, the user cannot modify control storage.

REGISTERS: Eight 32-bit general-purpose registers, a program counter, and a processor status register are available for machine-language programming.

ADDRESSING: Twenty-one addressing modes reference operands in registers, in memory, and instructions themselves. Addressing modes directly support compiler data structures, including stack, queue, and linked-list, with data elements of arbitrary size. Virtual to physical memory address conversion is performed in a one-bus cycle (67 nanoseconds) in parallel with instruction execution.

INTERRUPTS: Computational Processors present in the system configuration are subject to interrupts and traps, which are tracked by the VRM operating system.

Interrupts are generated primarily by I/O devices, and by the System Services Unit. Whichever Computational Processor is free first will pick up an interrupt. Traps (program exceptions) are generated by the user process running on a Processor, and direct the Processor to the appropriate trap routine.

OPERATING ENVIRONMENT: The nominal operating environment for the BTI 8000 system is 60 to 80 degrees F (15 to 27 degrees C) at 20 to 80 percent relative humidity, noncondensing.

A minimum configuration (2-bay cabinet) is 70.75 inches (179.7 centimeters) high, 48.5 inches (123.2 centimeters) wide, 32.75 inches (83.2 centimeters) deep, and weighs 715 pounds (324 kilograms).

An expanded configuration (3-bay cabinet) is 70.75 inches (179.7 centimeters) high, 71.0 inches (180.4 centimeters) wide, and 32.75 inches (83.2 centimeters) deep.

Power requirements for the BTI 8000 system are 200 to 250 volts AC, 60 Hz, single phase (50 Hz operation optional). For a base system, maximum AC power consumption is 4600 watts, and maximum heat dissipation is 16,000 BTUs per hour.

INPUT/OUTPUT CONTROL

I/O CHANNELS: Peripheral Processing Units (PPUs) are special-purpose processors which relieve CPUs of channel management overhead. Each PPU manages up to four independent I/O channel activities initiated by the CPUs, handling data transfers between memory and the peripheral devices. PPUs also provide buffering, blocking and deblocking capabilities. The PPUs' channels can be connected to ▶

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CHART D. PRINTERS (Continued)

MODEL	8430	8432	8435	8436
Type	Band	Band	Band	Band
Speed	900 lpm	660 lpm	1200 lpm	880 lpm
Bidirectional printing	Not applicable	Not applicable	Not applicable	Not applicable
Paper size	Up to 15"	Up to 15"	Up to 15"	Up to 15"
Character formation	Full char.	Full char.	Full char.	Full char.
Horizontal character spacing (char./inch)	10	10	10	10
Vertical line spacing (lines/inch)	6 or 8	6 or 8	6 or 8	6 or 8
Character set	64	96	64	96
Controller/Interface	8415	8415	8415	8415
No. of printers per controller/interface	1	1	1	1
Printer dimensions, in. (h x w x d)	44.5 x 34 x 24"	44.5 x 34 x 24"	44.5 x 34 x 24"	44.5 x 34 x 24"
Graphics capability	None	None	None	None
Comments	—	—	—	—

▷ The BTI 8000's operating system provides private virtual machine environments in which the system manager, operator, and all other users operate. The virtual system shields all users from the actual hardware present in any given configuration. Any program will execute regardless of the number of CPUs, amount of physical memory, or even the specific peripherals connected to the system. The user can make I/O assignments externally to the program to suit his or her convenience. The operating system is protected to ensure inviolate system operation despite any possibly harmful activities attempted by any user process or by the system operator. Each user program runs in a virtual work space of 512K bytes regardless of the actual amount of physical memory present or the number of other users sharing that memory. The operating system itself uses address space separate from the user's work space for all I/O services associated with the user's process.

Memory is organized in pages of 4096 bytes, all of which is available to the programmer. Real memory is dynamically allocated to users' processes on a demand-paged basis in a manner transparent to users. User processes can generate other concurrent processes to handle heavy work loads in parallel.

BTI has chosen not to develop application software, but reaches end-users requiring such software through an informal alignment of its computer systems with application software furnished by independent vendors. BTI offers a significant advantage to application software suppliers; protection for their software comparable to that of BTI's proprietary operating system. With their software protected by an exclusive "proprietary" screen initially set-up by BTI, vendors are able to install their software on BTI 8000 systems and can support their software over the telephone, much as BTI supports its own software.

Software emphasis is on the commercial DP market stressing data protection and on-line terminal access. Software bundled with the system includes the operating system, Control Mode (the system's command language), and the following utilities: copy, sort/merge, help, loader, spooler, backup/recovery, operator/manager, interactive editor, debugger, plus one programming language. Sequential, relative, and multiple-keyed indexed sequential file-access methods are supported. A file utility package (futil) is also provided as part of the bundled software. Languages ▷

▶ the controllers of the following peripherals: disk drives, 9-track magnetic tape drives, magnetic tape cartridge drives, line printers with speeds of 300 to 1200 lpm, and user communications facilities.

SIMULTANEOUS OPERATIONS: Up to eight PPUs can be configured to a BTI 8000 system providing an input/output capacity of 32 channels. All peripheral devices interfaced to the respective number of channels provided by the PPUs can be active simultaneously, accommodating multitasking operations.

CONFIGURATION RULES

GENERAL: Maximum configuration parameters for the BTI 8000 are as follows:

- Up to 16M bytes of main memory,

- Up to 8G bytes of on-line disk storage,

- Up to 32 channels for peripheral devices, and

- Up to 200 active ports for terminals and modems.

The 8000 is completely modular in configuration and is designed around a Variable Resource Architecture bus with a 32-bit wide data path and 16 slots for the attachment of major modules. At least one each of the four major modules (System Services Unit, Computational Processing Unit, Memory Control Unit, and Peripheral Processing Unit) must be included. Only one System Services Unit is necessary, but multiples of the other three may be attached as needed to increase memory size, to add peripherals, or to increase computational power.

Up to 16M bytes of main memory can be interfaced to the BTI 8000 via Memory Control Units (MCUs) with a single MCU controlling from 1M to 4M bytes of semiconductor memory. Additional memory is available in increments of 1M bytes. Memory is organized in pages of 4096 bytes. (Each MCU occupies one of the system's 16 basic module slots.) Memory connected to a given MCU must be of one type, but different MCUs can control different types of memory as BTI makes future memory offerings available.

WORKSTATIONS: Virtually any terminal with a standard RS–232–C interface can be used with the BTI 8000 system. Any modems with facilities for the RS–232–C interface can be used for remote applications. The BTI 8000 is capable of supporting up to 200 interactive users.

DISK STORAGE: The Model 8205 disk controller used in the BTI 8000 supports up to four drives, in any mix of capacities.

MAGNETIC TAPE: Nine-track, 800/1600-bpi, 45- and 75-ips reel-to-reel magnetic tape drives and a high-density cartridge tape unit can be configured to the BTI 8000 for loading and dumping data files and programs.

PRINTERS: One controller is required per printer for each printer configured to the BTI 8000 system. ▶

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CHART E. MAGNETIC TAPE EQUIPMENT

MODEL	8310	8330	8340
TYPE	Cartridge	Reel-to-reel	Reel-to-reel
FORMAT			
Number of tracks	4 (independent)	9	9
Recording density, bits per inch	6400	800/1600	800/1600
Recording mode	MFM	PE/NRZI	PE/NRZI
CHARACTERISTICS			
Controller model	Integral	8320	8324
Drives per controller	Max. 4	Max. 4	Max. 4
Storage capacity, bytes	15M	20M/40M	20M/40M
Tape speed, inches per second	30	45	75
Data transfer rate, units per second	192K	36K/72K	60K/120K
Streaming technology	None	None	None
Start/stop mode; speed	Not applicable	Not applicable	Not applicable
Switch selectable	—*	Yes	Yes

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

▷ offered by BTI include Cobol 74, Fortran 77, Pascal/8000, and BTI Basic (Basic–X).

COMPETITIVE POSITION

The major target markets for the BTI 8000 system are data processing departments requiring high processing response for up to 200 concurrent users working in Cobol, Fortran, Pascal, and Basic, and large database applications involving extensive multiuser access.

Since September 1983, BTI has been involved in an intensive planning and development program for marketing operations, with the aim of launching an extensive new marketing campaign for the 8000 system starting in August 1984. This major new marketing effort is intended to redress both a past history of marketing limitations which grew out of a predominantly research- and development-oriented organization, and, more specifically, the relatively low market profile of BTI's products engendered from the major cutbacks in marketing operations made necessary during the 1982 to 1983 period by significant cash flow problems.

With a major portion of past debt now successfully retired, BTI is "reentering" an ever-faster moving superminicomputer market characterized by stiff competition in the 8000 system's principal market areas of interactive transaction processing and high-response time concurrent-user technical and business data processing. The success of the 8000 system in the current superminicomputer market will to a significant extent depend on the accuracy, from the users' point of view, of BTI's claim for a substantial price/performance advantage in system configurations serving 60 to 200 users.

Major competition for the BTI 8000 is presented by other 32-bit superminicomputer systems and commercial applications-oriented minicomputer systems, in particular the Digital Equipment VAX-11/780 models, Hewlett-Packard 3000 Series models, Prime 50 Series models 750, 850, 9950, and Data General's MV/8000 and MV/10000 models, in their larger configurations. BTI's market for the 8000 system may also be increasingly impacted in the future by the growing number of fault-tolerant systems which, ▷

MASS STORAGE

For information on available mass storage devices for the BTI 8000, please refer to Chart B, Mass Storage Devices.

INPUT/OUTPUT UNITS

As a purchasing convenience to customers BTI offers, as options, a line of workstations manufactured by other vendors. Descriptive specifications for available workstations are usually presented in Chart C, Workstations, but the latter chart does not appear in this report at the request of the vendor. Readers are requested to contact BTI directly for information on currently available workstations.

For information on available printers please refer to Chart D, Printers. For information on available magnetic tape equipment please refer to Chart E, Magnetic Tape Equipment.

COMMUNICATIONS CONTROL

GENERAL: The BTI 8000, in its largest configuration, can support a practical limit of 200 interactive users.

The *8510 Asynchronous Communications Controller (ACC)* supports up to eight 8515 8-port (RS–232–C) interfaces for a maximum configuration of 64 ports. One Peripheral Processing Unit can control four ACCs (a total of 256 ports per PPU). Data rates can be set individually to any standard rate from 110 to 19,200 bps. The ACC includes internal buffering to accommodate full-screen (1920 characters), interactive terminals.

SOFTWARE

OPERATING SYSTEM: The BTI 8000 operating system pools and coordinates physical machine resources, including processors, to provide a secure environment for each user of the system. The operating system shields all users from actual hardware configurations, creating a virtual machine for each user process, and is itself protected from violation by user processes. It is also responsible for automating as much of the system operation as possible.

When the system is started, either from the operator's panel or through the remote maintenance facility, the System Services Unit sends a start signal through the bus, causing all units to run self-contained diagnostics. Upon successful completion of this first stage of system start, the first Computational Processing Unit to become ready temporarily takes over the system. It locks out other CPUs so that it can control system initialization, reads resident operating system code from a known location on the system disk volume into the low pages of physical memory, and then executes that code. This is the only circumstance in which one CPU assumes control of the system to the exclusion of other CPUs. ▶

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▷ although in many cases oriented toward very high volume, high-speed transaction environments, have system configuration characteristics that would allow them to serve the needs of many of the 8000 system's primary transaction-application environments.

ADVANTAGES AND RESTRICTIONS

The principal advantages of the BTI 8000 system are:

- A fail-soft Variable Resource Architecture with, in a multimode configuration, the loss of a processor or memory bank merely reducing the available resource pool, and one-button restart after operator replacement of faulty module(s).

- The ability to support a large number of concurrent users performing interactive tasks requiring fast system-response time.

- A hardware design that allows flexible expansion of the system configuration, without any change in operating or applications software.

- A software environment that, according to the vendor, affords exceptional security for operating software, individual user processes, and proprietary applications software.

- A vendor-claimed significant price/performance advantage in system configurations serving 60 to 200 users.

Additional advantages as reported by the users Datapro contacted include: responsive and effective maintenance service and troubleshooting technical support, easy system operation and reliable CPU and peripherals, and an outstandingly good operating system.

Aside from the desired improvements in programming language features and local-area maintenance response in certain geographical regions, the BTI 8000 users Datapro contacted had very little to report in the way of restrictions in the use of their systems. On the contrary, the users we talked with seemed, on the whole, to give the BTI 8000 an exceptionally strong vote of support in nearly every aspect they rated for their particular configuration/applications environments.

USER REACTION

Datapro contacted six BTI 8000 users in June 1984 from a list supplied by the vendor. One user had 1MB to less than 2MB and five users had 2MB to less than 4MB of memory configured on their systems. Two users had 100MB to less than 600MB and four users had 600MB to less than 1200MB of disk-storage capacity installed on their systems. Three users had from 6 to 15 and another three users had from 16 to 30 local workstations/terminals on site. One user had from 1 to 5, three users had from 31 to 60, and two users had over 60 remote workstations/terminals on their systems. Basic was the most-used programming language for three users, Basic and Pascal the most-used for another ▷

▶ When the other CPUs are unlocked, the system immediately enters its normal run mode. At the start, there are no users on the system (assuming a cold start), and all CPUs run that portion of the operating system code (from a fixed physical memory location) which investigates a task assignment table elsewhere in memory; at this point there will be no tasks, so all CPUs will go idle. When a device (particularly a communications controller) signals the beginning of what might be a user logon activity, the associated Peripheral Processing Unit places an interrupt signal on the bus. The first CPU to respond will handle the interrupt and post to the appropriate operating system tables.

In the steady state of system operation, when there are more processes than processors, each CPU requests an interrupt from the SSU (in varying intervals) after it "switches in" to any task to see if another task should be executed. Periodic interruption to run the operating system's task dispatching code does not require full context switching.

The memory tables used to direct and coordinate the activities of multiple CPUs are read and updated using software lockout. The lockout algorithms and the CPU instructions used to implement them are the same as those that the nonoperating system software can use to coordinate any set of cooperating simultaneous processes. A given memory location is chosen by mutual agreement to contain a "lock" word. Before proceeding through a critical region of code to be entered and executed completely by only one process at a time, the process executes a noninterruptible instruction that sets a special locked value into the public lock word while simultaneously bringing the previous value of that word into private storage for examination. If the retrieved value is other than locked, the process continues through the critical region, unlocking it when done. If, on the other hand, the retrieved value is locked, then the process waits, since this indicates that some other process has entered the critical region.

Even though memory modules can be physically interfaced through separate Memory Control Units, the system treats all of memory as a single continuous resource. The low $n+9$ pages ("n" is the number of resident CPUs) are unavailable for paging, since they contain resident operating system code and tables. The rest of memory is used on a page basis for temporary location of code and data transferred in from mass storage, with no preassigned boundaries or regions.

When a routine executing in a CPU instructs a PPU to transfer a page into memory from mass storage, the PPU is given two memory addresses. One is the location of the page itself; the other is the address of an operating system table element for storage of the structural information included in every mass storage block. In this way, programs can make use of the full 1024 words in every page, since pointers, flags, and other maintenance information are kept externally to the page contents. A similar procedure is used to write to disk.

The operating system keeps track of the logical status of all pages in memory, including their "home" addresses on mass storage. If a user requests execution of a program, the operating system will search its lists before executing a disk-read request and will take advantage of memory residency of any of the program pages to avoid disk access; any number of users can share any number of pages. This list searching takes place with every page-read request, including those for file data blocks.

Access control flags associated with each page indicate whether the page is read-only or writable, and, if writable, whether it has been altered during its residency. This information allows pages of writable program data or file data to be shared among multiple users. They will share the same physical memory page initially, but the operating system will create a private copy of a shared writable page for any process that issues an instruction that would alter the page contents. ▶

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user, Cobol and Pascal the most-used for another, and Basic and Fortran the most-used languages for the remaining user.

All six users described their companies as being in the service bureau industry. In addition, one company was also in the retail/wholesale industry; another was also in the computer software industry; and another company was also in the insurance, retail/wholesale, and agricultural industries. Two systems were being used for ticket services; one system was being used for accounting/billing, order processing/inventory, and job tracking; one system was being used just for accounting/billing; one system was being used for accounting/billing, insurance, order processing/inventory, payroll/personnel, sales/distribution, and finance; and one system was being used for accounting/billing and commercial applications. All six users employed in-house personnel to develop application programs; three users employed contract programming; and four users employed independent suppliers to acquire application programs. Five of the users acquired their systems by outright purchase, and one leased from a third party.

The six BTI 8000 system users we contacted rated their systems as shown in the table below. Only five users rated the BTI 8000 on compilers and assemblers, and only four users reported on ease of programming.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	4	2	0	0	3.7
Reliability of mainframe	4	1	1	0	3.5
Reliability of peripherals	4	2	0	0	3.7
Maintenance service:					
Responsiveness	5	1	0	0	3.8
Effectiveness	5	0	1	0	3.7
Technical support:					
Troubleshooting	5	1	0	0	3.8
Education	4	1	1	0	3.5
Documentation	4	0	2	0	3.3
Manufacturers software:					
Operating system	4	2	0	0	3.7
Compiler & assemblers	3	1	1	0	3.4
Application programs	NA	NA	NA	NA	NA
Ease of programming	1	3	0	0	3.3
Ease of conversion	5	1	0	0	3.8
Overall satisfaction	3	2	1	0	3.3

*Weighted Average on a scale of 4.0 for Excellent.
*NA = Not Applicable.

These BTI 8000 users were obviously very well pleased with their systems, as reflected in the ratings. Five of the users reported that delivery/installation of equipment was on schedule, and one user reported that it was ahead of schedule. Five of the users also reported that delivery of required software was on schedule, and one user reported that it was ahead of schedule. All six users said that the system configuration initially proposed by the vendor turned out to be what they needed. All six users also reported that it was either easy or very easy to keep up with and implement most vendor changes to hardware and software.

The access control and status flags, including a "page referenced" flag, are carried into the page files of the CPUs, so that the system need not make an extra memory reference merely to update or examine them. The page referenced flag is used to identify the working set of a process as it executes, for scheduling purposes.

The system is disk-based in the sense that structural information and operating parameters are ultimately entrusted to mass storage. Main memory is treated as a temporary area for process operation, with any structured or parameter changes written to disk. System restart presumes no information in memory. Thus the main concern in mass storage management is maintaining the integrity of its structures.

Disk drives, disk modules, and disk volumes (the logical contents of packs) are all identified separately, so that, for example, volumes can be copied from module to module. Files and libraries of files reside on individual mass storage volumes, so that volumes may be dismounted either logically . or physically without halting system operation or destroying the integrity of structures. The system volume, containing the operating system's operational tables and routines as well as other data, cannot be dismounted, but can be located on any physical disk drive in the system.

Internal system tables that are critical to operation or to the use of an entire volume are recorded redundantly in the interests of protecting operations and data. During a structural update, the more junior table is created first and removed last. Even relatively complex structures are handled in a crash-resistant manner by using the worst-case technique of creating an entirely new structure containing the new information and a copy of any previous information to be retained, updating the block that points to it, and finally freeing the old structure space.

Since the purpose of the BTI 8000 is to support many simultaneous processes, it is properly described as a multi-tasking system as well as a multiprocessor system. A "process" is the distinct invocation or separate execution of a program. Each process on the system is usually, but not always, associated one-for-one with an on-line interactive user. An interactive user process may generate other concurrent processes. Programs executed from batch queues are processes, and invocations of the operating system's routines are also processes.

The operating system creates a basically private, but identical, virtual machine for each process; one of its aspects is the process address space, or virtual memory. Any and every program on the BTI 8000 may be written to address a continuous virtual memory of 128 pages (512K bytes) as if it were the only program executing on a private computer with that much physical memory. The operating system creates and maintains the correspondence between each page of every process' virtual memory and some page in physical memory; this is what is loaded into a CPU's page file when a CPU runs a process.

Processes on the BTI 8000 may be running in some CPU; runnable, but waiting for a CPU to become available; or waiting for some other resource, including a page of virtual memory which is not yet resident in physical memory. Every process has all of its required virtual pages represented on blocks of a mass storage volume, but normally not all of them will be represented in physical main memory. When a running process references a virtual page that is not resident, as indicated by the page file, the process becomes suspended and the operating system assumes the responsibility of loading the page from mass storage into some page of physical main memory.

Three characteristics of this technique should be noted. First, the pages of a given process may be placed anywhere in paged memory. Second, a memory page that the operating system chooses to overlay with a new page will not first be written back to disk if it has not been altered since it was

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▷ On the negative side, two users were looking for more powerful and/or more up-to-date features in the versions of the standard programming languages supplied by BTI. One user cited a lack of responsiveness in technical support and a need for improvement of local-area maintenance service. □

▶ loaded in from disk. Third, frequently referenced pages, including pages referenced by more than one process, tend to remain resident, since the operating system's replacement algorithm tries to minimize disk access.

Demand-paging systems normally operate with a least-recently used replacement algorithm; that is, the page chosen for overlaying is that which has "aged" the longest since being referenced by any process. This algorithm is entirely reasonable with a moderate load on a system, but invites "thrashing" when the load grows too large. The pages used by a given process during a specified period of time are its working set for that period. In a demand-paging system, the relationship between the total pages required to hold all active working sets and the total number of memory pages available determines the amount of disk activity on the system. As the page load grows, disk transfers become more frequent until all processes are reduced to their minimum working sets, below which they are incapable of executing any instructions without demanding a new page. Thereafter, any increase in load causes the system to spend almost all of its time in disk transfers. At this point, essentially no work is performed.

The BTI 8000 modifies the conventional demand-paging algorithm to prevent thrashing. When a demand occurs, the operating system selects the "least valuable process," based on a number of criteria, including the distinction between interactive and batch processes, and strips this process of the least recently used page of its working set, overlaying that memory page with the one demanded. As the overall load grows, this procedure is repeated until all processes are reduced to working sets close to minimum. At this stage, *prior to the thrash point*, the operating system identifies the process that is the most critical "troublemaker"—normally the one with the largest current working set. It then suspends this process for a certain period of time, rolling out its entire working set to free up memory for the rest of the load. The BTI 8000 process management algorithm avoids thrashing by making a dynamic transition from demand-paging to a modified multiprogramming technique.

There are no preset, conventional priorities in this scheduling technique, although the system operator can modify certain scheduling parameters (e.g., to favor batch processing). The operating system automatically favors processes that are currently interactive on the assumption that a user at a terminal requires service as soon as possible after entering a message. Processes that are not currently interactive can relinquish their demands for system resources, including CPU's, in favor of interactive processes, although a "fairness" algorithm ensures that batch processes are not totally locked out of execution. Process scheduling operates with dynamic priorities according to the recent behavior and current characteristics of the processes. On a heavily loaded system, with all other considerations equal, the most efficiently written programs—those with compact working sets—will be favored for execution over potential troublemakers.

DATABASE MANAGEMENT SYSTEM: The BTI 8000 *File Management System (FMS)* supports indexed (ISAM) files and relative files. FMS services may be utilized for both indexed and relative files through BTI 8000 Pascal/8000 and BTI 8000 Cobol, and for relative files through BTI 8000 Fortran (Fortran 77). The transaction control features of FMS allow a user to lock a group of files or objects within files during a transaction, to ensure that other on-line users cannot impact or be influenced by a file update.

FMS is complemented by the *Interactive File Manager (IFM)* utility which provides direct access to all services of FMS. IFM is used primarily for specific tasks such as copying and loading files, where the performance of the task programmatically would be less efficient.

LANGUAGES: The BTI 8000 supports four programming languages: Cobol 74, Fortran 77, Pascal/8000, and BTI Basic (Basic-X). All four have the following concepts in common:

• Program development may occur in an interactive mode. Programs may be written, compiled, and linked from a terminal, and test files can be defined, built, and dumped from a terminal. Programs can be tested at a terminal with the aid of an interactive, symbolic level debugging facility.

• All languages support terminals as standard I/O devices. A terminal can be accessed by the operating system without special telecommunications software.

BTI 8000 Cobol is a high-intermediate implementation of the 2 ANSI Cobol X.3.23–1974 standard. An interactive Debug replaces the standard Debug module. It also includes full indexed I/O support, transaction handling, and an extended ACCEPT and DISPLAY for terminal handling.

BTI 8000 Fortran is a full implementation of Fortran 77, ANSI standard Fortran X3.9–78. This language allows the programmer to concentrate on the algorithm instead of its implementation. Support of upper-/lowercase symbolic data names is one of the language's features. Debugging statements (identified by a "D" in column 1) can be included in the compilation or interpreted as remarks, depending upon a selected compiler option. A fully interactive debugging facility aids in program test and verification.

BTI 8000 Fortran places the full power of the operating system in the hands of the programmer through the use of extended I/O facilities. Files may be created, attached, interrogated, and destroyed under program control using the OPEN, CLOSE, and INQUIRE statements. Data transfer to and from files may be formatted, unformatted, or list-directed. Files may be direct access or sequential and may contain variable length records. In addition, data may be transferred to and from character strings by using statements which are similar to regular I/O statements. Character strings may be concatenated and assigned to variables. Strings may be compared with other strings. Substrings may be extracted with a convenient subscript-like notation. Numeric data types (Real, Integer, and Complex) have over 15 digits of significance; Double Precision Real supports 34 digits of significance. Variables of any type may be subscripted, and an array may have up to seven dimensions with no restrictions on upper and lower bounds.

BTI 8000 Fortran extends the ANSI Fortran 77 standard with the following features:

• Debugging statements can be easily eliminated for compilation of production program version.

• Array subscript and computed GO TO expressions of real, double precision, or integer type.

• Interactive debug support.

• Symbolic names, 1 to 30 characters in length, in upper- and lowercase.

• Subexpression optimization.

• Variable length record I/O support.

BTI 8000 Pascal/8000 includes all the features of standard Pascal, and is a valid superset of standard Pascal. The BTI 8000 Pascal/8000 adds the following features to standard Pascal: ▶

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▶ • Full support for string data type.

• Loop state allows the user to accomplish repetition and decision in the same statement.

• Support of multikeyed indexed sequential and relative file access methods.

• Case labels arranged in ranges.

• Compile-time expression evaluation for "CONST" declarations.

• Spawning and management of concurrent processes, and generation and control of underprograms.

• An interprocess communication capability.

BTI Basic (Basic–X) is an extended version of Dartmouth Basic with many added features for improved file handling, matrix and string operations, and user interface facilities. Application programs written in Basic–X for BTI 5000 systems may be transported directly to the BTI 8000.

COMMUNICATIONS: The *EMIBM* utility is an IBM 2780/3780 terminal emulator that provides system-to-system communication between a BTI 8000 and a system using the IBM 2780/3780 communications protocol. Using EMIBM, a BTI 8000 may act as a remote job entry station to an IBM mainframe, or it may serve as a host to an IBM 2780 or 3780 terminal or emulator. In either case, both files and operator messages can be transferred between the two systems.

COMM is the BTI 8000 asynchronous communications utility. It allows a BTI 8000 to communicate with any other system that supports asynchronous ASCII terminals. It can also be used to transfer files between two BTI 8000 systems. COMM has a terminal pass-through mode that enables a user to work at a terminal as if it were connected directly to another computer.

PROGRAMMING AIDS/UTILITIES: *EDIT/8000* is a line-oriented editor for the input and editing of programs, data files, and files of Control Mode (system command language) commands to be executed as DO files or batch sessions.

SCREDIT is a versatile screen editor which allows data to be entered and modified in either a screen-oriented or line-oriented mode. It may be used for creating or editing programs, data files, and DO files to be run as batch sessions.

The BTI 8000 *DEBUG* utility permits interactive debugging of Cobol, Fortran, and Pascal programs, by specifying execution breakpoints and tracepoints, and displaying the values of memory locations. Execution may be traced either at the source statement level or at the machine instruction level. DEBUG permits single-stepping through a program, executing one source statement or machine instruction each time, or running the program at normal speed and stopping only at breakpoints.

The *HELP* utility allows the user to access the information in on-line HELP files provided for all BTI-supplied programs and commands. HELP information is organized into topics and subtopics, and may be examined by following the outline structure for a given topic, or searched by inputting keywords associated with the desired subject.

The *HELPMAKE* utility enables users to create their own HELP files, which may then be read with the HELP utility.

SYSTEM USER UTILITIES: The *LINK* utility is used to link-edit object modules produced by the compilers into a runnable program. Options are provided to allow the user to

include only the modules needed to execute a program. Through LINK, the user may request a memory-allocation map and external symbol table, which are useful in using the high-level language DEBUG utility.

The *SORT/MERGE* utility consists of two programs, SORT and MERGE, which provide the capability to sort and/or merge records from up to 32 input files to produce sorted data on a single output file. Up to 16 sort or merge keys, each with its own collating sequence, may be defined.

The *COPY* utility creates a duplicate of a single random access file, code file, or sequential access file, or concatenates data from up to 32 sequential access files to a single sequential access file. Subfiles within a sequential access file may be copied selectively, and data may be appended to the end of a sequential access file.

With the *VIEW* utility, the user can display all or part of the contents of a sequential access or random access file, or a program compiled-code file.

The *Object Binary Manager* utility permits a user to display the names and compilation dates of object modules produced by the compilers in a binary file, and to rename, update, move, or delete such modules.

The *COMPARE* utility compares the contents of two files of like type.

The *CONVERT* utility is a specialized copy program which permits converting specified fields in the input records from one data format to another. It also allows blocking and deblocking of records, and the use of declared fields to select specific input records to be written to the output file. Format conversions possible are: ASCII to and from EBCDIC; packed decimal with trailing sign to and from leading sign; packed decimal with trailing sign to and from ASCII; and 32-bit integer to and from 8-, 16-, and 24-bit integer formats.

OFFICE AUTOMATION: The *MAIL* utility provides a vehicle for users of a BTI 8000 to send messages to and receive messages from other users of the system. Messages are sent and received through personal "mail boxes." Access to each box can be controlled by specifying who is allowed to read messages from it, who is allowed to write messages to it, and who can delete messages from it or change its attributes. Users can also place messages on "bulletin boards" for general attention.

TEXT8 is a powerful document editing and formatting system. It may be used by writers, programmers, and other users for creating, editing, and formatting letters, reports, manuals, programs, and other kinds of documents. A line-oriented editor, TEXT8 provides commands to add, insert, replace, delete, modify, duplicate, split and join text lines, and change selected character strings within lines. Lines may be moved within the work file, and lines from other files may be copied into the work area. Documents can be displayed and printed in almost any format. Functions include line indention, justification, underlining, spacing, boldface printing, tabs, and centering. Page headers and footers can be included. Words and phrases can be flagged for automatic inclusion in the document index, and headings similarly included in the table of contents.

The *MAILER* system compiles, maintains, and prints mailing lists and mailing labels. In combination with TEXT8, MAILER also produces personalized form letters. Entries may be sorted and listed by name, company, or zip code, and may be selected for mailing labels by name, zip code, last response date, or class code.

APPLICATION SOFTWARE: BTI does not generate ▶ applications software, but assists in the marketing of

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▶ selected user-generated packages. A unique feature of the BTI operating system permits applications software to be installed on a system where it may be used in the execute-only mode by the system owner. It can, however, be accessed for updates and maintenance by the software vendor through a special "proprietary software account." Under this feature, the system owner and users are permitted access to the program and to all system management privileges except the proprietary source code. The vendor, however, given telephone access to the proprietary software, can update and correct the package without the need of sending copies or interrupting users.

PRICING

POLICY: BTI offers the 8000 system on a purchase-only basis. The base system configuration is complete and includes the operating system, Control Mode, the utilities package, a file system, and one programming language. BTI warrants all hardware for 90 days. Software is licensed for use on one system, but discounts are offered for multiple installations by one customer. BTI-furnished software is maintained free for one year, and continuing maintenance is available on a yearly contract basis. Upgrades of BTI software are offered for a nominal handling fee to customers using the existing software. The BTI 8000 is not listed on the GSA schedule.

SUPPORT: BTI features a unique customer-participation service and support system that combines human resources and hardware features of the 8000 system. The 8000 contains integrated maintenance aids for automatic fault diagnosis by a remote computer located at BTI's factory service center. BTI customer engineers can gain access to the operating system through a user port and exercise various system components. Customer cooperation, in the form of a person standing by the system to perform specified actions, may be required to aid the BTI engineer in testing and evaluating a failed system. The customer's responsibility to provide such assistance is noted in BTI's corrective maintenance contract.

Under the contract terms, BTI furnishes both parts and labor to correct all failures and to provide 7-day, 24-hour telephone service. Replacement parts are shipped from the factory or one of BTI's regional parts banks by air freight, scheduled airline, or package express service to users, who replace them and return the failed parts. A BTI field engineer is dispatched from Sunnyvale or from a regional office to any site where telephone consulting and testing cannot correct the malfunction.

BTI Corrective Maintenance Plan charges are based on the hardware configuration. Typical monthly charges covering both preventive and corrective maintenance are less than one percent of the purchase price.

TRAINING: System purchase prices include training by BTI personnel. Customer training for the BTI 8000 consists of a two-week course covering user familiarization, and system management and operation.

The first week is devoted to system features and use, and is suitable for persons already fluent in a high-level programming language (Cobol, Fortran, Pascal, or Basic). Students learn how to design, write, and debug terminal-oriented programs using Control Mode and other BTI-user software facilities. Approximately half of this section of the course is hands-on instruction.

The second week addresses system management and operations. Subjects covered include resource allocation and account structure, showing how account structures are set-up to fit the needs of individual installations. Students learn machine room operations, including how to establish proper backup procedures.

Purchase of a system includes attendance for two students. The charge, per person, for additional students is $1,500.

TYPICAL CONFIGURATIONS: Typical small, medium, and large BTI 8000 systems can be configured as follows:

Small BTI 8000 System Configuration

8110	Computational Processing Unit	$ 16,000
8130	Memory Control Unit	8,000
8170	Peripheral Processing Unit	10,000
8190	System Services Unit	8,000
8144	1MB Memory Module, two @ $14,000	28,000
8154	Memory Power Supply	8,000
8205	Disk Controller	10,000
8230	67MB Fixed Storage Disk Drive	11,500
8232	67MB Removable Storage Disk Drive	13,500
8310	Cartridge Magnetic Tape Controller and Drive	7,000
8320	Magnetic Tape Controller	5,000
8330	9-track, 45-ips Magnetic Tape Drive	9,000
8510	Asynchronous Communications Controller	8,000
8515	8-port Interface, four @ $3,000	12,000
8810	System Cabinet, Operator Panel, Power Supply	6,500
TOTAL		**$160,500**

Medium BTI 8000 System Configuration

8110	Computational Processing Unit, two @ $16,000	$ 32,000
8130	Memory Control Unit, two @ $8,000	16,000
8170	Peripheral Processing Unit, two @ $10,000	20,000
8190	System Services Unit	8,000
8144	1MB Memory Module, three @ $14,000	42,000
8154	Memory Power Supply, two @ $8,000	16,000
8205	Disk Controller	10,000
8230	67MB Fixed Storage Disk Drive, two @ $11,500	23,000
8232	67MB Removable Storage Disk Drive	13,500
8310	Cartridge Magnetic Tape Controller and Drive	7,000
8320	Magnetic Tape Controller	5,000
8330	9-track, 45-ips Magnetic Tape Drive	9,000
8415	Line Printer Controller	5,000
8425	600-lpm Line Printer	13,300
8510	Asynchronous Communications Controller	8,000
8515	8-port Interface, eight @ $3,000	24,000
8810	System Cabinet, Operator Panel, Power Supply	6,500
TOTAL		**$258,300**

Large BTI 8000 System Configuration

8110	Computational Processing Unit, three @ $16,000	$ 48,000
8130	Memory Control Unit, three @ $8,000	24,000
8170	Peripheral Processing Unit, two @ $10,000	20,000
8190	System Services Unit	8,000
8144	1MB Memory Module, six @ $14,000	84,000
8154	Memory Power Supply, three @ $8,000	24,000
8205	Disk Controller	10,000
8225	254MB Removable Storage Disk Drive, two @ $30,000	60,000
8310	Cartridge Magnetic Tape Controller and Drive	7,000
8324	Magnetic Tape Controller	5,000
8340	9-track, 75-ips Magnetic Tape Drive	14,000
8415	Line Printer Controller	5,000

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➤	8435	1200-lpm Line Printer	27,600	8810	System Cabinet, Operator Panel, Power Supply	6,500
	8510	Asychronous Communications Controller, two @ $8,000	16,000	8815	Cabinet Extension	3,000
	8515	8-port Interface, 24 @ $3,000	72,000		**TOTAL**	**$434,000**

EQUIPMENT PRICES

		Purchase Price ($)	Monthly Maint. ($)
BASE SYSTEM			
8000	Includes Computational Processing Unit, Memory Control Unit, 512K bytes of memory, Peripheral Processing Unit, 67M-byte disk drive and controller, 10M-byte magnetic tape cartridge drive and controller, asynchronous communications controller, 8-port interface, System Services Unit, double-bay system cabinet with bus backplane, operator control panel, and system power supply	110,000	827
SYSTEM RESOURCE MODULES			
8110	Computational Processing Unit (CPU)	16,000	96
8130	Memory Control Unit (MCU)	8,000	30
8170	Peripheral Processing Unit (PPU)	10,000	48
8190	System Services Unit (SSU)	8,000	30
MEMORY			
8144	Memory module, 1M bytes of semiconductor memory	14,000	210
8154	Memory power supply, supports up to 2M bytes of one MCU	8,000	56
MASS STORAGE			
8205	Disk controller for all drives listed below; supports up to four drives, in any combination	10,000	60
8215	67M-byte (14-inch) removable storage drive	13,500	135
8225	254M-byte (14-inch) removable storage drive	30,000	300
8230	67M-byte (8-inch) fixed storage drive	11,500	115
8232	67M-byte (8-inch) removable storage drive	13,500	135
8234	135M-byte (8-inch) fixed storage drive	17,000	170
MAGNETIC TAPE EQUIPMENT			
8310	Magnetic tape controller, tape-drive housing, one tape cartridge drive	7,000	72
8315	Additional tape cartridge drive; installs in 8310 module (up to three additional drives can be installed)	2,650	36
8320	Magnetic tape controller for up to four 8330 drives	5,000	30
8330	45 ips, 9-track, reel-to-reel magnetic tape drive, 800/1600 bpi	9,000	120
8324	Magnetic tape controller for up to four 8340 drives	5,000	30
8340	75 ips, 9-track, reel-to-reel magnetic tape drive, 800/1600 bpi	14,000	150
PRINTERS			
8415	Line-printer controller; supports any one printer listed below	5,000	30
8420	Line printer, 300 lpm, 64-character set	10,300	125
8422	Line printer, 220 lpm, 96-character set	10,300	125
8425	Line printer, 600 lpm, 64-character set	13,300	163
8427	Line printer, 440 lpm, 96-character set	13,300	163
8430	Line printer, 900 lpm, 64-character set	19,000	234
8432	Line printer, 660 lpm, 96-character set	19,000	234
8435	Line printer, 1200 lpm, 64-character set	27,600	340
8436	Line printer, 880 lpm, 96-character set	27,600	340
COMMUNICATIONS			
8510	Asynchronous communications controller, supports up to eight 8515 8-port interfaces	8,000	48
8515	8-port interface, EIA RS–232–C, at rates to 19.2K bps	3,000	12
ACCESSORIES			
8815	Cabinet extension (extends 8810 cabinet to triple-bay and larger configurations)	3,000	—
8816	Side cover	800	—
8850	System power supply (one included in 8810 cabinet furnished with base system)	3,000	30 ➤

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➤ ## SOFTWARE PRICES

		License Fee* ($)
8911	PASCAL/8000, on reel-to-reel tape	5,000
8912	PASCAL/8000, on cartridge tape	5,000
8921	ANS 77 FORTRAN, on reel-to-reel tape	5,000
8922	ANS 77 FORTRAN, on cartridge tape	5,000
8941	ANS 74 COBOL, on reel-to-reel tape	5,000
8942	ANS 74 COBOL, on cartridge tape	5,000
8951	BASIC–X, on reel-to-reel tape	5,000
8952	BASIC–X, on cartridge tape	5,000

*Discounts are offered for multiple installations by one customer.   ■