BTI 5000

MANAGEMENT SUMMARY

BTI Computer Systems started out in 1968 as Basic Timesharing, Inc., a time-sharing service company serving the San Francisco peninsula. The experience gained in the next two years led to the development of a packaged proprietary time-sharing system capable of accommodating up to 16 users.

Installation of these initial systems took place in 1971. Main memory (core) was 48K bytes, and the basic on-line disk storage capacity was 2.4 megabytes, available in fixed- and removable-cartridge configurations. Up to three drives could be added for a total on-line capacity of 9.6 megabytes.

BTI's first formal product line, the BTI 3000 Series, an outgrowth of the company's assembled systems, was introduced in November 1972. This new system was based on a Hewlett-Packard 2100 minicomputer, chosen primarily because its user-microprogrammability enabled implementation of an efficient time-sharing facility in a system of relatively modest cost. At the time, micro-programmability was not as popular as it has since become, and manufacturers usually didn't even bother to mention the feature to anyone except those with the most specialized applications in mind. However, the concept of microprogrammability was far from new; micro-programmable computers had been in limited use in process control and measurement applications since the mid-1960's because of the need for faster programmable real-time systems.

The BTI 5000, introduced in September 1978, is BTI Computer Systems' current 16-bit computer offering. The 5000 is based on a modified Hewlett-Packard 21MX CPU and uses an upgraded version of the operating system used in the previously marketed BTI 4000 Series systems. The principal design advance is in automatic, remote computer-to-computer fault diagnosis, which can be carried out even if the customer's system has halted. The 5000 supports up to 32 simultaneous users, but over 5000 users can access the system through authorized ID's and passwords.

CHARACTERISTICS

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

BTI Computer Systems started in the San Francisco Bay area in 1968 as a time-sharing 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 two product lines: a 16-bit single-processor system capable of supporting up to 32 users and a 32-bit modular multiprocessor system which can support over 500 users. BTI's manufacturing facility is in Sunnyvale, California, and U.S. sales offices are in Piscataway and Cherry Hill, New Jersey; Braintree, Massachusetts; Dallas, Texas; Minneapolis, Minnesota; Chicago, Illinois; St. Louis, Mis-

The BTI 5000 is shown with the optional Model 5620 (300 lpm) line printer to the right of the processor cabinet. The terminals shown are examples of units frequently used with the 5000. Terminals are not included in BTI's product offerings.

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In addition to the 48K bytes of 980-nanosecond core memory and the on-line disk storage, the basic 3000 system included 8 user ports, expandable to 16 ports, and the ability to extend the disk storage capacity beyond 9.6 megabytes by adding more disk controllers as required.

The Model 3000, at the outset, was offered to: 1) end users interested in acquiring in-house systems to save on outside time-sharing services; 2) users with dedicated applications, based on proprietary software developed by the system owners; and 3) time-sharing service bureaus. Most minicomputer manufacturers offered system hardware and time-sharing operating systems ostensibly comparable with those required by time-sharing service companies. But what no other vendor offered then, and few offer now, are the accounting and security functions supplied by the BTI system.

In June 1973, BTI expanded the 3000 system into a series. The initial system, described above, was designated the Model 3000/30, and two more models were added: the 3000/20 and 3000/40. The 3000/20 low-end model was a 32K-byte system for up to 8 users. The 3000/40 high end model had 64K bytes of memory and could support up to 32 users. In addition, the new 3000's featured enhanced file capabilities and string arithmetic functions. Subsequently, in September 1973, BTI announced the 3000/35 and 3000/45, which offered substantially more disk storage in the form of 49-megabyte 2314-type disk drives. One disk controller could operate up to 10 drives, and more than one controller could be used in a system.

During the product life of the 3000 Series, from 1972 to 1974, the 3000's application programming language, an extended version of BASIC, was successively enhanced to further the 3000's use in business applications. One feature of the 3000 which set it apart from other minicomputer-based, multiple-user systems was the high degree of security provided for system access and application software designed into the operating system. As upgraded versions of the operating system became available, they were offered to system owners for just a handling charge. This practice encouraged system owners to upgrade their systems to the latest configuration and made it easier for BTI to service its products since it minimized the number of installations using different software.

The method of maintenance which BTI adopted for the 3000 and subsequent series is noteworthy in that it is based on fault diagnosis by dial-up telephone access to the customer's system from BTI's factory service center. The ability to perform remote diagnosis was specifically designed into the 3000's operating system. Since its inception, BTI's diagnosis-by-phone support has been available 24 hours per day, 365 days per year.

BTI's service is also unusual in that it relies on "customer cooperative maintenance." Under this arrangement, the customer is expected to assist the factory in preventive and corrective maintenance activities in exchange for maintenance charges considerably lower than the prevailing

souri; and Sunnyvale and Anaheim, California. BTI also has a European subsidiary, BTI Computer Systems (UK), Ltd., with a sales office in Slough, England, and a service office in Birmingham, England.

MODEL: 5000 (supersedes former Models 4000 and 3000).

DATE ANNOUNCED: September 1978.

DATE OF FIRST DELIVERY: October 1978.

NUMBER INSTALLED TO DATE: Approximately 475.

DATA FORMATS

BASIC UNITS: 16-bit word and 8-bit byte.

FIXED-POINT OPERANDS: 16-bit operand for all instructions except extended arithmetic (integer double-word) and floating-point instructions, which are 32 bits long. String arithmetic instructions, implemented in microcode, permit variable-length operands.

FLOATING-POINT OPERANDS: Six floating-point instructions are implemented in the basic instruction set of the HP 21MX. Operands for these instructions are 32 bits, including a signed 7-bit exponent (8 bits) and a signed 23-bit fraction (24 bits). BTI has implemented additional floating-point instructions in firmware.

Within the 5000 system, floating-point numbers range between 5.87747×10^{-39} and $1.70141 \times 10^{+38}$. Decimal numbers are limited to six digits and are internally rounded if they exceed six digits. Scientific or "E" notation is used for floating-point numbers. For example, the number 458146 is changed to 4.58146 E+05, and 0.00576 becomes 5.76E-03.

INSTRUCTIONS: All user-written instructions to the BTI 5000 system are either BASIC language statements or system control statements defined by BTI.

All HP 21MX machine instructions, including the optional DMS instructions, are one word long except for 10 extended arithmetic instructions, each of which is two words long.

Memory reference instructions combine an operation code and a memory address into one word. Ten bits in the instruction plus 5 bits in the P-register are used to specify an absolute address within the current 1024-word page or within the base page (page zero). Indirect or direct addressing is specified by one bit position. Register reference instructions are used to manipulate bits in the A, B, and F registers. One bit is used to specify the shift rotate group (SRG) of register reference instructions, or the alter-skip group (ASG) of instructions. Four bits are used to specify type or class of instruction, and 10 bits are used to contain one or more "micro instructions" defining register manipulation operations.

I/O instructions contain a 4-bit class identifier, a 5-bit operation code, and a 6-bit channel identifier. Extended (2-word) arithmetic memory reference instructions use 5 bits to specify the class of instruction, 7 bits to indicate an operation code, and 15 bits to specify the memory address of the operand. One bit is used to signify direct or indirect addressing (32K words directly addressable). Extended arithmetic register reference instructions provide long shifts and rotates on combined A and B registers. Five bits identify the class, and seven bits specify the direction and type of shift. Four bits specify the number of shifts (1 to 16 places).

INTERNAL CODE: ASCII.

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
MAGNETIC TAPE UNITS		
5330	9-track, 800/1600 bpi, switch-selectable density, 45 ips, 10.5-inch reels, IBM/ANSI compatible; 70K char./second	Datapoint
5520	Cartridge, 4-track, 6400 bpi, 30 ips; 23K char./ second	BTI
PRINTERS		
5620	Line printer, 96-character set, 132 cols.; 300 lpm	General Electric
5630	Line printer, 64- or 96-character set, 136 cols.; 300 lpm	Dataproducts
5660	Line printer, 64- or 96-character set, 136 cols.; 600 lpm	Dataproducts
5690	Line printer, 64- or 96-character set, 136 cols.; 900 lpm	Dataproducts

rates in the industry. The customer's preventive maintenance obligations are simple, consisting primarily of inspecting the system for cleanliness and replacing air filters as needed. Kits that contain all materials necessary to perform required maintenance are mailed to customer sites, and the required routines are performed by the customer. Such functions as air filter replacement, tape head cleaning, and other preventive functions are carried out and reported back to BTI via enclosed forms. For corrective maintenance, customer personnel contact the BTI factory by telephone. Service engineers at BTI log onto the operating system through special access passwords and then exercise the system remotely. If it is determined that a part has failed, a spare is immediately shipped by the fastest method to the customer site. If the malfunction cannot be cleared up through telephone consultation, a field service engineer is then dispatched to the site from BTI's California headquarters.

Thus, while BTI started small in terms of personnel, it was able to maximize the value of its most expert service people by having them concentrate on the important task of problem diagnosis.

The 4000 Series, introduced in January 1975, was a continuation of the total hardware and software system established by the 3000 Series. The 4000 Series was based on the newer, more cost-effective, Hewlett-Packard 21MX minicomputer (Report M11-472-201) and initially consisted of three models: the 4000/10, 4000/20, and 4000/30. The new CPU's incorporated many system functions implemented in microcode. All of the 4000 Series models had 64K-byte core memories and differed in the type and amount of mass storage offered with each system. The 4000/10 used the same 2.4-megabyte disk drives as the 3000/20 and 3000/30, while the 4000/20 used the same 49-megabyte disk pack drives as the 3000/40. The 4000/30 featured 73-megabyte disk drives. All models were supplied initially with ports for up to 16 users, with the 4000/20 and 4000/30 having expansion capabilities to 32 ports.

To aid in system maintenance and operation, a new 10-button front panel was substituted for the standard HP front panel. The standard panel functions were not

MAIN STORAGE

TYPE: N-channel dynamic MOS RAM.

CYCLE TIME: 650 nanoseconds.

CAPACITY: 65,536 bytes. No user expansion is offered.

CHECKING: One parity bit per 16-bit word is standard.

PROTECTION: Although hardware memory protection is available for the 21MX, BTI does not use it. Instead, the operating system provides protection to both user programs and files through an elaborate scheme.

Files are automatically assumed to be "read only" to all accounts (users) except the owner, unless specifically designated as shared files. The user can share a file on a "read only" or "read-write" basis and change the designation at will. To preclude update errors, files can also be shared on a "non-interfering read-write" basis in which write requests to a file are queued while a current write access is in progress.

RESERVED STORAGE: The first 64 main memory addresses may be used for vectored interrupts. The uppermost 64 locations are used by the binary loader, which is loaded from ROM. Both areas may be overwritten by the operating system.

CENTRAL PROCESSOR

The BTI 5030 processor is a modified Hewlett-Packard 21MX CPU, greatly enhanced through BTI-generated microcode implemented in the CPU's writable control storage. BTI purchases the mother board from HP and adds its own memory, peripheral controllers, and programming panel. The programming panel is a specially designed unit with the normal displays and data switches mounted on the inside, accessible only for maintenance purposes. On the outside, the panel contains a 2-digit display and 10 push-buttons. Eight of these pushbuttons initiate ROM-stored system functions, including system startup, program syntax changes to accommodate system software updates, an upgrade installation routine, core dump, a disk-to-disk copying routine, and a disk-to-magnetic-tape copying routine.

Only the characteristics of the BTI 5030 that differ from those outlined in the Hewlett-Packard 21MX report (M11-472-201) are presented in this report.

CONTROL STORAGE: Consists of 325-nanosecond PROM fixed user control storage (UCS) or RAM writable control storage (WCS). Combinations of both types can be

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discarded, but were compressed and re-created *inside* the new panel, to be available for maintenance purposes. The new panel contained a START button, a STOP button, and eight special-function buttons designated A through H. These buttons initiated microcoded system functions such as system start-up, operating system conversions, core dumps, disk-to-disk copying, and disk-to-tape copying. Except for system start-up, these functions were reserved for service usage.

In March 1976, the 4000 Series was upgraded and redesignated Models 4000/15, 4000/25, and 4000/35. The most visible difference between the new 4000's and the old was the cabinetry. Using a special modular packaging technique, the equipment mounting chassis were stacked together. Decorative skins were then added to lock the stack together and form an integrated cabinet.

Less visible differences included 650-nanosecond MOS memory instead of the 980-nanosecond core, more internal functions implemented in microcode, and 7.5-megabyte disk drives substituted for the 2.4-megabyte drives on the low-end model. Sources within Hewlett-Packard regarded the BTI product line as one in which the microprogramming capabilities of the 21MX were most extensively exploited.

Another enhancement over the 4000/10, /20, and /30 was the addition of a magnetic tape subsystem which incorporated a new tape pack. This tape subsystem was used as a backup device to dump files and programs and to regenerate a user's complete system in the event of a catastrophic failure. A tape pack copy of the operating system and BASIC compiler was supplied with each system. User files and programs could also be added to the tape pack, which served as a convenient method for storing software. In addition, the tape packs contained an internal mechanism to keep the tape under proper tension during transportation, making them well suited for shipment to other sites. A conventional 9-track, 800/1600-bpi tape transport, which operated in IBM/ANSI format, was also offered.

The basic 4000 Series system now included the CPU with 64K bytes of main memory, a disk subsystem, a magnetic tape pack subsystem, and eight user-terminal ports.

The only difference between the 4000/15 and the 4000/25 was the disk subsystems they used. The 4000/15 was supplied with 7.5-megabyte nonremovable disk drives, and the 4000/25 had 49-megabyte 2316-type disk pack drives. The 4000/15 system could be upgraded, and the two disk subsystems could be intermixed. The 7.5-megabyte disk controller could accommodate up to four drives, and the 49-megabyte controller could handle up to eight drives. No additional hardware was required to add disk drives to either subsystem.

Although three of the new 4000 Series systems were originally announced, BTI subsequently withdrew the largest, the 4000/35, from the market, citing problems encountered with the 73-megabyte disk drives.

implemented up to a maximum of 4096 24-bit words. User control storage is organized into 256-word pages. The basic 21MX instruction set occupies 1024 words, and there are provisions for another 1024 words to be added. Writable control storage is on 256-word modules that mount with the I/O controllers.

REGISTERS: The internal data structure of the 21MX cannot be accessed by the BTI user. Please consult Report M11-472-201 for details.

INSTRUCTION REPERTOIRE: The BTI 5030 CPU uses the standard Hewlett-Packard 21MX instruction set plus several additional functions implemented in both user control storage and writable control storage. These additional functions include string arithmetic, matrix operations, and binary operators.

PHYSICAL SPECIFICATIONS: The CPU, communications interfaces, Model 5430 disk drive, and magnetic tape pack drive are mounted in a cabinet 26 inches wide, 34 inches deep, and 54 inches high. The addition of a third and fourth disk drive requires a second cabinet.

Power requirements for the 5000 are either 120 VAC ± 10%, 60 Hertz ± 1%, single phase or 240 VAC ± 10%, 50 Hertz ± 1%, single phase. Heat dissipation for the basic system, including Model 5430/5460 disk drives, is between 5300 and 7400 BTU's per hour, depending on the number of drives. The Model 5260 disk pack drive dissipates 2500 BTU's per hour.

Operating environment for the 5000 Series systems is 60 to 80 degrees F. with a relative humidity of 20 to 80 percent, noncondensing.

CONFIGURATION RULES

The 5000 system includes a CPU with 64K bytes of main memory, a magnetic tape cartridge subsystem, eight user-terminal ports, and one disk subsystem.

The Model 5420 disk controller used in the 5000 system supports up to four 29- or 58-megabyte disk drives in any mix. The Model 5220 disk controller supports up to four 62.4-megabyte disk drives.

The basic system includes one 5810 communications controller with eight ports, which can be expanded to 32 ports in eight-port increments by adding one, two, or three 5810's.

Virtually any terminal, CRT or hard-copy, with a standard RS-232C interface can be used with the system. Likewise, any modem with facilities for the RS-232C interface can be used for remote applications.

An optional 9-track, 800/1600-bpi, 45-ips magnetic tape subsystem can also be added to the system for loading and dumping data files and programs.

MASS STORAGE

29-MEGABYTE DISK SUBSYSTEM: Includes one 29-megabyte 5430 disk drive and one 5420 controller capable of supporting up to three additional drives. Data is recorded at 256 bytes per sector, 36 sectors per track, and 400 tracks on each surface. Average head-positioning time is 40 milliseconds. Data transfer rate is 1 million bytes per second. Maximum formatted subsystem capacity is 116 million bytes.

58-MEGABYTE DISK PACK SUBSYSTEM: Includes one 58-megabyte 5460 disk pack drive and one 5420 controller capable of supporting up to three additional drives. Data is recorded at 256 bytes per sector, 24 sectors per track, and

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This photo shows the BTI 5000 system cabinet with the plexiglass cover lifted. The magnetic tape cartridge module (with four drives in this version) and the CPU are below this unit. The disk drives and system power supply are behind the cover panel, below the CPU.

The new 4000/15 and 4000/25 represented substantial cost reductions in addition to the performance increases they offered over the original 4000 Series systems. The 4000/10, smallest of the original 4000 Series, was priced at $49,500 but required a second disk drive, raising the true system price to $55,500. A similar situation occurred with the 4000/20 and 4000/30. The true cost of a 4000/30 was $91,400 when the extra disk pack drive was added to the basic system. The new 4000's, the 4000/15 and 4000/25, did not require any equipment other than that included in the basic configurations. The new low-end price for a BTI 4000 system was $35,950, which included 7.5 megabytes of disk storage, compared to 4.8 megabytes in the older system, plus a magnetic tape subsystem. One small difference was that the older 4000 Series systems included 16 user ports, while the newer systems started at 8. Both, however, were expandable, in increments of 8 ports, up to 32 ports.

Besides the user terminal ports, the new 4000 Series systems offered optional ports for intersystem communications via any asynchronous protocol. These ports were compatible with Bell System 202C-type modems and allowed system-to-system communications with another BTI 4000 system or with another mainframe. Communications protocol was established by the user with a BASIC program. Up to four such communications ports could be included in a system.

One essential component of all time-sharing systems, user terminals, was *not* (and still is not) supplied by BTI. The company recognized that many terminals are available directly to users and passed on to its customers the potential savings of direct procurement. Any terminal with a data rate between 100 and 2500 bits per second and a standard RS-232C interface could be used on any

400 tracks on each surface. Average head-positioning time is 38 milliseconds, and average rotational delay is 10 milliseconds. Data transfer rate is 996K per second. Maximum formatted subsystem capacity is 232 million bytes. The 5430 and 5460 disk pack drives are manufactured by Okidata and Kennedy.

62.4-MEGABYTE DISK PACK SUBSYSTEM: Includes one 62.4-megabyte 5260 disk drive and one 5220 controller capable of supporting up to three additional drives. Data transfer rate is 1,200,000 bytes per second, and average seek time is 36 milliseconds. Maximum formatted subsystem capacity is 250 million bytes. The 5260 disk pack drives are manufactured by Ampex.

COMMUNICATIONS CONTROL

The BTI 5000 system can support up to 32 local or remote user terminals.

5810 ASYNCHRONOUS CONTROLLER/MULTIPLEXER: Can interface up to eight RS-232C terminal or modem interfaces, and up to 32 interfaces if communications controllers are added. Data rates can be set individually, to any speed between 110 and 9600 bps. The data rate for a port is normally established by the system manager but can be temporarily overridden by the user. The original data rate again becomes effective whenever the user relinquishes the line. Character lengths, also program-selectable, can be either 10 or 11 bits long.

SOFTWARE

OPERATING SYSTEM: The BTI 5000 operating system provides a time-shared environment for the BASIC-X compiler and also performs all control and accounting functions necessary to determine usage and maintain security and privacy between users. The time-sharing control portion of the operating system includes a dynamic time-slicing and allocation task. About 20K bytes of the 64K-byte main memory are allocated as the user area. Only one user program is resident in main memory at a given time. As each program's time expires, a complete roll-out/roll-in cycle occurs and the next highest priority

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4000 Series system. BTI made no specific endorsement or recommendations in favor of any particular vendor's terminals, but instead supplied a list of terminals known to have been used successfully with its equipment. Some interactive terminals on the list:

- Anderson Jacobson 830
- Data Terminals DTC-300 and DTC-300/S
- Digital Equipment LA36 DECwriter II
- GE TermiNet 30, 300, and 1200
- Teletype ASR 33, 35, 37, and 38
- Texas Instruments 725, 733 KSR, 733 ASR
- ADDS Consul 880 and 840
- Beehive Mini Bee and Super Bee
- Digital Equipment VT50 DECscope
- Hazeltine 1000 and 2000
- Infoton Vistar and Vistar/GT
- Lear-Siegler ADM-1, ADM-2, and ADM-3
- TEC 430, 435, and 436.

Similarly, any modem with the RS-232C interface could be used for remote terminals.

BTI chose not to develop application software, but reached end users requiring such software through an informal alignment of its computer systems with application software furnished by independent vendors. BTI was able to offer a unique advantage to the application software supplier: protection for his software comparable to that of BTI's proprietary operating system. With his software protected by an exclusive "proprietary" screen initially set up by BTI, the vendor was able to install his software on BTI systems of his choice where he could support his software over the telephone, much as BTI supported its own software. This exclusive proprietary software protection facility is also available with BTI's current products. The 4000's special protection for added-value software made it easier for the company to establish joint selling arrangements with independent software suppliers, including OEM purchasers. This feature was also an advantage in selling to service bureaus because it enabled the service bureau to become an OEM supplier to clients whose billings had grown to the point of justifying the acquisition of an in-house system.

In September 1978, BTI introduced the BTI 5000 to replace the 4000. The 5000 is BTI's current offering in this class of system. It uses an upgraded version of the operating system proven on the 4000. The principal design change in the 5000's CPU enables BTI to perform *automatic* remote fault diagnosis. With BTI's long experience in manually implemented diagnosis, many advantages could be seen in having this work performed by a computer. The 5000 was therefore designed to allow it to be called and tested by a computer at BTI's service center without on-site assistance by the customer. Diagnostic tests can be performed even if the customer's system has halted. The diagnosing computer can perform its tests faster and more precisely than a human operator, and its use can be initiated by a service engineer in the field.

program is brought in from disk. Users in interactive mode are given the highest priority for system resource allocation.

The operating system is designed primarily for commercial time-sharing applications. As such, it maintains all user programs and files within separate *accounts*. The software system is organized into three levels: control, master, and user. At the control account level, the system manager has responsibility for the overall system operation. Through three specially defined accounts, the system manager can:

- Establish new master accounts.
- Remove both user and master accounts from the system.
- Change passwords and disk authorizations for master accounts.
- List disk authorizations on command.
- List locations of accounts and files by logical disk.
- Protect programs and files.
- Make programs and files permanent at the system level.
- Produce lists of shared files.
- Produce status reports on user storage utilization and time usage.
- Produce current activity reports.
- Copy accounts from one disk to another.
- Resequence program and file serial number.

The three accounts used by the system manager are the system management account, the system operations account, and the system resources account. The latter account controls non-time-sharable system resources such as magnetic tape. The system manager also controls the system public library.

The system manager can subdivide the system into as many as 26 independent segments, each supervised by a master account manager. This group of master accounts makes up the master level within the system. Master accounts are identified by a single-letter prefix. Each master account has a separate master library accessible only to users in that master account. For accounts in his letter group at the master level, the master account manager can:

- Open and close user accounts.
- Establish passwords, time limits, and storage for user accounts.
- Protect and unprotect programs and files.
- Make programs permanent or temporary.
- Produce status activity reports.
- Designate the "Hello" program—the program entered automatically by each user immediately after logging on the system.

Each master account can be subdivided into 10 user groups, each with its own group library. User groups can be made up of as many as 100 individual user accounts, each with a separate private library of programs and data files.

Although the *theoretical* maximum number of user account numbers is 26,000 (26 x 10 x 100), the BTI 5000 operating system restricts the number to 5800.

Programs and files in private libraries belonging to specific user accounts can be accessed by the corresponding master account or, ultimately, through the system manager account, without the need for a password. Users, however, cannot access other users' private libraries without the passwords. In the same fashion, both group and master libraries can be accessed by members of their own groups or master accounts, but not by members of the other groups of master accounts. Programs and files, however, can be declared universally or selectively "sharable" by the individual users.

Selective sharing permits each user to designate those accounts that are to be granted access to specified programs

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BTI's diagnostic computers are also used to monitor a customer's system after a repair has been made and to carry out periodic "health checks," looking, for example, at the incidence of soft (disk-read) errors which could later lead to a hard failure. Another advantage of computer-to-computer communication is the ease with which patches can be inserted into an operating system. If a bug is discovered, possibly on just one system, a patch can be made automatically and quickly by BTI's service computers (usually overnight) on *all* Model 5000 installations.

New disk drives, available in 29- and 58-megabyte capacities (nonremovable), are offered for the 5000. The 49-megabyte, removable-pack drive included in the 4000 product line and initially offered with the 5000 has been discontinued, and BTI expects to introduce a new storage-module-type drive with a formatted capacity of 62.4 megabytes in the first half of 1979. For terminal communications, a new communications controller/interface is used in the 5000. It can be expanded from 8 to 32 ports in 8-port increments and supports terminal data rates up to 9600 bits per second, up from the 4000's limit of 2400 bps.

A magnetic tape cartridge drive is furnished for software backup and recovery. One cartridge stores 10 megabytes. A single-drive module is included in the basic system configuration, and up to three additional drive units can be installed in the drive module. Software backups and recoveries can be performed under command or programmatically. With four drives installed, up to 40 megabytes can be transferred without physical handling of tape cartridges. Optional peripherals are a 9-track, open-reel magnetic tape drive which is IBM/ANSI-compatible and four line printers with print speeds from 300 to 900 lines per minute. As with the 3000 and 4000 systems, BTI does not include terminals in its offerings, feeling that users will have their own preferences. Virtually any terminal operating in ASCII and with an asynchronous, full-duplex RS-232C or CCITT V.24 interface can be used with the BTI 5000.

USER REACTION

In April 1979, Datapro interviewed six BTI 5000 users chosen at random from a list supplied by the vendor. The average length of time the systems had been installed was about six months.

The users included a college, four time-sharing services, and two service bureaus, one of which was also a time-sharer and supplier of contract software. All had 64K of memory and were using BASIC-X. Applications included teaching courses in BASIC-X, handling payrolls and general ledgers, and evaluating the cost-effectiveness of engineering equipment.

Peripherals included terminals from DEC and Diablo and a TI 700 printer. Disk storage capacities ranged from 30 to 64 megabytes.

and files. Users can also share programs or files with the public library or any other master or group library. All shared files are automatically assumed to be read-only unless read-write access is granted. File sharing is done on a non-interfering read-write basis. Requests to write into shared files are automatically queued if the desired file is in the process of being updated. This assures that the file is updated in the proper sequence.

Other protection mechanisms available include making programs run-only or read-only, making files and programs non-deletable or non-closable, or making programs non-abortable. The latter form of protection ensures that a particular program will run to completion.

The operating system provides extensive accounting information to both the system manager and the master account supervisor. Information in the report includes the user account storage limits, current storage usage, and peak storage used. Connect time and user time limits are also included, as well as the amount of time each terminal was in use as a private dedicated port. The system also enforces the limits specified for each user. Requests to save files that would exceed the stated storage limit are refused, with an appropriate notation. Users exceeding their allocated time intervals are not thrown off the system, but subsequent attempts to log on are denied.

Library activity is also monitored by the system. For each library level (system, master, group, or private) the system records the length, date saved, date of last access, and cumulative number of times accessed. Protected and permanent programs and files are noted on the status reports, together with the level (system, master, user) at which the protection or permanence was established. Non-abortable programs are also noted.

Port activity and status are monitored, showing the number of user ports in use at the moment and also the identity of the account using each port. Other activities monitored and noted by the operating system include all user log-ons and log-offs; all user-specified terminal data rate changes; all operator-commanded system halts; all system startups, date changes, and software loadings; and snapshot copies of the disks.

LANGUAGES: BTI offers only the BASIC-X program development language for the 5000.

BASIC-X is an enhanced version of Dartmouth BASIC that features extensions such as matrix operations, character string manipulations, extended numerical precision, extensive file handling facilities, and program chaining.

BASIC-X matrix operations include addition, subtraction, multiplication, transposition, and inversion. In addition, one- and two-dimensional arrays are treated as single-value variables. Multiple arrays can be dimensioned and defined by the MAT READ or MAT INPUT statements. In the same manner, the MAT PRINT statement will print one or more arrays in packed or unpacked format.

Character strings from 1 to 254 ASCII characters in length can be manipulated and stored through single commands. Substrings can also be extracted and operated upon. String operations include input printing, copying from other strings, and string comparisons. String variables can also be mixed with numeric variables in the READ, INPUT, DATA, and PRINT statements. The string manipulating capabilities of the 5000 system have also been extended to arithmetic operations, providing string addition, subtraction, and multiplication. Decimal number strings of up to 252 digits can be operated on by the system.

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The ratings assigned by these users are shown in the following table:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	6	0	0	0	4.0
Reliability of mainframe	4	2	0	0	3.7
Reliability of peripherals	2	1	0	0	3.7
Maintenance service:					
Responsiveness	4	2	0	0	3.7
Effectiveness	3	3	0	0	3.5
Technical support	2	4	0	0	3.3
Manufacturer's software:					
Operating system	3	3	0	0	3.5
Compilers and assemblers	1	3	0	0	3.3
Ease of programming	4	1	1	0	3.5
Ease of conversion	2	1	0	0	3.7
Overall satisfaction	4	2	0	0	3.7

*Weighted Average on a scale of 4.0 for Excellent.

The six users were well satisfied with their choice of BTI equipment. The college spokesman was pleased that "we have had practically no down-time." The 5000 was called "100 percent better than the 4000" and "one of the best-performing machines on the market if it meets your requirements." One user had "selected BTI because of the recommendations of other users, all of which proved to be true." One time-sharing service was especially impressed by BTI's ability to handle problems by phone.

Datapro appreciates the cooperation of these six BTI customers, none of whom had a negative comment about the system.□

All system users can create and maintain data files in private libraries. Data or programs from these files can also be transferred into the group, master, or system public library. Files transferred into higher libraries from user private libraries are available to other users on a read-only basis, unless otherwise specified. Users can specify other levels of access, such as read-write access, through the SHARE command.

The BTI 5000 provides random and sequential file access, and a utility for indexed sequential access. Data files can contain up to 9502 records, each record 256 bytes long. Thus, a maximum-length file contains 2.4 million bytes and is called a disk "volume." File sharing capabilities permit a data base to occupy as many volumes as required. User programs can have up to 63 files open simultaneously, and file links can be changed during program execution to permit access to greater numbers of files. Programs can also create scratch files for internal usage. File buffers are variable in length and can contain up to 32 records.

The user area in main memory is limited to 20,224 bytes; however, the CHAIN command causes a new program segment to overlay the previous segment. Chained programs can be specified either by name or as the current value of all or a portion of a string variable. During program chaining, the COMMON statement can be used to preserve selected variables and allow them to be passed intact between program blocks. In the same manner files can be declared common to avoid the need of relinking.

APPLICATION SOFTWARE: BTI does not generate applications software, but assists in the marketing of 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 read-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 his proprietary software, can update and correct the package without the need of sending copies or interrupting users.

Currently, 13 packages are available from independent vendors. These include three data base managers, four accounting packages (including one especially for truckers), a financial modeling package, a college administrative system, a medical billing system, a service bureau billing system, a comprehensive microprocessor development package, and a structured version of BASIC.

BTI provides an extensive text-processing package, a mailing list management system, and a keyed-sequential access program, in addition to a comprehensive set of utilities and a substantial program library.

PRICING

POLICY: BTI provides the 5000 system on a purchase-only basis. In some areas, distributorships have been established by system builders serving particular market segments. The system price includes the operating system and the BASIC-X language. BTI warrants all hardware for 90 days and software for one year.

SUPPORT: BTI features a unique customer-participation service and support system that combines human resources and hardware features of the 5000 system. The BTI 5030 CPU 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 by air freight, scheduled airline, or package express service to users, who replace them and return the failed parts. A BTI systems engineer is dispatched from Sunnyvale to any site where telephone consulting and testing cannot correct the malfunction.

BTI Corrective Maintenance Plan charges are based on a basic charge, related to the hardware configuration. Typical charges covering both preventive and corrective maintenance for a $50,000 system are about $400 monthly.

BTI also features a customer-participation Preventive Maintenance Plan that includes the periodic sending of kits to customer sites. These kits include necessary air filters, cleaning agents, supplies, and reporting forms. Customer personnel perform the stipulated activities and return the completed forms to BTI.

System purchase prices include on-site training by BTI personnel. Training includes both operation and maintenance procedures.

The BTI operating system is typically updated about three times a year. Customers can update their systems for a nominal handling fee. Each update extends the software warranty for one year.■

BTI 5000

EQUIPMENT PRICES

		Purchase Price
SYSTEMS		
5000	Time-sharing system; includes central processor, 64K bytes of MOS memory, battery backup for two hours, one 29-megabyte disk drive and controller, one magnetic tape cartridge drive and controller, eight terminal ports, power supply, and cabinet	$38,950
MASS STORAGE		
5420	Disk controller for one to four 5430 or 5460 disk drives, in any mix	8,500
5430	29-megabyte disk drive (nonremovable)	9,000
5460	58-megabyte disk drive (nonremovable)	11,000
5220	Disk controller for one to four 5260 disk drives	8,500
5260	62.4-megabyte disk drive (removable)	12,500
MAGNETIC TAPE EQUIPMENT		
5502	Optional cartridge tape subsystem, including one 5510 tape controller and one 5520 tape cartridge drive	5,000
5530	Additional tape cartridge drive; installs in 5520 module (total of four drives can be accommodated)	2,500
5302	Optional magnetic tape subsystem, including one 5320 controller, one 5330 tape drive, and cabinet	14,000
PRINTERS		
5602	Includes 5610 line printer controller and 5620 line printer; 300 lpm	8,950
5604	Includes 5612 line printer controller and 5630 line printer; 300 lpm	15,000
5606	Includes 5612 line printer controller and 5660 line printer; 600 lpm	18,000
5608	Includes 5612 line printer controller, 5690 line printer, and quietized cabinet; 900 lpm	23,700
—	Quietized cabinet for 5604 or 5606	800
—	96-character set for 5604, 5606, or 5608	1,500
INTERFACES		
5810	Communications controller and interface, 8 ports, EIA RS-232C-compatible	2,850