

BTI 8000

MANAGEMENT SUMMARY

UPDATE: BTI has split the BTI 8000 product line into two models since we last updated this report. Previously, the BTI 8000 consisted of one model, the BTI 8000/100, with 16 slots. Additions to the line include another model, the 8000/50, which includes six slots. Except for the different number of slots and different memory and disk capacities, the two models are similar in design.

The BTI 8000 is targeted for database applications with extensive multiuser access requirements and for data processing departments which require high processing response times. Modular in design, the BTI 8000 system permits expansion and configurability, allowing users to add memory, processors and peripherals as needed. The BTI 8000 also boasts reduced downtime, due to its system architecture. The BTI 8000 system consists of two models, the Series 100 and the Series 50. The Series 100 supports a 16-slot bus while the Series 50 is a six-slot version of the same machine. Except for differing memory and disk storage capacities, the two models are similar.

The BTI 8000 is based on a 32-bit, 67-nanosecond bus serving multiple processors, controllers for main memory modules, a System Services Unit (SSU), 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 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 BTI 8000 is a 32-bit, multiprocessor, multiuser, and multifunction system. Modular in configuration, the 8000 is designed around a central bus with a 32-bit-wide data path and six or 16 slots for plug-in attachment of system resource modules. The system is capable of supporting as many as 256 interactive users, and provides a high level of security for users in a timesharing environment.

MODELS: 8000/100, 8000/50.
MEMORY: 2M to 24M bytes.
DISK CAPACITY: Up to 8.9G bytes.
WORKSTATIONS: Up to 256 (interactive).
PRICE: Basic system packages—\$54,950 to \$89,950.

CHARACTERISTICS

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

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 from one 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).



The BTI 8000 is a 32-bit multiprocessor packaged system designed to support up to 256 interactive users in a multilanguage, multifunction environment. The system, which is modular in configuration, can also support up to 24MB of main memory and 8.9GB of disk storage.

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CHART A. SYSTEM COMPARISON

MODEL	BTI 8000/50	BTI 8000/100
SYSTEM CHARACTERISTICS		
Date of introduction	1986	May 1980
Date of first delivery	—	June 1981
Operating system	8000-VRM	8000-VRM
Upgradable from	BTI 6000	BTI 6000
Upgradable to	—	Not applicable
MIPS	1.0 to 3.5	1.0 to 3.5
Relative performance	Not applicable	Not applicable
MEMORY		
Minimum capacity, bytes	2M	2M
Maximum capacity, bytes	16M	24M
Type	ECC-MOS	ECC-MOS
Cache memory	None	None
Cycle time, nanoseconds	401	401
Bytes fetched per cycle	4	4
INPUT/OUTPUT CONTROL		
Number of channels	Max. 32	Max. 32
High-speed buses	32-bit	32-bit
Low-speed buses	Not applicable	Not applicable
MINIMUM DISK STORAGE		
	64MB	64MB
MAXIMUM DISK STORAGE		
	1.9GB	8.9GB
NUMBER OF WORKSTATIONS		
	64	256
COMMUNICATIONS PROTOCOLS		
	RS-232-C asynchronous	RS-232-C asynchronous

➤ The system's computational power, memory, and I/O resources are automatically pooled for efficient processing of the overall work load. 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 system (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 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 on the Series 100, and up to six resource modules on the Series 50, can be plugged into the bus. In addition to the CPU, MCU, and PPU modules, the system requires one 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 ➤

➤ **INSTRUCTIONS:** Machine instructions are all one word in length and reside on memory word boundaries; there are 174 machine instructions. The lowest 22 bits of most instructions specify an operand, while the next three 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 401 nanoseconds, including two bus transfers (read request and response) and byte parity check. Write time is 267 nanoseconds.

CAPACITY: Minimum memory is 2M bytes and is increased in 2M-byte increments to a maximum of 24M bytes. Refer to Chart A for the memory capacities of specific models.

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 ➤

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▶ 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 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 that identifies the system in which the SSU is installed. This permits vendors of proprietary software packages to have control of what systems can run their packages by checking the system ID before executing.

The Computational Processing Unit is a microprogrammed processor that 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.

The BTI 8000 uses MOS (metal oxide semiconductor) memory with ECC (error-correcting code). Memory is furnished in 1M-byte increments and is interfaced to the system via the MCUs. Minimum memory is 2MB, and the system will support up to 24MB 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.

Mass storage for the BTI 8000 is provided by disk drives in formatted capacities from 67MB to 279MB. Drives are 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. The Series 100 supports 32 disk drives, for up to 8.9GB of disk storage. The Series 50 supports up to eight disk drives, for up to 1.9GB of disk capacity.

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 1,200 lines per minute.

Terminals and modems are interfaced to the BTI 8000 through an Asynchronous Communications Controller ▶

▶ 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-bytes), 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 six or 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 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 (program exceptions), 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 are generated by the user process running on a Processor and direct the Processor to the appropriate trap routine. ▶

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CHART B. MASS STORAGE

MODEL	8230	8232	8234
Type	8" fixed	8" removable	8" fixed
Controller model	8208	8208	8208
Drives per subsystem/controller	1 to 4	1 to 4	1 to 4
Formatted capacity per drive, megabytes	67	67	135
Number of usable surfaces	5	5	10
Number of sectors or tracks per surface	3,292 tracks	3,292 tracks	3,292 tracks
Bytes per sector or track	4096 per track	4096 per track	4096 per track
Average seek time	35 ms	30 ms	30 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms
Average access time	43.3 ms	38.3 ms	38.3 ms
Data transfer rate	1.2MB per sec.	1.2MB per sec.	1.2MB per sec.
Supported by system models	8000/100, 8000/50	8000/100, 8000/50	8000/100, 8000/50

CHART B. MASS STORAGE (Continued)

MODEL	8236	8215	8225
Type	8" fixed	14" removable	14" removable
Controller model	8208	8208	8208
Drives per subsystem/controller	1 to 4	1 to 4	1 to 4
Formatted capacity per drive, megabytes	279	67	254
Number of usable surfaces	—	5	19
Number of sectors or tracks per surface	3,292 tracks	3,292 tracks	3,292 tracks
Bytes per sector or track	4096 per track	4096 per track	4096 per track
Average seek time	20 ms	30 ms	30 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms
Average access time	28.3 ms	38.3 ms	38.3 ms
Data transfer rate	—	1.2MB per sec.	1.2MB per sec.
Supported by system models	8000/100, 8000/50	8000/100, 8000/50	8000/100, 8000/50

➤ (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 of ports to be 256 for the 8000/100 system, and 64 for the 8000/50. 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, online 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. Online disk packs are not encrypted. A special recording format is used to provide security.

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 possible ➤

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

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

An expanded three-bay cabinet configuration is 70.75 inches (179.7 cm) high, 71.0 inches (180.4 cm) wide, and 32.75 inches (83.2 cm) deep. A four-bay system is the same height and depth as the three-bay configuration, but is 22.5 inches wider, for a total width of 93.5 inches.

Power requirements for the BTI 8000 system are 200 to 250 VAC, 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

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. PPU's also provide buffering, blocking, and deblocking capabilities. The PPU's channels can be connected to the controllers of the following peripherals: disk drives, 9-track magnetic tape drives, magnetic tape cartridge drives, line printers with speeds of 300 to 1,200 lpm, and user communications facilities.

Up to eight PPU's 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 PPU's can be active simultaneously, accommodating multitasking operations. ➤

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▷ 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 online 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, and debugger, plus one programming language. Sequential, relative, and multiple-keyed indexed sequential file-access methods are supported. A file utility package is also provided as part of the bundled software. High level languages offered by BTI include Cobol 74, Fortran 77, Pascal/8000, and BTI Basic (Basic-X). There is also an assembler.

COMPETITIVE POSITION

BTI competes with a number of other 32-bit systems, including Digital Equipment Corporation's VAX line, Hewlett-Packard's 3000, Prime's 50 Series, and Data General's MV systems. With its Variable Resource Architecture, which is not affected by a component malfunction that would bring the system down on a traditional mini-computer system, the BTI 8000 also competes indirectly with fault-tolerant vendors.

In this arena, the BTI 8000 system could compete with a low-end, fault-tolerant vendor such as Parallel Computers, Inc. Although Parallel is a true fault-tolerant vendor and BTI is not, still, the two systems do share common ground. Both systems are targeted to environments that require "company critical" applications and can accept very little system downtime. Both the BTI system and Parallel systems are priced under \$100,000, and both can serve as general-purpose data processing machines with effective system response time.

► CONFIGURATION RULES

GENERAL: The BTI 8000 system is divided into two models, the 8000/100 and the 8000/50. The 8000/100 includes a 16-slot bus while the 8000/50 includes a six-slot bus. Except for the difference in the number of slots, the two models are similar in design. The 8000 is modular in configuration and is designed around a Variable Resource Architecture bus with a 32-bit-wide data path and six or 16 slots for the attachment of major modules. At least one each of the four major modules (SSU, CPU, MCU, and PPU) 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 24M bytes of main memory can be interfaced to the BTI 8000 via MCUs with a single MCU controlling from 2M to 8M bytes of semiconductor memory. Additional memory is available in increments of 2M bytes. Memory is organized in pages of 4096 bytes. (Each MCU occupies one of the system's 6 or 16 basic module slots.)

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 8000/100 is capable of supporting up to 256 interactive users. The 8000/50 supports up to 64 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 on the BTI 8000 system.

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; however, Chart C 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 8000/100, in its largest configuration, can support a practical limit of 256 interactive users.

The 8510 Asynchronous Communications Controller (ACC) supports up to eight 8515 eight-port (RS-232-C) interfaces for a maximum configuration of 64 ports. One PPU 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 (1,920 characters), interactive terminals.

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► ADVANTAGES AND RESTRICTIONS

One of the major advantages of the BTI 8000 is its fail-soft Variable Resource Architecture. The failure of a processor or memory board will not halt the system; rather, the available resource pool is reduced and traffic is routed away from the failed component. This provides the user with a system that will suffer less downtime, and be more reliable in general than a system where a failed component brings the entire system down.

Another advantage of the BTI 8000 system is its modular expandability. The system is designed for flexible expansion and reconfigurability, enabling a user to start out with a small installation and add memory, processors, and peripherals as needs dictate.

This expansion is limited, however. Since the BTI 8000 is not a member of a compatible family of systems, like many of its competitors, there is no clear migration path to follow should a user outgrow the system parameters. While 24MB of main memory, 8.9GB of disk storage, and support for 256 terminals is quite sufficient for many installations and applications, the BTI systems are still considered limited for upgradability.

USER REACTION

We received no BTI 8000 responses in Datapro's 1986 Computer Users Survey. However, we contacted two BTI 8000 users from a list supplied from the vendor in September 1986 to obtain assessments of their computer systems.

The first user we contacted by telephone was the data processing manager of a college located in the Southwest. Before buying the BTI 8000 Model 100, the manager considered the Hewlett-Packard 3000 Series and Prime 50 Series. The BTI system was selected because of its basic architecture and its expandability. And, expandability was one of the system highlights the user noted about the 8000. In addition, other pluses about the 8000 included scant downtime and, "an easy to handle machine." Drawbacks to the system included the lack of a manufacturer-offered database and lack of vendor-supplied software in general for the system. But, the user noted the school developed its own database program that runs effectively on the 8000. Another problem encountered with the system was documentation; the manager said it was weak, and slow in coming. Overall, though, the user highly recommended the BTI 8000, noting the college supports over 600 users on the system. They have had it for five years and plan on keeping it another three to five years.

The second user we contacted was the president of a timesharing company located on the West Coast. He had considered systems from Digital Equipment Corporation and Hewlett-Packard before buying the 8000. He selected the 8000 based on its reliability and good dollar value. While the user said he has encountered no major drawbacks with the system, he would like to see BTI include bulk RAM memory, that is, bulk memory that acts like a ►

► 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.

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 stage of system start, the first CPU 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.

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 PPU 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.

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.

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. ►

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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	Full	Full	Full
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			
Graphics capability	None	None	None	None

CHART D. PRINTERS (Continued)

MODEL	8430	8432	8435	8436
Type	Band	Band	Band	Band
Speed	900 lpm	660 lpm	1,200 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	Full	Full	Full
Horizontal character spacing (char./inch)	10	10	10	10
Vertical line spacing (char./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			
Graphics capability	None	None	None	None

➤ disk drive, to the system. This user described the 8000 as a great machine, endorsing it for prospective customers needing a system that offered reliability and remote diagnostics. □

➤ 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.

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.

DATABASE MANAGEMENT SYSTEM: BTI offers the *MARS II* relational database management system and application development system for the BTI 8000 system. With *MARS II*, database creation is reduced to defining the groupings of data, called datasets or tables.

Provided with *MARS II* is the *COMP* fourth-generation language. *COMP* can accelerate application and maintenance by a ratio of 4 to 1 over high-level languages, according to BTI. Pre-coded modules and command sequences permit rapid prototyping of new applications.

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 online 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 high-level programming languages: Cobol 74, Fortran 77, Pascal/8000, and BTI Basic (Basic-X). In addition to these high-level languages, an Assembly language is available.

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.

UTILITIES: *EDIT/8000* is a line-oriented editor for the input and editing of programs, data files, and files of Control ➤

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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	No	Yes	Yes

► 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.

The *HELP* utility allows the user to access the information in online 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.

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 system users.

TEXT8 is a powerful document editing and formatting system. It can be used for creating, editing, and formatting letters, reports, manuals, programs, and other kinds of documents.

The *MAILER* system compiles, maintains, and prints mailing lists and mailing labels. In combination with *TEXT8*, *MAILER* also produces personalized form letters.

APPLICATIONS: BTI does not generate applications software, but assists in the marketing of selected user-generated packages and third-party software.

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.

SUPPORT: BTI features a 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.

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 airfreight, scheduled airline, or package express service to users who then replace them and return the failed parts. A BTI field ►

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► engineer is dispatched from Sunnyvale, California, 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.

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

TYPICAL CONFIGURATIONS: Sample configurations for the BTI 8000 systems are shown below. Complete equipment and software prices follow these configurations.

8000 BASE SYSTEM, which includes:	\$54,950
Computational Processing Unit, Memory Control Unit, 2MB memory module, memory power supply, Peripheral Processing Unit, System Services Unit, disk controller with four ports, asynchronous communications controller, eight-port interface, system cabinet, operator panel, and power supply	
One Model 8230 67MB fixed storage disk drive	7,500
One Model 8232 67MB removable storage disk drive	10,500
One Model 8310 cartridge magnetic tape controller and drive	7,500
One Model 8320 magnetic tape controller	5,000
One 8330 9-track, 45-ips magnetic tape drive	9,000
Three Model 8515, 8-port interfaces, @ \$4,000	12,000
TOTAL PURCHASE PRICE:	\$106,450

8000 BASE SYSTEM, which includes:	\$89,950
Computational Processing Unit, Memory Control Unit, 4MB memory module, memory power supply, Peripheral Processing Unit, System Services Unit, disk controller with one port, asynchronous communications controller, eight-port interface, system cabinet, operator panel, and power supply	
One Model 8112 Computational Processing Unit	20,000
One Model 8170 Peripheral Processing Unit	12,000
One Model 8234 135MB fixed storage disk drive	12,000
One Model 8232 67MB removable storage disk drive	10,500
One 8310 cartridge magnetic tape controller and drive	7,500
One Model 8320 magnetic tape controller	5,000
One 8330, 9-track, 45-ips magnetic tape drive	9,000
One Model 8415 line printer controller	5,000
One Model 8425, 600-lpm line printer	13,300
Seven Model 8515, 8-port interfaces, @ \$4,000	28,000

TOTAL PURCHASE PRICE: \$212,250

8000 BASE SYSTEM, which includes:	\$89,950
Computational Processing Unit, Memory Control Unit, 4MB memory module, memory power supply, Peripheral Processing Unit, System Services Unit, disk controller with one port, asynchronous communications controller, eight-port interface, system cabinet, operator panel, and power supply	
Two Model 8112 Computational Processing Units, @ \$20,000	40,000
One Model 8162 Memory Control Unit	22,000
One Model 8170 Peripheral Processing Unit	12,000
Two 8236, 279MB fixed storage disk drives	30,000
One 8232 67MB removable storage disk drive	10,500
One Model 8310 cartridge magnetic tape controller and drive	7,500
One Model 8324 magnetic tape controller	5,000
One 8340, 9-track, 75-ips magnetic tape drive	14,000
One Model 8415 line printer controller	5,000
One Model 8435, 1,200-lpm line printer	27,600
Two 8510 asynchronous communications controllers, @ \$10,000	20,000
23 Model 8515, 8-port interfaces, @ \$4,000	92,000
One Model 8815 cabinet extension	3,000

TOTAL PURCHASE PRICE: \$378,550

EQUIPMENT PRICES

		<u>Purchase Price (\$)</u>	<u>Monthly Maint. (\$)</u>
BASE SYSTEM			
8000/100	Includes Computational Processing Unit, Memory Control Unit, 4MB of memory, Peripheral Processing Unit, disk controller, asynchronous communications controller, 8-port interface, System Services Unit, double-bay system cabinet with bus backplane, operator control panel, and system power supply	89,950	880
8000/50	Includes Computational Processing Unit, Memory Control Unit, 2MB of memory, Peripheral Processing Unit, disk controller, asynchronous communications controller, 8-port interface, System Services Unit, double-bay system cabinet with bus backplane, operator control panel, and system power supply	54,950	820 ►

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Purchase Price (\$)	Monthly Maint. (\$)
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► SYSTEM RESOURCE MODULES

8112	Computational Processing Unit (CPU)	20,000	160
8130	Memory Control Unit (MCU)	10,000	80
8160	Memory Control Unit (MCU), 2MB	16,000	80
8162	Memory Control Unit (MCU), 4MB	22,000	—
8164	Memory Control Unit (MCU), 8MB	34,000	—
8174	Peripheral Processing Unit (PPU)	12,000	100
8190	System Services Unit (SSU)	8,000	70

MEMORY

8144	Memory module, 1MB of semiconductor memory (quantity one)	7,500	60
8154	Memory power supply, supports up to 2MB of one MCU	8,000	70
8166	Upgrade from 2MB to 4MB of memory	6,000	30
8168	Upgrade from 4MB to 8MB of memory	12,000	30

MASS STORAGE

8205	Disk controller, with four ports, for all drives listed below	10,000	250
8225	254M-byte (14-inch) removable storage drive, with one 8227 disk pack	20,000	300
8230	67M-byte (8-inch) fixed storage drive	7,500	75
8232	67M-byte (8-inch) removable storage drive	10,500	150
8234	135M-byte (8-inch) fixed storage drive	12,000	120
8236	279M-byte (8-inch) fixed storage drive (quantity one)	16,000	160

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	140

PRINTERS

8415	Line printer controller; supports any one printer listed below	5,000	30
8420	Line printer, 300 lpm, 64-character set	10,300	160
8422	Line printer, 220 lpm, 96-character set	10,300	160
8425	Line printer, 600 lpm, 64-character set	13,300	250
8427	Line printer, 440 lpm, 96-character set	13,300	250
8430	Line printer, 900 lpm, 64-character set	19,000	340
8432	Line printer, 660 lpm, 96-character set	19,000	340
8435	Line printer, 1,200 lpm, 64-character set	27,600	430
8436	Line printer, 880 lpm, 96-character set	27,600	430

COMMUNICATIONS

8510	Asynchronous communications controller, supports up to eight 8515 eight-port interfaces	10,000	80
8515	8-port interface, EIA RS-232-C, at rates to 19.2K bps	4,000	20

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

SOFTWARE PRICES

License Fee* (\$)

8910	Pascal/8000, on disk	5,000
8911	Pascal/8000, on reel-to-reel tape	5,000
8912	Pascal/8000, on cartridge tape	5,000
8920	ANS 77 Fortran, on disk	**
8921	ANS 77 Fortran, on reel-to-reel tape	**

*Discounts are offered for multiple installations by one customer.

**Fortran is an unsupported product, available at no charge except for the medium on which it is furnished.

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		License Fee* (\$)
▶ 8922	ANS 77 Fortran, on cartridge tape	**
8940	ANS 74 Cobol, on disk	5,000
8941	ANS 74 Cobol, on reel-to-reel tape	5,000
8942	ANS 74 Cobol, on cartridge tape	5,000
8950	Basic-X, on disk	5,000
8951	Basic-X, on reel-to-reel tape	5,000
8952	Basic-X, on cartridge tape	5,000
8960	Assembler, on disk	5,000
8961	Assembler, on reel-to-reel tape	5,000
8962	Assembler, on cartridge tape	5,000

*Discounts are offered for multiple installations by one customer.

**Fortran is an unsupported product, available at no charge except for the medium on which it is furnished. ■