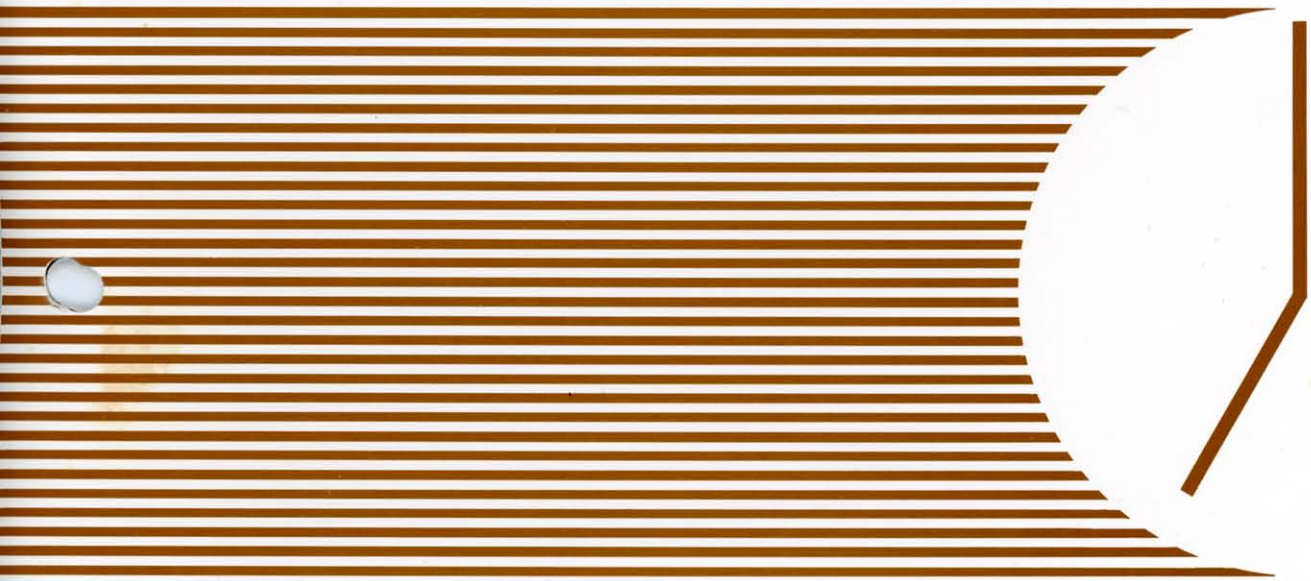
BTI COMPUTER SYSTEMS

About BTI . . .



The BTI 8000 32-Bit Multiprocessor System can accommodate over 200 concurrent users and supports all the major business and scientific programming languages.

The BTI 5000 family is BTI's current offering in a series of 16-bit interactive computer systems. BTI has delivered more than 3000 systems, with installations in the United States, Canada and Europe.

About BTI . . .

Introduction

BTI Computer Systems is a leading manufacturer of 16-bit minicomputers and 32-bit multiprocessor systems. Housed in a modern 123,000 square foot complex in Sunnyvale, California, BTI is now in its 13th consecutive year of successful business. In 1980 sales increased to a record $33 million, four new sales offices were opened, and the number of employees rose from 350 to over 450.

Known for being exceptionally reliable and simple to operate, BTI systems are popular with service bureaus, OEMs, and in-house users alike. Over 3000 BTI computers have already been installed in the U.S., Canada, and Europe. Applications for BTI systems include: general and specialized accounting, dealer inventory control, entertainment ticketing, school administration, text publishing, transportation accounting, mailing list management, laboratory records management, and more.

A major reason for BTI's success is the company's continued history of technical innovations. For example, a remote service plan using computer-to-computer diagnosis; advanced software safeguards for optimum data security; and the BTI 8000—a revolutionary new 32-bit multiprocessor system with growth potential equivalent to an entire family of computers.

Tradition of Success

Established in 1968, BTI initially began as a company that sold timesharing services in the San Francisco Bay Area. Since no computers were available to meet the exact needs of this new business, company founders purchased a conventional timesharing computer then added hardware and software improvements. Substantial customer interest in this advanced computer convinced company founders that they should market their own proprietary interactive system for timesharing applications.

First installations of this new product, called the BTI 3000, took place in 1971. Four years later, in 1975, the Model 3000 was replaced by the BTI 4000, a more advanced system that featured programming language improvements and more sophisticated file handling. In turn, the 4000 was replaced by the company's current 16-bit system, the BTI 5000.

With the system business thriving, BTI discontinued timesharing services in 1975. Today, the company is exclusively involved in designing, manufacturing, marketing, and maintaining computer systems.

BTI 5000

The BTI 5000 Interactive Computer System has been the mainstay of company business since it was introduced in 1978. Designed with the knowledge and experience gained in previous product lines, the BTI 5000 features 16-bit architecture with hardware floating-point arithmetic, 27 to 468 Mbytes of on-line disk storage, and capacity to support up to 32 users at the same time.

Peripherals include magnetic tape cartridge drives, removable and nonremovable pack disk drives, an industry-compatible open-reel magnetic tape drive, a choice of line printers and terminals.

An Important New Product

Beginning in 1980, BTI placed major emphasis on introducing the company's newest product, the BTI 8000. The result of over six years research and development, this 32-bit multiprocessor, multi-language system features a revolutionary design concept called "Variable Resource Architecture" (VRA).

VRA, a flexible mix of hardware resources controlled by a single self-regulating operating system, gives the BTI 8000 growth potential equivalent to an entire family of computers. Customers may add or delete hardware modules to create the exact configuration they need for their performance requirements.

The BTI 8000 can support up to 200 interactive and/or batch processes. Memory can be added in increments of 512 Kbytes up to a total of 16 Mbytes. Peripherals include magnetic tape cartridge drives, removable pack disk drives for up to 8 gigabytes of on-line storage, industry-compatible open-reel magnetic tape drives, line printers with rates of 300, 600, and 900 lines-per-minute, and terminals.

Pioneers in Remote Diagnosis

BTI's Customer Service Department offers 24 hour-a-day, 7 day-a-week support for all BTI systems. Using over-the-phone hardware and software fault diagnosis, a program BTI pioneered over a decade ago, over 90% of all customer problems are solved without requiring an on-site visit by BTI.

As an integral part of the program, computers at BTI's National Service Center can be linked directly to the customer's system to perform automatic, in-depth diagnosis, even on a non-operating system. The remote diagnostic computer can also look for and identify potential problems before they cause a system to go down.

If on-site assistance is required, BTI's closest service engineer is dispatched immediately, and every effort is made to return the system to full operation within 24 hours.

Field Sales Offices

BTI's National Sales Organization consists of four regions. The Eastern Regional Office is located in Piscataway, New Jersey; the Southern in Atlanta, Georgia; the Midwestern in the Chicago area; and the Western in Sunnyvale, California.

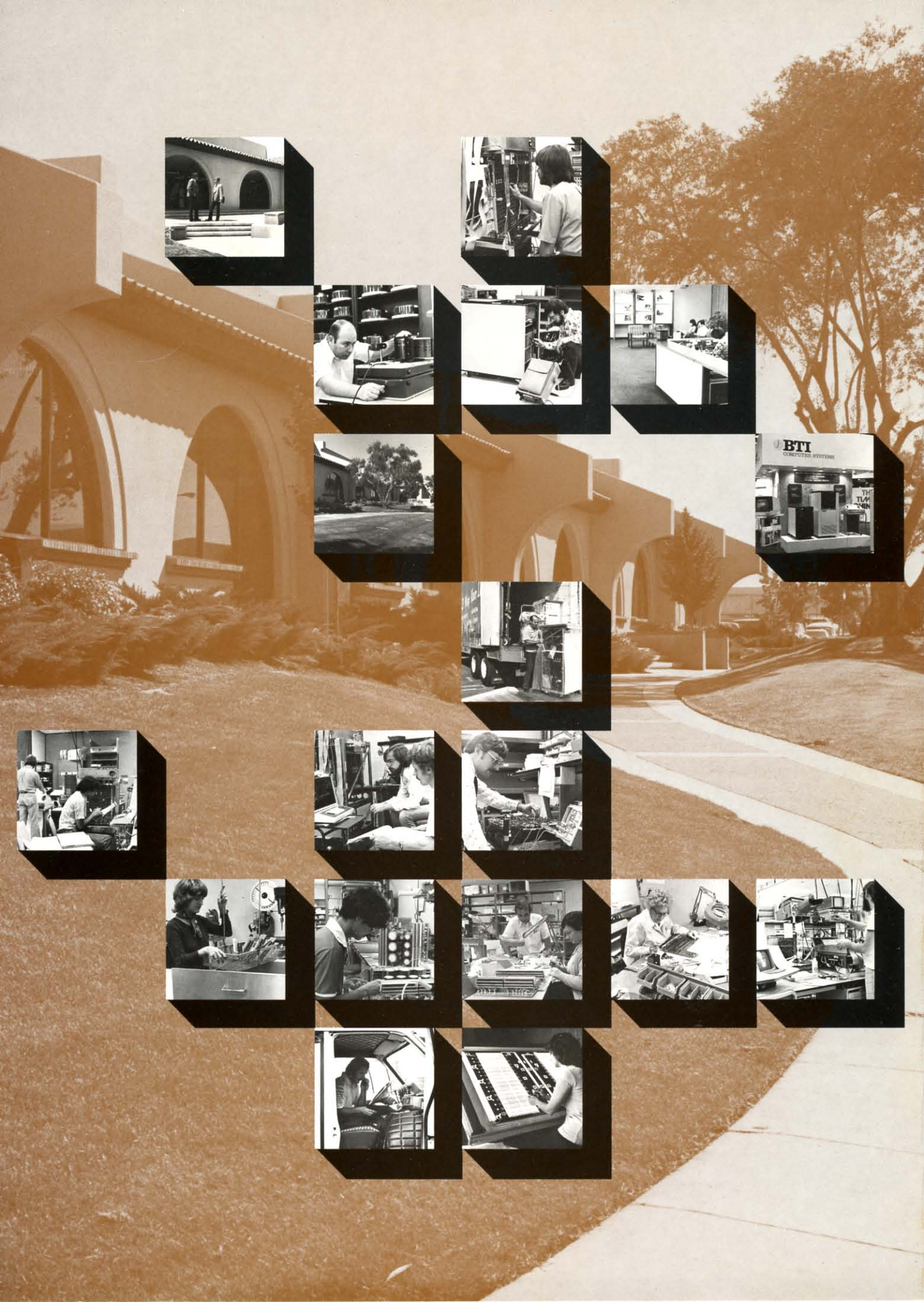
Locations for District Offices within the regions include: Seattle, Washington; Los Angeles and El Monte, California; Denver, Colorado; Minneapolis, Minnesota; St. Louis, Missouri; Cincinnati, Ohio; Washington, D.C.; Cherry Hill, New Jersey; Boston, Massachusetts; and Dallas, Texas.

The European Market

BTI sold and installed its first systems in the United Kingdom in 1976. These systems are supported by a BTI sales and field service group headquartered in Birmingham, England, which functions in the same manner as the U.S. service organization. Increasing acceptance led to the establishment of a British subsidiary, BTI Computer Systems (UK) Ltd., in 1978, based in Birmingham.

A Promising Future

Over the past decade, technological advances such as introduction of the BTI 8000 and a well-established remote diagnostic program have earned BTI a strong position in the computer market. The company will continue this tradition of technical excellence in the future by constantly revising and improving its product lines. BTI recognizes that in this highly-competitive industry there is no substitute for quality products and superior service at a fair price.


BTI
COMPUTER SYSTEMS

BTI COMPUTER SYSTEMS

Regional Sales Offices

East

225 Old New Brunswick Road,
Piscataway, NJ
08854
(201) 457-0600

South

1155 Hammond Drive,
Suite E5050
Atlanta, GA
30328
(404) 396-1630

Midwest

2401 Plum Grove Road,
Palatine, IL
60067
(312) 397-9190

West

977 Benicia Avenue,
Sunnyvale, CA
94086
(408) 749-0500

United Kingdom

1433 Bristol Road South
Birmingham B31 2SU
021-477-3846

Corporate Offices

870 West Maude Avenue,
Sunnyvale, CA
94086
(408) 733-1122

Sales Offices Throughout the United States.

Printed in U.S.A. 1001-R0481

Panorama by V. Farmer and H. Fling

NEWSPAPER

COMPUTERWORLD

THE NEWSWEEKLY FOR THE COMPUTER COMMUNITY

Weekly Newspaper Second-class postage paid at Framingham, Mass., and additional mailing offices

Vol. XV, No. 19 May 11, 1981 $1.25 a copy; $36/year

Reagan Backs Down From Data Base Scheme

By Bill Laberis
CW Staff

WASHINGTON, D.C. — The Reagan administration has backed down from a plan to create a computerized data base of all the nation's welfare recipients. The move follows allegations that the proposed plan violated constitutionally guaranteed privacy rights.

Instead, the U.S. Department of Health and Human Services is now proposing a vastly scaled-down version of the plan to detect welfare cheats.

The new proposal, which may not involve the creation of any new computerized files, seeks to allow local welfare agencies to access the files of four major federal agencies: the Social Security Administration, Office of Personnel Management, Veterans Administration and Railroad Retirement Board.

This plan differs greatly from drafts of the original proposal for a National Recipient Information Sys-

(Continued on Page 6)

A Business-Like NCC: Suits Replace Sandals

CHICAGO — The maturing of the computer community was evident here last week as pinstripe suits and leather briefcases won out over beards and leather sandals as the preferred dress among the more than 73,000 attendees at the National Computer Conference.

The 30th edition of the computer community's annual "rite of spring" also stressed applications of proven systems over flashy new technology, again reflecting the attendees newfound business-like approach.

The maturing of the industry was most evident on the main convention floor — the "penthouse suite" — where the older, more established mainframe and minicomputer vendors were joined by a raft of micro vendors who stressed business over hobby and home applications in their first major penetration of NCC's main exhibit hall.

However, several smaller, newer and perhaps more innovative firms were stuffed into the basement of the cavernous convention hall here — and also received good attention.

But while the exhibits stressed business and proven applications of the computer technology, the technical session program did not keep pace. The program was dominated by the more traditional academic-oriented papers, although some effort was made this time around to give a smattering of sessions that would be of interest to

(Continued on Page 2)

Users Want Proven Solutions

No Big Product Splashes at Show

By Brad Schultz
CW Staff

CHICAGO — Perhaps the most significant product announced here last week wasn't even announced at the National Computer Conference — it was announced in a hotel suite rented for the occasion.

At the show itself, few products were introduced. That reflected the tone of the exhibit floor, where the action was business-like as attendees made it clear they wanted to see tried-and-true solutions.

The product introduction with the most pow — a 32-bit minicomputer from Systems Engineering Laboratories, Inc. — was not introduced on the show floor. The Concept 32/87 reportedly benchmarks at three times the rate of the Digital Equipment Corp. VAX-11/780 (see story on Page 8).

Perkin-Elmer Corp. gave NCC attendees more evidence that AT&T's most important penetration into DP shops may be through software, not the hardware mentioned in federal court dockets.

PE gave its 3230 superminicomputer Bell Laboratories' Unix operating system, which already runs on many DEC systems and is the standard operating system for software development at BBN Computer Corp. The 3230 now has a version of Unix developed by The Wollongong Group under Bell licensing in Palo Alto, Calif., that reportedly supports up to 128 users in multiprogramming, time-shared environment.

Bell is allowed to sell software like Unix, provided it was developed internally to improve efficiency in Bell's voice communications business.

Media Coverage

Several vendors timed important product announcements for media coverage during the week of NCC. The biggest surprise was Data General Corp.'s revision of its Xodiac network architecture, which is now compatible with both IBM's Systems Network Ar-

(Continued on Page 10)

BTI at Top, GA at Bottom In Datapro Mini Ratings

By Tim Scannell
CW Staff

DELRAN, N.J. — Minicomputers from BTI Computer Systems, Inc. fared better than those from Digital Equipment Corp., Data General Corp. and even IBM in Datapro Research Corp.'s recent annual survey.

But, users told Datapro, machines from General Automation, Inc. leave a lot to be desired in terms of vendor support and software. This marks the second year in a row that GA has managed to crowd the other minicomputer contenders out of last place.

As the charts beginning on Page 45 indicate, last year's top winner, Tandem Computers, Inc., slid down to third position, closely trailing BTI and Point 4 Computer Corp.

Although Datapro contacted only six users of BTI's 5000 computer system, the 16-bit multiuser time-sharing minicomputer scored highest in overall user satisfaction with a near-perfect rating of 3.8. Tandem scored a 3.7 in overall user satisfaction, while Point 4

(Continued on Page 44)

BTI Minis Rated Above DEC's, DG's, IBM's

(Continued from Page 1)

and its relatively inexpensive small business computer held second place with a 3.78. BTI was also the only company out of 28 individually listed firms to have absolutely no problems listed in a category focusing on such things as late deliveries, inflated hardware and software costs and system compatibility.

Extensive Project

In its annual survey, which is the second most extensive project ever undertaken by the research firm, Datapro contacted computer users from its and *Computerworld's* subscriber lists. The company received replies from 2,173 users for a total of 2,804 minicomputer systems. Last year's survey, which generated more of a response, included 2,309 users and 3,437 systems. Also, in that survey a total of 34 vendors were rated, six more than this year's number.

The number of users and systems represented for any one firm ranged from a low of four users and four computers for Modular Computer Systems, Inc. to a high of 835 users and 996 systems for IBM. Systems were rated on a scale of zero to 4 — with 4 being the highest — or assigned percentages indicating how many of the polled users were happy with vendor support, system reliability and other human/machine aspects.

Besides coming in last with an average score of 2.2 in overall user satisfaction, GA — which was represented by 12 users with a total of 13 systems — scored lowest in technical support, a category that includes vendor troubleshooting, education and documentation. In addition, more than half of the polled users reported that GA did not provide all of the promised software and support, and three claimed that it was difficult to keep up with all of the vendor's changes to system hardware and software.

Finally, summing up their frustrations with GA's SPC-16 and 18/30 machines — the two systems spotlighted in the survey — nine out of the 12 users noted they would not recommend their system to other users. This ratio was greater than any other contained in the extensive survey.

About half of the surveyed GA system users were planning to replace their systems sometime this year, preferably with another vendor's machine. None of the dissatisfied users planned to stay in the firm's seemingly troubled hardware or software neighborhood. In addition, although the majority of GA system users claimed their computers lived up to expectations, a larger majority — nine of the users — said they would not recommend the system to other users.

Of the minicomputer heavyweights and those with more than 100 users and systems represented in the survey, Hewlett-Packard Co. gathered the greatest number of user satisfaction points, followed by IBM, DEC and DG. However, 8% of the IBM and 12% of the DG users reported they would not recommend their systems.

DG users showed the least enthusiasm for the firm's Nova 2 and Nova 800 computers, with about a quarter of the 11 polled users stating that the machines did not do what was expected. The firm's CS 40, 50 and 60 computers fared much better in the survey, although a small portion indicated that software deliveries were late and the CS 60 users noted some problems with the system's vendor-supplied applications programs.

Series/1 Complaints

Most complaints aimed at IBM minis seemed to center around the Series/1 and the System/38, according to Datapro's figures. About one-fourth of the 27 Series/1 users that responded to Datapro's questions noted the system and its software were delivered behind schedule. In addition, the same number pointed out that the configuration initially proposed by IBM was much too small to handle their requirements. Twelve percent of these users complained that the system did not do what was expected, and nearly 10% said they would not recommend the system to another user.

Although the 26 System/38 users in the survey have had their computers for only nine months or less, six have already complained that IBM did not keep all of its software support promises. A small percentage also stated that deliveries of both the System/38 hardware and software were late.

Despite these isolated problems, only about 3% of the 835 IBM users reported that their systems did not do what was expected, and a little more than 8% indicated that IBM computers would not be on the tips of their tongues when they whispered recommendations into other users' ears.

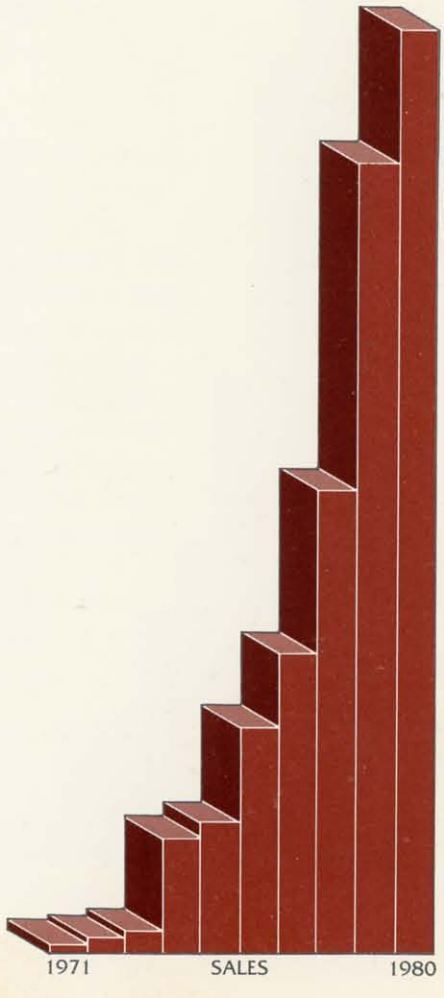
The computer systems voted most likely not to be recommended to other users were those from Computer Automation, Inc. Although only six users responded to the survey, two said the system was not all the vendor claimed it was and an equal number admitted that their comments would probably not be used by the firm to sell additional computers. Also, three of the six CA system users in the survey claimed the vendor did not provide all the promised software or support.

While a healthy portion of the more than 2,000 users surveyed by Datapro acknowledged they would be expanding their present hardware, only a small percentage indicated they would add distributed processing capabilities. In fact, a large majority of the users in the survey currently had central processing operations, with only a small chunk running distributed processing sites.

About a third will expand their data communications facilities, while about 12% to 15% will add integrated word processing to their sites. About a quarter of those surveyed said they would be acquiring additional software in 1981, with the sources for this software split almost evenly between the system vendor and outside suppliers.

BTI COMPUTER SYSTEMS

Excerpts from ANNUAL REPORT 1980



To Our Shareholders:

INTRODUCTION

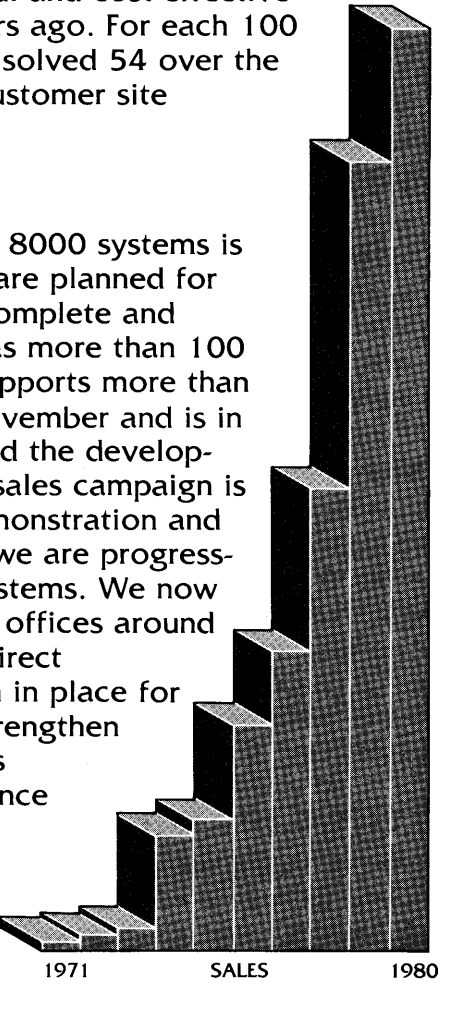
BTI® and its subsidiary organizations continued to progress and mature during 1980 in spite of the generally worsening economy and the dramatic excursions in the prime rate. A substantial portion of our Model 5000 systems have been resold into the automobile dealer market. With the continued slump in auto sales we saw a 40% decrease in the shipment rate for those systems as the year drew to a close. For the year, however, our sales were up 17% and our consolidated operating earnings[1] were up 7%. Although we expect a slow beginning for 1981, we anticipate even greater increases in both sales and earnings for 1981 with the addition of the Model 8000 to our product line.

FIELD SERVICE

Our most dramatic improvements in 1980 were in Field Service. Our service revenue was $9,290,000 in 1980, an increase of 82% as compared to $5,093,000 in 1979. Our gross profit on service revenue increased substantially which, after allocating appropriate expenses, now makes a positive contribution to our net income. The principal contributions came from the introduction of our own central processor with greater field repairability, generally increased hardware reliability, and refinements in our diagnostic, operating and shipment methods. We continue to service U.S. and Canadian systems from Sunnyvale and all others from Birmingham, England. Both service groups still use the very successful and cost-effective remote diagnostic techniques pioneered by BTI ten years ago. For each 100 trouble calls for the Model 5000 received we typically solved 54 over the telephone, 43 by shipping parts, and only 3 required customer site visits.

PROGRESS ON THE BTI 8000

All of the documentation for the pilot run of 15 Model 8000 systems is released to manufacturing and the first customer units are planned for shipment in May. Five R&D-built systems are already complete and operating well. The "software development" system has more than 100 terminals and modems connected to it and routinely supports more than 60 users. One system was delivered to Marketing in November and is in use for trade shows, demonstrations, benchmarking, and the development of training courses and user documentation. The sales campaign is beginning in earnest as the sales aids, manuals and demonstration and benchmarking capabilities become available. To date, we are progressing well, having received orders for 17 Model 8000 systems. We now have 19 direct salesmen in the field working out of 14 offices around the country. By the end of 1981, we plan to have 38 direct salesmen in the United States and a marketing program in place for Europe and possibly Australia as well. The 8000 will strengthen our position in our existing markets, make new markets available to us, and provide us with a long-sought balance in our customer distribution.



[1] "operating earnings" for 1979 = Net Income less litigation settlement net of income taxes.

OTHER ACCOMPLISHMENTS OF 1980

In December of 1980 we shipped our 3,000th system, finishing the year with 3,013 systems delivered to customers. Production continued to match our schedule. Our employment increased from 360 to 450 during the year. We opened five new sales offices and doubled our direct sales force. We invested 12% of our sales revenue in Research and Development in support of the 5000, the 8000, and future product programs. Substantial reductions were made in production costs of the 5000 as the result of a program begun in 1979. And last, but not least, we accelerated the audit process to produce this annual report three weeks earlier than last year.

INCREASED REVENUE AND PROFITS IN 1980

Revenue for the year ended December 27, 1980, was $33,978,000, an increase of 17%, as compared to $29,102,000 in 1979. Consolidated net income for 1980 was $1,009,000, an increase of 7%, as compared to the 1979 net income (taken before the litigation settlement income net of taxes). Both revenue and net income exceeded our plan.

FINANCING BTI'S PAST GROWTH

Since 1973 BTI has averaged a compound sales growth rate of more than 50% per year. We financed that growth primarily through retained earnings, increased bank loans and, to a minor degree, through sales of stock to key employees. We have controlled our capital needs through a four-part strategy:

1. We have intentionally avoided the capital-intensive portions of the manufacturing processes.
2. We have kept very close control of our production inventory, typically turning it four or more times per year.
3. We routinely maintain our accounts receivable at 20 to 30 days. We have accomplished this by insisting on "net 10" terms for all but our very largest customers who are on net 20.
4. We have for years had excellent support from our commercial bankers. In the summer of 1980, we were pleased to negotiate a new and larger line of credit with the Bank of America. Prior to that, we were with The Bank of California for almost ten years.

LONG-TERM SALES PROSPECTS

As we begin 1981, we have contracts for almost $50 million each in service and sales spread over the next three and five years, respectively. With the addition of the 8000 and major new OEMs for the 5000, our contracts for the automobile dealer market represent less than 22% of our total system sales orders. The 8000 is a new and unique product, and with continued development work should produce growing sales for a decade or more. While the 5000 and its ancestor systems have been in production for a decade now, we have good reason to believe that we may sell and ship another 3,000 systems from that family.

FINANCING BTI'S FUTURE GROWTH

While we might wish to continue our past financing strategies, we also consider it prudent to have alternatives available. Since 1978 we have developed relationships with eight first-rate venture capital firms who have expressed continuing interest in

investing in BTI. We also have developed relationships with what we consider to be the two foremost investment bankers engaged in taking high-technology companies public. Each has expressed an interest in underwriting a public offering of BTI stock should we need and want to do so. We intend to work closely with the investment bankers in early 1981 to develop a detailed strategy for a public offering. With the addition of the Model 8000, we will further reduce our dependence on the automobile dealer market and have a much more saleable market balance for a public offering.

PRO FORMA RESULTS OF OPERATIONS—COMBINED

In order to facilitate a comparison of the company's performance with other companies in the industry, management has prepared a summary for 1980 as if all the operations had been combined into a single company. Starting with the combined income before taxes and profit sharing, the summary shows profit sharing, income taxes (calculated on a regular basis as opposed to BTI's current Subchapter S status) and net income of BTI Computer Systems and its subsidiaries.

	Amount	% of Revenue
Income before taxes and profit sharing	$ 2,222,477	6.5
Add minority interest	416,600	1.2
Pro forma income before taxes and profit sharing	2,639,077	7.7
Less profit sharing	308,847	0.9
Pro forma income before taxes	2,330,230	6.8
Pro forma income taxes	1,097,000	3.2
Pro forma net income	$ 1,233,230	3.6

The gyrations in the economy and the auto industry have required some adjustments by us during the year, but we have no regrets about our past dependence on that market. Now that the 8000 is in manufacturing's hands, its schedule will be more predictable, and we look confidently to the future.

Thomas C. Poulter, Jr.

January 23, 1981

Thomas C. Poulter, Jr.
President

BTI COMPUTER SYSTEMS AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEET

December 27, 1980 and December 29, 1979

ASSETS	1980	1979
Current assets		
Cash	$ 260,582	$ 721,607
Accounts and notes receivable		
Trade, less provision for doubtful accounts ($144,000 and $28,051)	1,810,168	2,131,388
Vendor agreements	—	92,788
Other	64,478	—
Inventories, at cost (first-in, first-out) not in excess of replacement market	9,396,437	8,204,374
Prepaid expenses	203,765	140,195
Total current assets	11,735,430	11,290,352
Equipment and improvements, at cost		
Electronic equipment	2,921,776	2,349,047
Furniture and fixtures	490,623	385,273
Transportation equipment	410,868	428,574
Improvements	387,736	317,321
Communication equipment	263,599	261,801
Construction in process	851,383	—
	5,325,985	3,742,016
Less accumulated depreciation and amortization	1,772,417	1,161,047
	3,553,568	2,580,969
Other assets	76,493	63,578
	$15,365,491	$13,934,899

LIABILITIES AND SHAREHOLDERS' EQUITY		
Current liabilities		
Current maturities of long-term debt	$ 935,088	$ 145,910
Current maturities of note payable— Control Data Corporation	147,667	147,667
Note payable—bank	4,335,027	4,998,151
Accounts payable	2,215,597	2,749,871
Income taxes	51,579	1,002,503
Deferred revenue and customer advances	11,445	38,445
Accrued expenses	1,177,561	772,680
Total current liabilities	8,873,964	9,855,227
Long-term debt, less current maturities	1,594,909	230,528
Note payable—Control Data Corporation, less current maturities	49,222	184,583
Deferred income taxes	228,115	87,250
Commitments		
	1,872,246	502,361
Minority interest in subsidiary	2,049,583	1,470,643
Shareholders' equity		
Capital stock with no par value; authorized 500,000 shares, issued 88,000 shares	108,000	108,000
Retained earnings	2,461,698	1,998,668
Total shareholders' equity	2,569,698	2,106,668
	$15,365,491	$13,934,899

BTI COMPUTER SYSTEMS AND SUBSIDIARIES
CONSOLIDATED STATEMENT OF INCOME

Years (52 Weeks) Ended December 27, 1980 and December 29, 1979

	1980	1979
Net sales	$33,978,177	$29,102,536
Cost of sales	20,679,378	18,659,962
Gross profit	13,298,799	10,442,574
Operating expenses	10,091,991	7,206,838
Operating income	3,206,808	3,235,736
Other income (expense)		
Minority interest in net income of subsidiary	(416,600)	(478,991)
Interest expense	(938,878)	(859,876)
Litigation settlement	—	255,019
Miscellaneous, net	62,300	(2,670)
	(1,293,178)	(1,086,518)
Income before income taxes	1,913,630	2,149,218
Income taxes	905,000	1,087,500
Net income	$ 1,008,630	$ 1,061,718

RESEARCH AND DEVELOPMENT AND MARKETING EXPENDITURES

Such expenditures are charged to operations in the period incurred, and are included in operating expenses as follows:

Research and development	$4,116,788	$2,734,794
Marketing	$2,720,721	$1,959,698

The foregoing information has been summarized from financial statements, which have been examined by Main Hurdman and Cranstoun, independent certified public accountants. A copy of such financial statements with the accountants' report, which is unqualified, is on file at BTI Computer Systems.

Thomas C. Poulter, Jr. William D. Mazzera

President Vice President, CFO

BTI
COMPUTER
SYSTEMS

870 West Maude Avenue, Sunnyvale, California 94086

Printed in U.S.A.
1199-F0481

BTI COMPUTER SYSTEMS

SALES OFFICE LOCATIONS

CORPORATE HEADQUARTERS

BTI Computer Systems
870 West Maude Avenue
Sunnyvale, CA 94086
(408) 733-1122

WESTERN REGION

REGIONAL HEADQUARTERS:

BTI Computer Systems
977 Benicia Avenue
Sunnyvale, CA 94086
(408) 749-0500

BTI Computer Systems
11100 Valley Boulevard
El Monte, CA 91734
(213) 350-4383

BTI Computer Systems
2040 Avenue of the Stars
Century City, CA 90067
(213) 552-0400

BTI Computer Systems
220 West Mercer
Seattle, WA 98119
(206) 284-2355

BTI Computer Systems
7346 South Alton
Englewood, CO 80112
(303) 771-3069

MIDWESTERN REGION

REGIONAL HEADQUARTERS:

BTI Computer Systems
2401 Plum Grove Road
Palatine, IL 60067
(312) 397-9190

BTI Computer Systems
3001 Metro Drive
Minneapolis, MN 55420
(612) 854-1122

BTI Computer Systems
8170 Corporate Park Drive
Cincinnati, OH 45242
(513) 984-6442

SOUTHERN REGION

REGIONAL HEADQUARTERS:

BTI Computer Systems
1155 Hammond Drive, Suite E5050
Atlanta, GA 30328
(404) 396-1630

BTI Computer Systems
1341 West Mockingbird Lane
Dallas, TX 75247
(214) 630-2431

EASTERN REGION

REGIONAL HEADQUARTERS:

BTI Computer Systems
225 Old New Brunswick Road
Piscataway, NJ 08854
(201) 457-0600

BTI Computer Systems
900 Dudley Avenue
Cherry Hill, NJ 08002
(609) 662-1122

BTI Computer Systems
8150 Leesburg Pike
Vienna, VA 22180
(703) 356-0670

BTI Computer Systems
1812 House
1000 Worcester Road
Framingham, MA 01710
(617) 875-1122

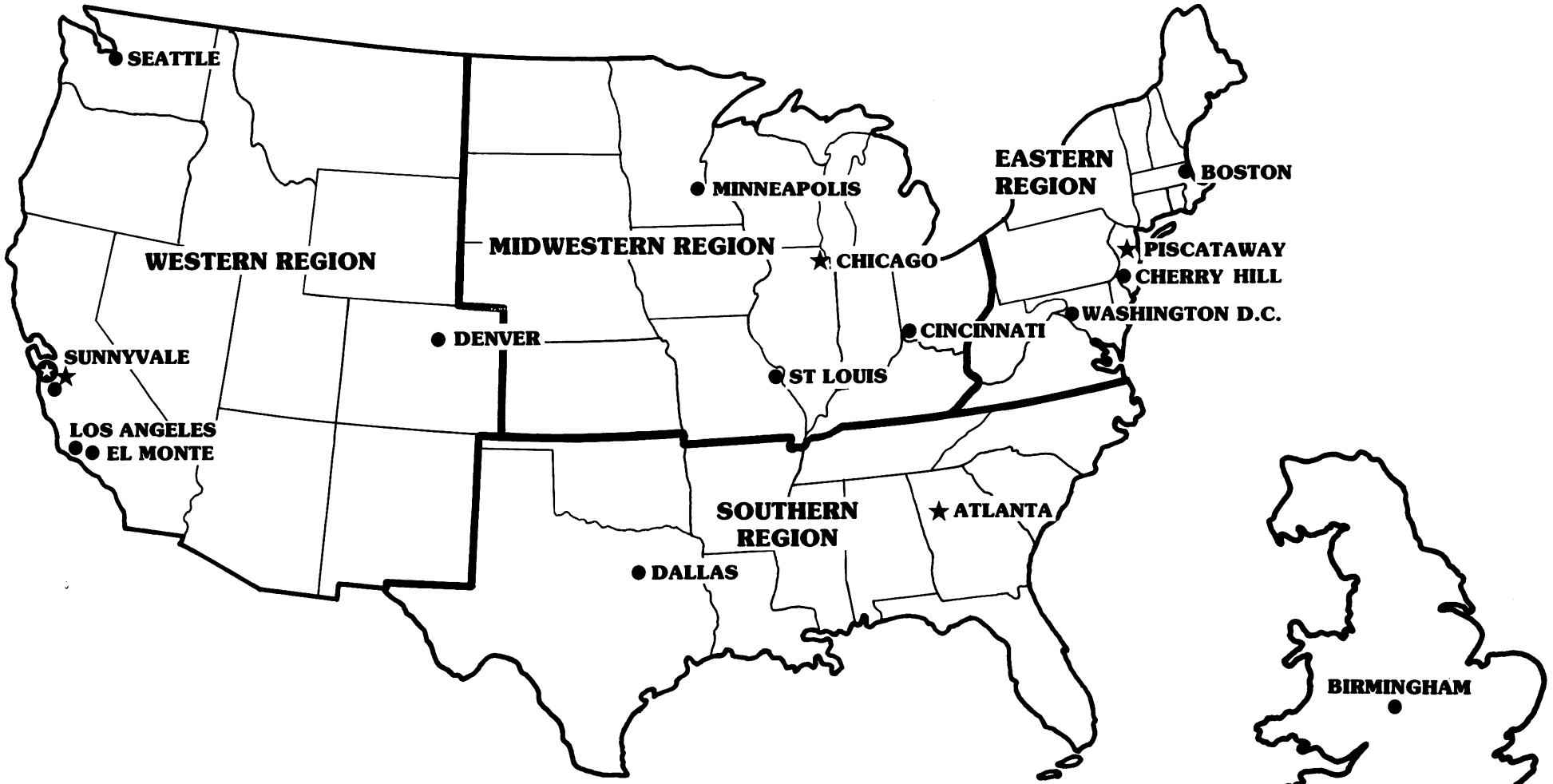
UNITED KINGDOM

BTI Computer Systems
1433 Bristol Road South
Birmingham, England B31 2SU
021-477-3846

169-R0681
ted in USA

BTI COMPUTER SYSTEMS

SALES OFFICE LOCATIONS



KEY: ✪ CORPORATE HEADQUARTERS
★ REGIONAL HEADQUARTERS
● DISTRICT SALES OFFICE

BTI
COMPUTER
SYSTEMS

Customer Service

A complete service program...

BTI Customer Service

Service is one of the most significant expenses of owning a computer system. Yet, it is frequently overlooked when comparing costs. Often, the annual bills for maintaining a well-running system amount to a substantial percentage of the purchase price of the system. And these costs are on the rise. Scarce manpower and increasing transportation charges are making on-site service a very expensive way to repair a system.

To combat these rising prices and still keep up the quality of service, many computer companies are beginning to set up programs for over-the-telephone support of the systems they sell. Here at BTI, we agree that this is a good idea. *In fact, we've been doing it for over ten years!*

Aided by computer-to-computer diagnosis, BTI offers its customers a sophisticated remote service plan with time-saving, cost-cutting features unmatched by any competitor. Our plan provides customers with 24-hour-a-day, instant access to the best-trained computer service engineers at our National Service Center in Sunnyvale, California. Most of the problems are solved right over the phone, some require a simple exchange of hardware modules by the customer, and only 3% of the cases require an on-site visit. We currently support over 3,000 BTI systems in the U.S., Canada and Europe with this plan.

All this means that you, as a BTI customer, will receive the best possible support at the lowest possible price.

Director of Field Service (far right) at BTI's National Service Center. Map shows over 3,000 BTI systems installed in the U.S., Canada and Europe.

Comprehensive Service Plan

Because on-site visits are the slowest, most expensive form of service, BTI's plan is specifically designed to limit these visits, while still providing full support.

When a customer call comes in, a senior service engineer, who is experienced in both hardware and software, first tries to locate and correct the trouble over the phone. BTI's computer-to-computer diagnosis helps the engineer to pinpoint the problem. For both BTI and the customer, over-the-phone correction is the fastest, least expensive way to provide support. Our records show that over 53% of all problems are solved this way.

When required, a replacement part is immediately sent to the customer. This method also saves money because the customer replaces the part by himself, a task that is never more difficult than replacing a component in a home stereo system. Over 43% of all problems are solved this way.

In only 3% of the reported failures does a BTI service engineer have to visit the customer's site. Even then, the engineer can go right to work, because he already has a complete record from BTI's on-line customer service files of exactly what the problem is and what has already been done to correct it.

Quick Return to Operation

To fix problems quickly, no matter what time you need help, BTI's National Service Center is open 24 hours a day, every day of the year.

Our service department is staffed so that a trained service engineer will usually respond to your call within 20 minutes, even during peak hours. In fact, over 80% of all calls are answered within five minutes. This means that a specialist is immediately at work on your problem.

Because 53% of all problems are corrected over the phone, delays are held to a minimum and your staff is not kept waiting. Most systems are back in operation within *two hours*.

First Team Approach

BTI's remote service plan is based on a "first team approach" which means the best-trained, most experienced service engineer available begins working on your problem from the very start. Aided by advanced record-keeping and diagnostic computers, this expert solves the majority of customer problems over the phone, within two hours after they have been reported.

Rigorous, on-going training programs and substantial on-the-job experience makes each BTI service engineer a qualified repair specialist. Required training subjects for all telephone and travel engineers include: technically-oriented classes on the theory

that keeps your system running...

and operations of all component parts of our systems (CPU, power supplies, disk drives, etc.), plus additional sections on assembly language programming and operating system software.

Moreover, because our service engineers are concentrated at the National Service Center, they are able to confer with each other and keep up to date on all the latest repair techniques.

The BTI approach contrasts sharply with conventional service programs where the least experienced, least trained service engineer is the first to respond to a customer's call. If, after a few hours' work, this engineer can't fix the problem, he calls in someone with more experience. After several additional hours, a regional or factory specialist is brought in. In many

As a first step in remote diagnosis, a senior service engineer discusses the problem with the customer.

cases, the problem is made worse by the first level service engineers, complicating and delaying the eventual repair. With BTI's first team approach, this will never happen.

Lowest Possible Cost

BTI's 24 hour support is actually less expensive than conventional programs that provide service only during normal business hours. This is possible because our service plan ensures that the most skilled people are at work on your problem from the very beginning. A minimum amount of time is wasted locating the trouble.

Manpower costs are minimal because on-site visits are rarely needed, and computers are used to run diagnostic tests, keep service records, locate parts, and dispatch personnel.

Remote Fault Diagnosis

After your call for help comes in, the service engineer first tries to diagnose the trouble by talking to you. The next step is to run a series of over-the-phone tests on your system using the special diagnostic computer at BTI's National Service Center.

Every BTI computer system is specifically built to accommodate remote diagnosis. Tests can be run when your system is completely halted, or even while people are still using it.

In communication with your system, the diagnostic computer can check CPU registers, main memory locations, disk contents, transfers between disk and main memory, disk seek operations, disk pack integrity, CPU arithmetic operations, CPU speed, tape read and write operation, and communications interface operations.

In addition to standard computer-to-computer diagnosis, the service engineer can dial your system directly and run his own special programs to test individual PC boards or other sub-portions of the system not covered by the normal diagnostic procedure.

Preventive Maintenance

Quickly diagnosing and correcting problems isn't the only way BTI's remote service plan maximizes the availability of your system. Our support plan can also prevent trouble from happening. By giving your system periodic "health checks," BTI's diagnostic computers can detect impending problems before malfunctions even occur. For example, a health check can uncover a failing disk drive or memory board. In these cases, BTI will arrange for a replacement to be ready and waiting on-site.

Health checks are done automatically over the phone, and your system remains in full operation. Normally, users are not even aware that this diagnosis is taking place.

From the phone room at BTI's National Service Center, engineers can run computer-to-computer diagnostic tests on customer systems located anywhere in the country.

and minimizes costs.

Complete, On-Line Service History

To avoid any possible confusion about your exact service needs, a special computer at our National Service Center keeps a complete service history of all BTI computers. For every customer problem, past or present, these records include details on all current activities, diagnostic test results, recommended repair action, repair steps already completed, and a full list of parts that have been shipped.

This information is kept on-line, and service engineers may access it either at the factory or by telephone from their home, a customer site, or anywhere in the field. If, for example, work shifts are changed and the problem is reassigned, this complete service history ensures that the engineer taking over the problem will be instantly updated on your system's status, and know exactly what to do next.

BTI's Man-in-the-Van with a full stock of repair parts.

Speedy Parts Supply

For hardware problems, BTI makes certain that a replacement part is shipped from the nearest parts depot by the fastest possible means. In most cases, new parts will arrive at your site within 24 hours. This is true even for major pieces, such as replacement disk drives or CPUs.

Parts can be sent from any one of BTI's strategically located parts facilities in Sunnyvale, California; Minneapolis, Minnesota; and Memphis, Tennessee. For areas where the installation density of systems is high, BTI provides a "Man-in-the-Van": a service engineer in a van stocked with enough spares and test gear to repair any system.

Frequently, parts are air shipped from the van to the system site, with replacement of the van's spares then sent from Sunnyvale.

To help ensure the fastest response, a computer at BTI's National Service Center keeps a complete inventory of all parts, including those on the roving vans.

On-Site Services

Although only required in unusual cases, BTI maintains a team of two dozen service engineers who specialize in on-site support. Typically, one-third of these engineers are in the field at any given time, either visiting customer sites or assigned to a roving van.

Systems configured with removable pack disk drives require head alignment twice a year. To save an unnecessary trip, a service engineer visiting one of these sites to do other repairs will also perform this routine adjustment.

Central dispatch at the National Service Center keeps careful records of where each man is assigned, ensuring that an engineer will be located and dispatched to your site quickly.

With each new assignment, the service engineer is given a complete history of the problem, including what action has already been taken and the results of all diagnostic tests. Even before he arrives on-site, the engineer knows exactly what repairs your system needs. No time is wasted, and your system is back in operation with a minimum of delay.

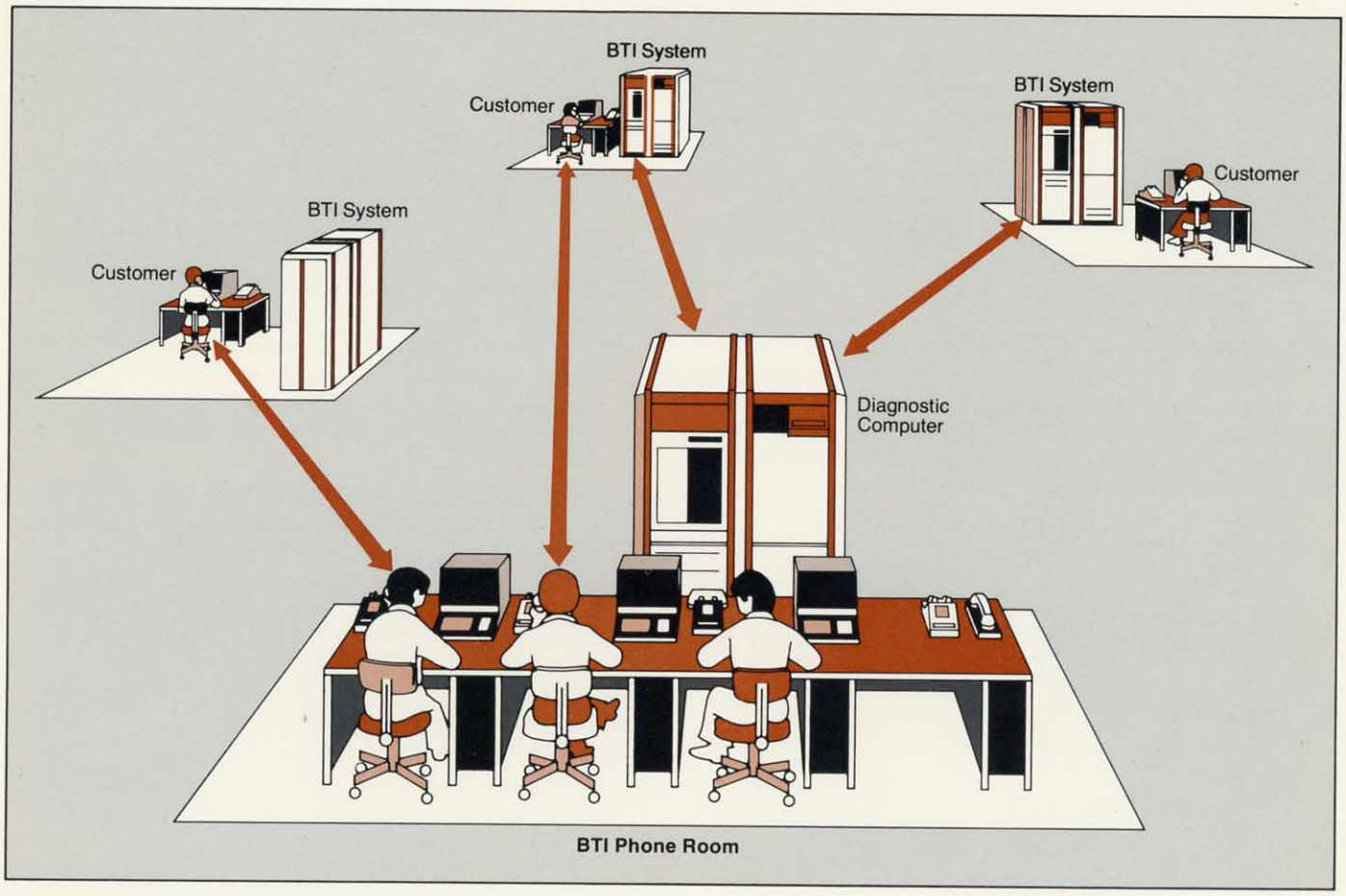
Tradition of Excellence

Here at BTI Computer Systems, we pride ourselves on our sophisticated remote service plan and the comprehensive benefits it provides. Every facet of the plan — including round-the-clock availability, computer-to-computer diagnosis, instant response, and expert service personnel — is designed to give you the best possible support at the lowest possible price.

Ten years ago, we pioneered over-the-telephone support. And with maximum system availability and minimum repair delays, we've been making our customers happy ever since. It's your turn next.

For more information on our remote service plan, or answers to any questions you might have about BTI, please contact our nearest sales office.

Responsive, on-line customer support



Rapid Fault Diagnosis and Correction

With BTI's Remote Service Plan, support is as close as the nearest telephone. Senior service personnel are available 24 hours a day, every day of the year at BTI's National Service Center. To help pinpoint and correct a problem, customers talk directly to the service engineer. In addition, standard phone lines are used to link BTI's Diagnostic Computer to the customer's system for special troubleshooting tests and periodic "health checks."

- More than 53% of all customer problems are solved over the phone.
- Over 43% are corrected by simply sending a part.
- Only 3% require an on-site visit by BTI.

BTI products

BTI 5000

The BTI 5000 Interactive Computer System has been the mainstay of company business since its introduction in 1978. Designed with the knowledge and experience gained in previous product lines, the BTI 5000 features 16-bit architecture with hardware floating-point arithmetic, 27 to 468 Mbytes of on-line disk storage, and capacity to support up to 32 users at the same time.

Peripherals include magnetic tape cartridge drives, removable and non-removable pack disk drives, an industry-compatible open-reel magnetic tape drive, and a choice of line printers with rates of 300, 600 and 900 lines-per-minute.

BTI 8000

BTI's newest product, the 8000, is a 32-bit multilingual, multiprocessor system that features a revolutionary design concept called "Variable Resource Architecture" (VRA).

VRA, a flexible mix of hardware resources controlled by a single, self-regulating operating system, gives the BTI 8000 a growth potential equivalent to an entire family of computers. Customers may add or delete hardware modules (i.e., computational processors, memories, and peripheral processing units) to create the exact configuration they need.

The BTI 8000 can support up to 200 interactive and/or batch processes. Memory can be added in increments of 512 Kbytes up to a total of 16 Mbytes. Peripherals include magnetic tape cartridge drives, removable pack disk drives for up to 8 gigabytes of on-line storage, industry-compatible open-reel magnetic tape drives, and line printers with rates of 300, 600 and 900 lines-per-minute.

Corporate Headquarters:
870 West Maude Avenue
Sunnyvale, California 94086
(408) 733-1122

Regional Offices:

East
225 Old New Brunswick Road
Piscataway, New Jersey 08854
(201) 457-0600

Midwest
2401 Plum Grove Road
Palatine, Illinois 60067
(312) 397-9190

South
1155 Hammond Drive, Suite E5050
Atlanta, Georgia 30328
(404) 396-1630

West
977 Benicia Avenue
Sunnyvale, California 94086
(408) 749-0500

Sales offices in major U.S. cities.

United Kingdom
1433 Bristol Road South
Birmingham, England B32
2SU 021-477-3846

BTI COMPUTER SYSTEMS

Litho in U.S.A.

5M 3/81

1193

BTI 8000

32-BIT MULTIPROCESSOR SYSTEM

Variable Resource Architecture

Growth in processing power when you need it

The BTI 8000 32-bit multi-processor system introduces a unique computer design known as VARIABLE RESOURCE ARCHITECTURE.

The fundamental innovation of VRA is a flexible mix of hardware resources controlled by a single self-regulating operating system.

Hardware resources consist of multiple processors, memories, and input-output channels operating in parallel without the complex internal networking normally associated with such arrangements.

Performance of a BTI 8000 can be varied *over a ten-fold range* merely by incrementally adding or deleting hardware modules, including full scale 32-bit processors. The virtual machine environment created by the operating system makes the resource mix transparent to the job mix. Differences in configuration are invisible to user software, and no reprogramming or recompilation is required.

Key features of the BTI 8000 are:

- ☐ From 1 to 8 CPU's controlled and coordinated by one operating system.
- ☐ Up to 16 megabytes of main memory.
- ☐ Up to 200 interactive users and multi-stream batch processes.
- ☐ From 4 to 32 input-output channels.
- ☐ Fail-soft architecture.
- ☐ Secure multi-user operations.
- ☐ Demand-paged virtual memory.
- ☐ Task oriented assignment of hardware and software.
- ☐ Simultaneous use of ANS COBOL 74, ANS FORTRAN 77, PASCAL/8000 and BASIC/8000.

Cost Effective Data Processing

A checklist for the professional manager

High Performance at the Right Price

The CPU's use 32-bit architecture throughout with 32- or 64-bit integer arithmetic and 64-bit floating point arithmetic. Virtual memory support is built into the CPU's, with address translation performed in 67 nanoseconds. All transfers between modules take place at the rate of 60 megabytes per second. A powerful instruction set directly supports the linked-list, stack, and array structures generated by modern compilers.

Optimize for Today

Each system can be configured to a specific workload requirement, whether it be for a large number of interactive users, a heavy batch processing load, or a large disk data base.

No Growing Pains

System performance can be increased in any or all of four areas — processing power, main memory, storage capacity, and number of I/O channels — by incrementally adding resource modules. Respond to changing conditions with full protection for your hardware and software investments.

Maximum Staff Productivity

No need to maintain or modify the operating system — now or ever. The data processing staff can focus efforts on applications rather than on the system itself. Just as important, programmers can develop and test all applications, including batch jobs, interactively.

Maximum Up Time

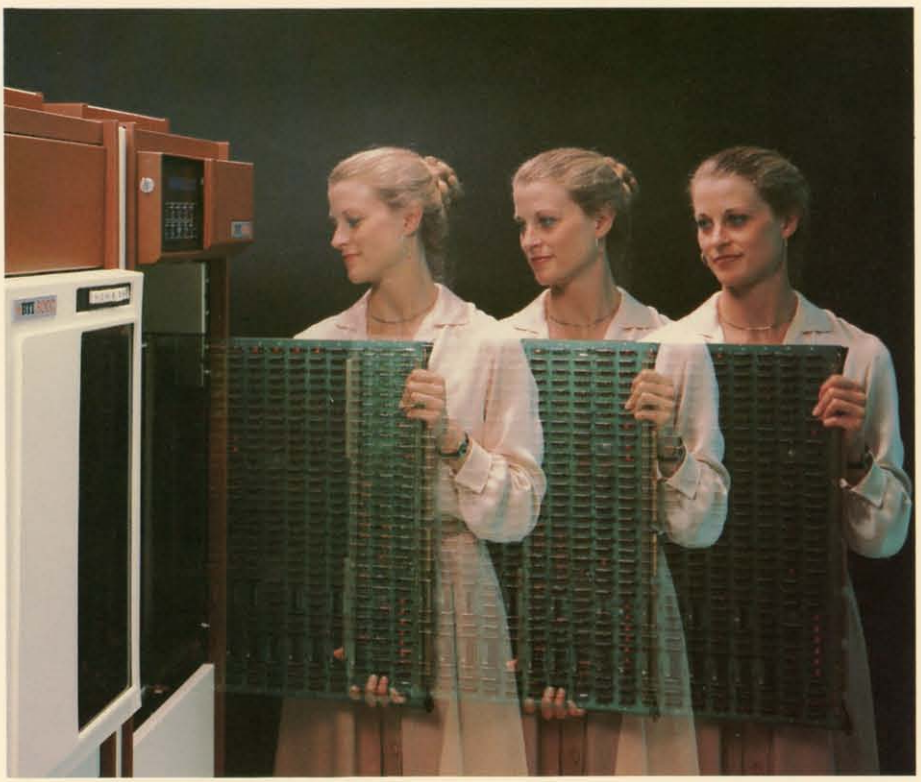
In a multiple resource configuration, the system is fail-soft. Self-tests at the module level isolate faults rapidly. Once a faulty module has been removed, system start-up and operating system reconfiguration take about 8 seconds. In addition, the BTI system of computer-to-computer diagnostics can be called upon to identify more difficult problems within minutes.

Built-In Data Protection

Program re-runs and application failures resulting from disk read errors are minimized. Unique hardware support provides automatic reconstruction of data blocks in a majority of read error situations.

Security and Privacy

The operating system is isolated from all user programs, communicating only on a request-for-service basis. The system is thus protected from inadvertent or deliberate violations of integrity. Further, each user operates in a private virtual machine environment, secure from other users. All data, programs, and access privileges are private unless explicitly shared.



Variable Resource Architecture

A unique combination of hardware and software design

Hardware Architecture

The basis of the BTI 8000's hardware architecture is a high speed, distributed logic bus with a 32-bit wide data path. Up to 16 hardware resource modules may be attached to this bus. Transfers between modules take place at the rate of 60 megabytes per second.

Four types of resource modules are used:

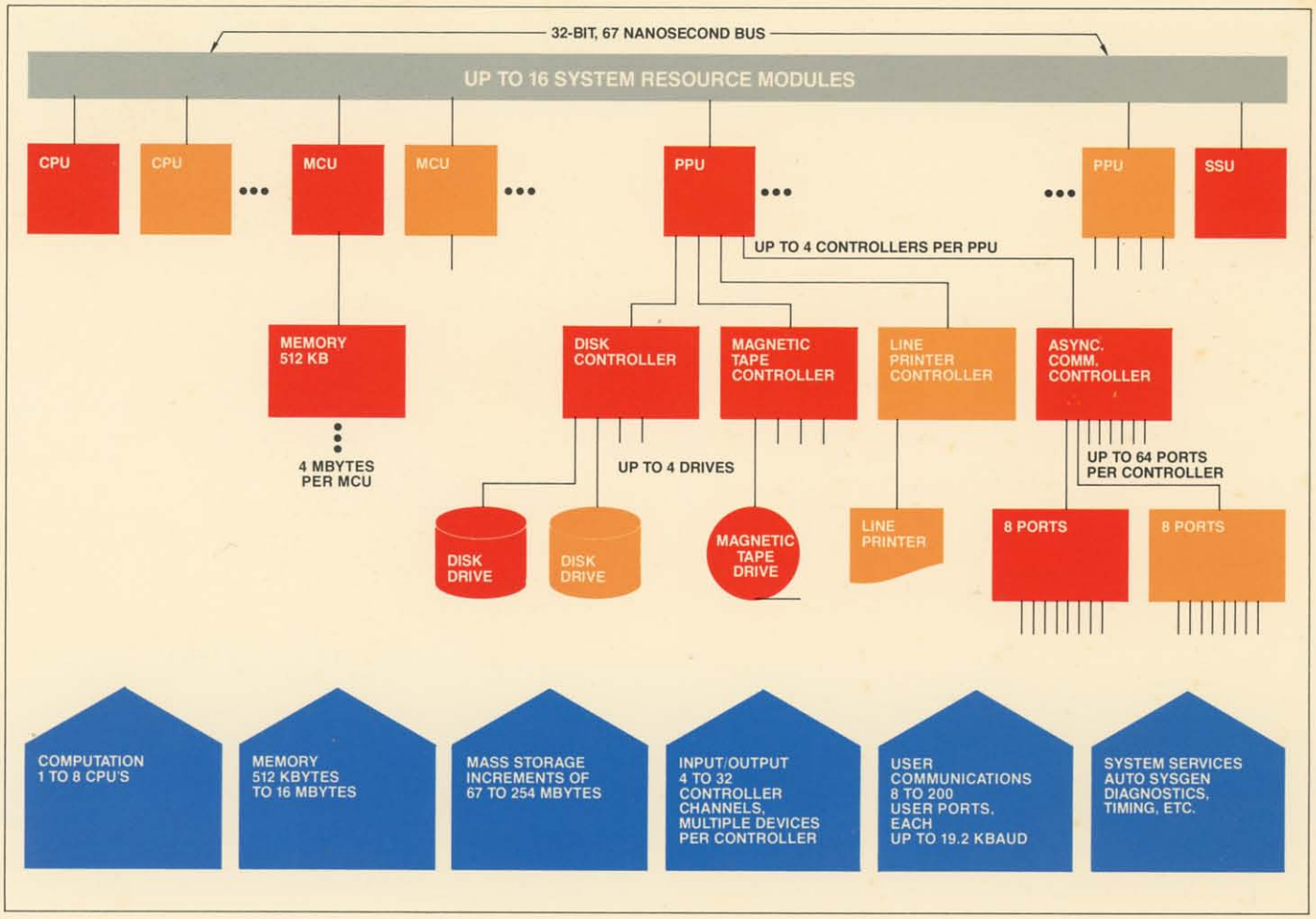
Computational Processing Unit	CPU
Memory Control Unit	MCU
Peripheral Processing Unit	PPU
System Services Unit	SSU

One module of each type is required for a minimum system configuration. More CPU's, MCU's, and PPU's may be added in the appropriate mix to meet application needs. Only one SSU is required, although a second (inactive) may be installed to provide redundancy.

Processors

One, or more, identical 32-bit CPU's, operating in parallel and asynchronously, perform the processing. The CPU's are instruction processors only, with no private memory. They execute both user programs and operating system tasks on an as-available basis: when a CPU becomes free due to an I/O roadblock or time slice interrupt, it executes the operating system code which dispatches it to the next task, also updating the central dispatch table.

Since all CPU's share the workload equally, the addition of a CPU is a simple and direct means of increasing system throughput. Conversely, removing a CPU does not disable the operating system or any class of user jobs.



Main Memory

Up to 16 megabytes of main memory can be interfaced to the system via Memory Control Units, with a single MCU controlling from 512 Kbytes to 4 megabytes of memory. All main memory is treated as a single entity, even if interfaced via more than one MCU. Multiple units operate in parallel, decreasing overall effective memory cycle time.

Peripheral Processing Units

Peripheral Processing Units are special purpose processors which relieve CPU's of channel management overhead. Each manages up to four independent I/O channel activities initiated by CPU's, handling data transfers between memory and peripheral devices without further CPU involvement.

PPU's also provide buffering, blocking, and deblocking services. Their channels can be connected to controllers for the following: disk drives, 9-track magnetic tape drives, magnetic tape cartridge drives, line printers with rates from 300 to 900 lines per minute, and user communications.

Disk Drives Disk drives can be interfaced in any mix of sizes through multiple-drive controllers. Access times are minimized through overlapping seek capability in the disk controllers.

All drives are high density storage units, and are available in formatted capacities of 67 to 254 Mbytes. A practical system configuration can have over 8 billion bytes of storage.

User Communications

Terminals and modems are interfaced through microprogrammed Asynchronous Communications Controllers (ACC's). System port capacity can be configured in 8-port increments up to a practical maximum of 200 ports. Expansion is accomplished simply by adding port modules and ACC's. Data transfers at rates up to 19.2 kilobaud are possible at all ports.

User programs may have control over interface pins, terminating character selection, and input/output buffers, allowing use of non-standard asynchronous devices.

System Services Unit

The System Services Unit provides a variety of functions designed to enhance system automation, reliability, and security. A control panel provides alphanumeric displays and eight switches for simplified off-line operations.

Automatic System Generation is initiated by the SSU. At start-up the hardware resource modules present are checked. If the configuration has been changed since the previous start-up, the operating system automatically reconfigures itself to match the resources in use.

Diagnostic Self-Tests are run by each hardware resource module at start-up. Any module not in working order is identified on the control panel display. Modules that fail during operation will cause the system to stop and will be identified on the control panel display. In a multiple module system, the failed module may be removed and the system restarted without it.

Remote Diagnostic Service provided by BTI's central maintenance facility is interfaced through the SSU. Via a telephone link, both on and off-line diagnostics can be conducted, even if no system operator is present.

A System ID Number is stored in the SSU. It is program-accessible, allowing software suppliers to build ID checks into their packages, and thus, prevent unauthorized installations of their software.

Power-Fail/Auto Restart capability provides for automatic unattended restart without loss of processing continuity.

The System Clock is backed up by a rechargeable battery in case of power outages or disconnections.

Virtual Machine Multiprocessing

For optimum use of resources

Operating System Principles

The BTI 8000 operating system is the central mechanism that ties the hardware elements into a powerful, applications-oriented computer system. Using these elements as a pool of resources, it creates the user-environment structures that provide hardware independence, program capabilities, security, and control.

Hardware — Independent Application Design

The operating system creates a private virtual machine environment for each distinct process on the system, and can run up to 200 processes simultaneously.

Each virtual machine provides the same standard, fixed program environment. Since the operating system shields all users and all programs from actual hardware, programs may be designed without concern for present or future configurations.

Program Capabilities

The virtual machine includes a user address space of 512 Kbytes (one-half megabyte), exclusive of buffer space for data record blocking and deblocking. This virtual memory is always available for each process, regardless of the amount of physical memory present or the number of other processes sharing that memory.

Device-Independent Programming

Each virtual machine is also furnished with 200 logical data channels which may be linked to system-provided logical I/O devices, for device-independent I/O. The same unchanged program may be alternately used to output to a terminal, a spooled printer, a disk file, a magnetic tape, or even an inter-process communications path. Since the system command language is the same for both interactive and batch processing, batch jobs may be developed and even tested interactively, with the terminal substituting for batch input and output units.

Non-Interference and System Integrity

Unless they communicate explicitly, virtual machines are also functionally independent of one another. Jobs cannot interfere with each other, and even a fatal error in a virtual machine does not affect the integrity of the operating system.

Low Overhead Resource Management

Multiprocessor (and multiprocessing) management is an efficient, low-overhead activity, aided by CPU design. Whichever CPU is currently free runs the system code that dispatches it to the next eligible task. When a CPU runs a process, all memory addressing is automatically mapped through a hardware translation table in only 67 nanoseconds.

Memory and Paging Optimization

Process scheduling and memory management are handled together, to optimize resource usage. Memory is organized into pages of 4 Kbytes; a sophisticated demand-paging technique minimizes disk access by keeping lists of all currently resident pages. No disk access will be made if a requested page is currently resident and sharable, even if that page belongs to a foreign process. Under extreme load, the system temporarily removes the most memory-intensive processes from contention, ensuring that thrashing does not occur.

Comprehensive System Software

Program and programmer efficient

For the User

Designed-In Security

Security protection, accounting and control of data, programs and user access are fundamental in the BTI 8000. Every process on the system, both interactive and batch, must begin by logging into an account with a private password.

The uniquely identified accounts, which remain on the system through logon and logoff, provide for independent ownership and use of programs and data. Every program and data file on the system belongs to some account, which also possesses individual access and control privileges, and an individual user-assigned password.

Automatic Access Protection

The system is passively secure. Except for special public library accounts, the programs and data files within an account library are not accessible or even visible outside that account unless explicitly declared "shared" with other specific accounts or groups of accounts. This automatic security specifically applies to system operator accounts, as well as to other users.

Flexible Control

Accounts are created in a four-level hierarchy. The system manager account creates and controls subordinate manager accounts, as well as operator accounts; these managers in turn create and control their subordinates' accounts. There is no limit to the number of user accounts. At any level, a manager may "encapsulate" his account group, preventing any data from leaving its boundaries even if a subordinate has shared access outside the group.

Turnkey Applications and Programmer Convenience

Any account may have an individual or shared INITIAL program, which runs automatically when the account is entered. These programs can be part of a fully controlled interactive environment, menu-driven and BREAK-protected for turnkey end-user access. Alternatively, programmer accounts may use INITIAL programs for individual logon services, such as declaring a private set of tailored system commands as an alternative to the system-defined command set.

For the Programmer

Interactive system software provided with the BTI 8000 is designed for programmer efficiency, ease of use, and data protection.

Control Mode

The BTI 8000 command and response language is the same for both interactive and batch processing. It uses a simple verb-noun structure, and furnishes two levels of on-line assistance. DO-files and user-defined variables allow command-language programming, including conditional branching.

File System

The file system provides common data management services for all languages. Supported data organizations include multi-key indexed, relative record, and sequential.

Utilities

The utility package includes the editor, linking loader, universal copy program, sort/merge, symbolic debugger, file system, integrated spooling programs, and HELP program. Executable code files include symbolic information furnished by the compilers, debugging can be done through source-program variable names and statement labels. Special compilation is unnecessary, and the debugger can even auto-step through a program one or more source lines at a time.

Programming Languages

COBOL: A "high intermediate" implementation of ANS COBOL 74 with full Indexed I/O and SORT. Other extensions include interactive debugging, and full formatted screen handling with the ACCEPT and DISPLAY verbs.

BASIC/8000: A powerful, comprehensive language specifically designed to accommodate easy conversion of programs written in other popular versions of BASIC.

FORTRAN: A full, optimized, implementaton of ANS FORTRAN 77, plus extensions.

PASCAL/8000: An extended version of this programmer efficient, structured language.

Computerized On-line Service

BTI is successfully servicing over 2500 computers throughout the United States and Canada using computerized on-line service.

Fast Service is provided by a national service center manned round-the-clock 7 days a week. Skilled service engineers respond to telephone calls for service—usually within five minutes. A centralized diagnostic computer connected by telephone to the customer's site is the heart of the system.

Service Costs are held to a minimum by the use of such remote diagnostics rather than initial on-site service calls. A decade of experience has demonstrated that over 97% of all problems—hardware or software—can be identified in this manner. In most cases, the system owner can replace faulty hardware modules himself. Factory software support can be provided via telephone using the central service computer.

ABOUT BTI

Starting as a commercial timesharing service in 1968, BTI moved rapidly into the development and manufacture of interactive computer systems. Since 1971, BTI has delivered over 3000 Series 3000/4000/5000 16-bit interactive computer systems. There are installations in 48 states of the U.S., in Canada, and in Europe. The BTI 8000 is a planned outgrowth of BTI's special experience in the manufacture and support of interactive computer systems.

BTI occupies a modern facility in Sunnyvale, California, with over 100,000 square feet of space. The facility houses over 400 employees in research and development, marketing, manufacturing, service, and administrative functions.

Corporate Headquarters:
870 West Maude Avenue
Sunnyvale, California 94086
(408) 733-1122

Regional Offices:

East
225 Old New Brunswick Road
Piscataway, New Jersey 08854
(201) 457-0600

Midwest
2401 Plum Grove Road
Palatine, Illinois 60067
(312) 397-9190

South
1155 Hammond Drive, Suite E5050
Altanta, Georgia 30328
(404) 396-1630

West
977 Benicia Avenue
Sunnyvale, California 94086
(408) 749-0500

Sales offices in major U.S. cities.

BTI COMPUTER SYSTEMS

Litho in U.S.A.

10M 3/81

BTI 8000

32-BIT MULTIPROCESSOR SYSTEM

TECHNICAL OVERVIEW

BTI 8000
Multiprocessor System

Technical Overview

BTI COMPUTER SYSTEMS

TECHNICAL OVERVIEW
Version 1.0 April 1981
Document Number 1171
BTI Part Number 9100-0147

This document corresponds to Software Revision 1 of the BTI 8000 operating system. Please address your questions, comments, and suggestions to:

BTI Computer Systems
Marketing Technical Publications
870 West Maude Avenue
Sunnyvale, California 94086
Telephone: 408-733-1122

INTRODUCTION

The BTI 8000 Computer System is a medium-scale, general purpose system designed to provide cost-effective computing in terminal-intensive data processing environments. It is distinguished by an innovative multiprocessor-based architecture that facilitates system expansion across a ten-fold range of computing capacity. This hardware organization, called **Variable Resource Architecture** (VRA), provides unprecedented flexibility in system configuration and growth.

The BTI 8000 operates under control of an equally innovative operating system called Variable Resource Manager (VRM). VRM dynamically optimizes the concurrent operation of up to eight 32-bit Computational Processing Units (CPUs). The operating system automatically provides a secure virtual machine environment to each of scores of interactive and batch users. A BTI 8000 user is free to perform any mix of program development and production processing tasks in COBOL, FORTRAN, BASIC, or PASCAL, without interference from other system users. VRM and the individual virtual machine environments it provides to users, are the same on all BTI 8000 systems. Therefore, programs that run on any BTI 8000 will run on all BTI 8000s, without modification or recompilation; VRM shields the system user from changes in the underlying hardware configuration.

The BTI 8000 provides unparalleled protection for the system purchaser's computing investment. As the processing requirements of the organization increase, computational, memory, and input/output channel capacity can be increased by adding appropriate resource modules. Since the only difference between a "small" BTI 8000 supporting 25 users and a "large" BTI 8000 supporting 200 users is a larger number of modular components (computational processing units, memory control units, peripheral processing units, and system services units), the purchaser's hardware investment is fully protected. It is never necessary to replace a small system with a larger system — the small system actually **becomes** the larger system.

The BTI 8000 provides comparable protection for a purchaser's software investment. All BTI 8000s operate under control of the same operating system — VRM. Since VRM provides a standard virtual machine environment to all users, existing programs will operate correctly without modification on any and all system configurations. VRM includes a common command language that operates in both batch and interactive modes. VRM provides a common, device independent file system to users of COBOL, PASCAL/8000, BASIC/8000 and FORTRAN 77. All disk resources on the system are managed dynamically by VRM without need for user application or systems programming specification. The virtual machine environment protects the purchaser's software investment by insulating application programs from changes in the hardware

and systems software environment. There is never a need to balance more system capacity against the conversion cost of gaining that capacity. Traditional software upgrade conversions simply do not exist on the BTI 8000.

The BTI 8000 maximizes the productivity of the purchaser's EDP staff. Variable Resource Manager (VRM) automates much of the traditional task of the systems programmer. VRM automatically manages any permissable hardware configuration as part of a 20-second system startup procedure. Requiring no operator intervention, this initialization procedure is functionally equivalent to generating a full operating system (SYSGEN in IBM terminology) for the given hardware configuration. The startup process also tailors the operating system to provide RS-232-C terminal support for all asynchronous ports on the system. Automatic SYSGEN capability is one of a host of system features that enables the BTI 8000 to operate without systems programming support.

VRM also automates many of the traditional tasks of the EDP center's operations staff. It provides demand-paged virtual memory support for all users, and thus eliminates the need for partition-oriented job scheduling. Batch processing is controlled by disk files which contain sequences of command language statements. Command files can invoke batch processing during active terminal sessions, or at a specific time of day. The command language provides tools that allow many operational decisions to be made automatically without operator intervention. For example, the command language processor can detect abnormal conditions and terminate or modify the processing of a job without operator action. Finally, VRM dynamically balances the system workload to assure the most effective use of system resources. The system operator's job is limited to functions **requiring physical access to the machine** such as printer, magnetic tape, and disk pack handling. Other operations tasks have been automated and delegated to the operating system.

The BTI 8000 increases the effectiveness of the data processing staff by reducing systems management and operations tasks. Since the system is self-managing, self-tuning, and self-optimizing, the talents and expertise of EDP specialists can be applied to the real information needs of the organization rather than to system operation.

VARIABLE RESOURCE ARCHITECTURE

The BTI 8000 Computer System embodies a new concept in computer design: **Variable Resource Architecture** (VRA). The most effective way to explore the implications of VRA is to contrast it with traditional computer architectures.

CONVENTIONAL ARCHITECTURE AND COMPUTER FAMILIES

Figure 1 depicts an example of traditional system architecture.

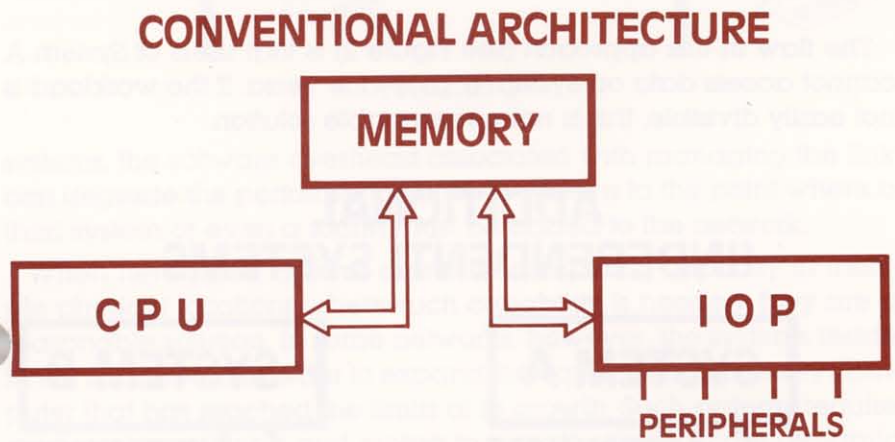


FIGURE 1

The computer is composed of three basic modules, each serving a different function. The memory stores and provides high speed access to currently active programs and data. The central processing unit (CPU) is an "instruction engine". It extracts data and instructions from memory, performs arithmetic and logical operations using the data, and stores the results back into memory. The input-output processor (IOP) manages the transfer of data between system main memory and various peripheral devices. This traditional architecture is characterized by independent paths from the CPU and IOP to memory, so that both units can operate in parallel.

Most commercially available computers employing conventional architectures are organized into groups of systems known as **computer families.** The IBM SYSTEM/360, introduced in 1964, was the first complete computer family. Each member of the family was based on the same underlying architecture and scaled to provide a specific level of computing power for a specific price. All family members had the same hardware instruction set, and were the industry's first **compatible machines.**

The owner of a computer below the top of the range in a compatible family can replace his machine with a larger member of that family when his workload outgrows the installed system. That upgrade, however, may be extremely complex. Although all

members of a computer family are built with software compatibility as a design objective, each model in the family is the product of a discrete hardware engineering effort. Differences in implementation details can cause unexpected conversion difficulties. In addition, the system owner may further complicate matters by migrating from one operating system to another as part of the upgrade.

UPGRADE OPTIONS AT THE TOP OF THE LINE

As the processing needs of the organization increase, smaller systems are replaced by progressively larger systems until the largest computer in the family is installed. Since an upgrade problem exists at the high end of every computer family, the system owner who needs a larger system has only a few options.

The oldest solution to this problem is the installation of separate, independent systems with the processing workload split between them.

The flaw in this approach (see Figure 2) is that users of System A cannot access data on System B, and vice versa. If the workload is not easily divisible, this is not a reasonable solution.

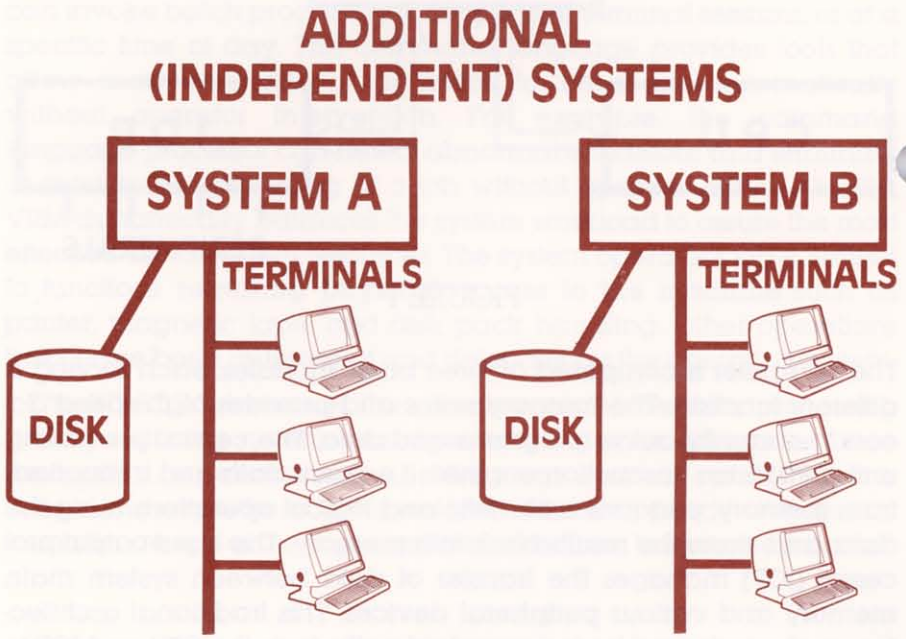


FIGURE 2

An updated version of this solution, networking, is described in Figure 3. A communications link between the computers allows users on one system to access data on the other system. Unfortunately this solution is not without its cost. The intercomputer links operate at a small fraction of the speed of the data channels inside the computer system. If a great deal of data must be moved across the communications channel, the link itself becomes a bottleneck.

Networked-systems support tends to involve high software execution overhead, particularly if the addition of the capability to an existing system has compromised the design objectives of the underlying operating system. If too much data must pass between the

MULTIPLE NETWORKED SYSTEMS

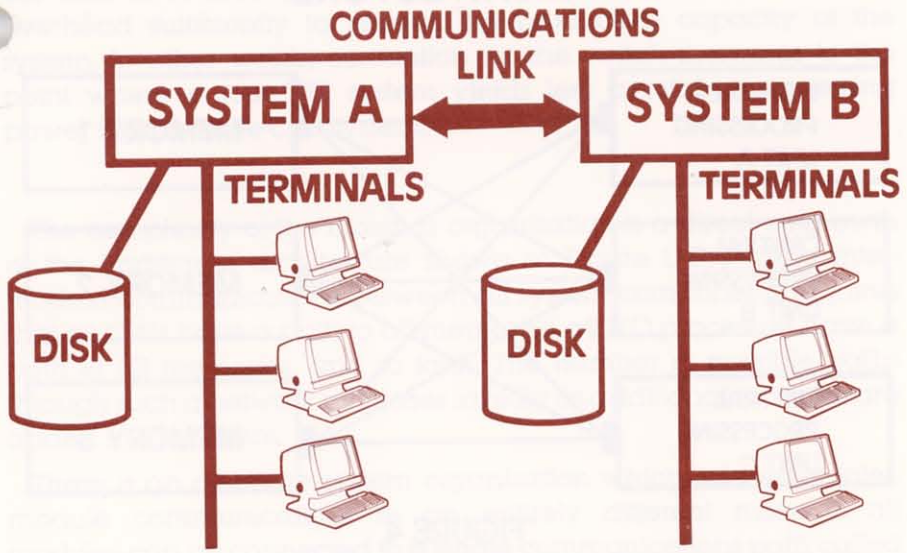


FIGURE 3

systems, the software overhead associated with managing the link can degrade the performance of **both** systems to the point where a third system or even a fourth must be added to the network.

When networked systems distribute computing capacity to multiple physical locations where such capability is needed, they are a reasonable solution. In some networks, however, the systems reside in the same room in order to expand the capacity of a primary computer that has reached the limits of its growth. Such systems require continual monitoring and tuning to remain viable under dynamic workloads.

Since expansion beyond the high end of a computer family is often caused by a need for more CPU capacity, one solution is the addition of CPUs to the high-end system. For a number of years computer vendors have been expanding the capacity of their largest systems in this manner. Called **multiprocessor** systems, these large systems use a variety of interconnect schemes to link multiple CPUs into a single system.

The interconnection between multiple CPUs typically takes the form shown in Figure 4. Multiple CPU and main memory devices are linked together by an internal crossbar network performing the same function as a telephone switching station. Through the switching matrix an instantaneous connection can be established between any two components in the network.

There are two basic problems with this approach. First, by the time there are four or more components in the network the crossbar switch has become more complex than a typical CPU. At that point it is often easier to implement a more powerful CPU rather than the switch. The second problem concerns the total capacity of such a system. The arbitration process to determine who gets access through the switch is a highly complex operation that requires a significant amount of the increased capacity. Therefore, the throughput performance of systems with this design is quite disappointing.

TYPICAL CROSSBAR ARCHITECTURE

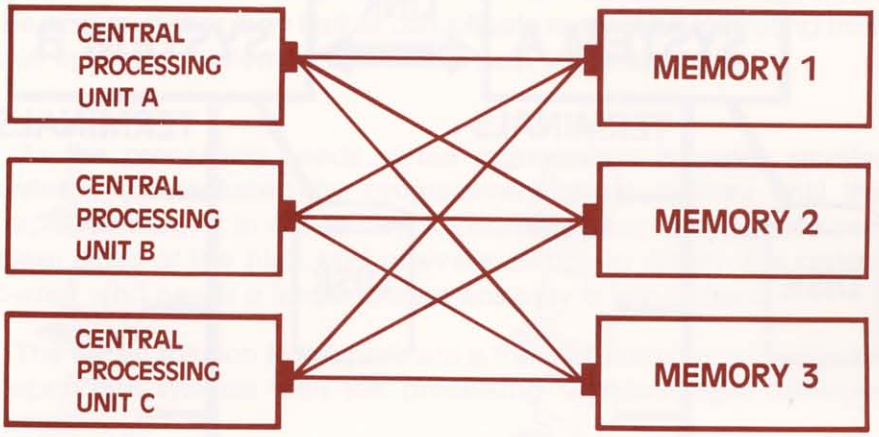


FIGURE 4

The objective in adding CPUs to a multiprocessor system is to increase the productive capacity of the system. If it were possible to gain access to all the processing capacity of all the processors in such a system, the increase in throughput would follow the "ideal" line in Figure 5. A single CPU system will always, by definition, provide one CPU's worth of throughput. Under ideal circumstances a two CPU system would have twice the capacity of a single CPU system, and so forth.

MULTIPROCESSOR THROUGHPUT GAIN

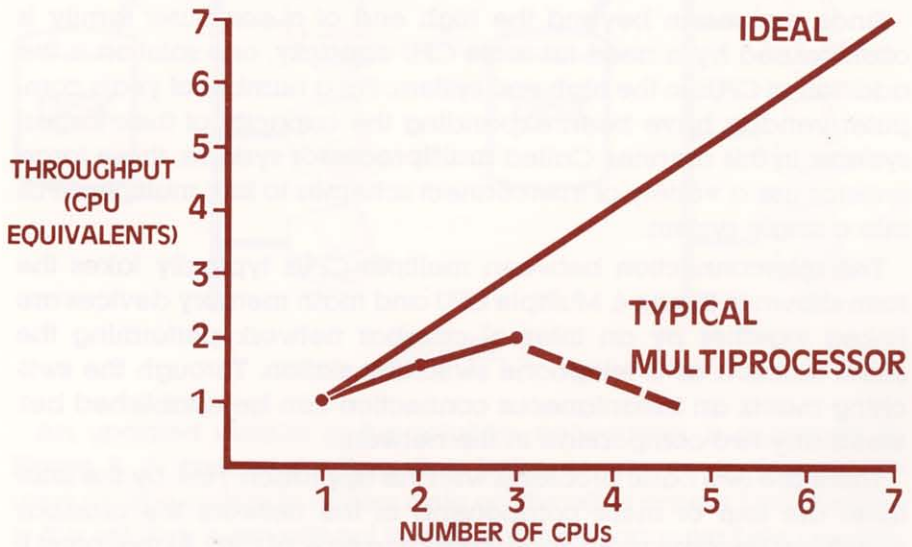


FIGURE 5

In actual practice the overhead inherent in crossbar interconnect schemes severely diminishes the level of available CPU power. A typical two-processor system delivers the availability of approximately 1.6 CPUs, so the system owner gets only 60% of the second processor. A three-processor system rarely yields more than the

capacity of two stand-alone systems — the owner gets only 40% of the third CPU. Usually the addition of a fourth CPU increases the overhead sufficiently to reduce the productive capacity of the system. In other words, contention for the switch increases to the point where a four-CPU system yields less available processing power than a three-CPU system.

UNIFIED BUS ARCHITECTURE

The complexity of the crossbar organization is a direct outgrowth of the traditional architecture shown in Figure 1. Providing inter-module communications between all system components requires that all CPUs have a path to all memories, all I/O processors have a path to all memories, and so forth. The number of possible paths through such a network increases rapidly as additional modules are added to the system.

There is an alternate system organization which addresses inter-module communications in an entirely different manner: all modules can be connected to a single communications path called a **bus**. A piece of information can be transferred between any two modules on the bus during each **bus cycle**. The bus is "owned" by the sending module for a single cycle, after which any unit on the bus can claim the next cycle. The single, shared communications path performs the same communication function as the intermodule paths seen in traditional systems. Depicted in Figure 6, this design is called **Unified Bus Architecture**.

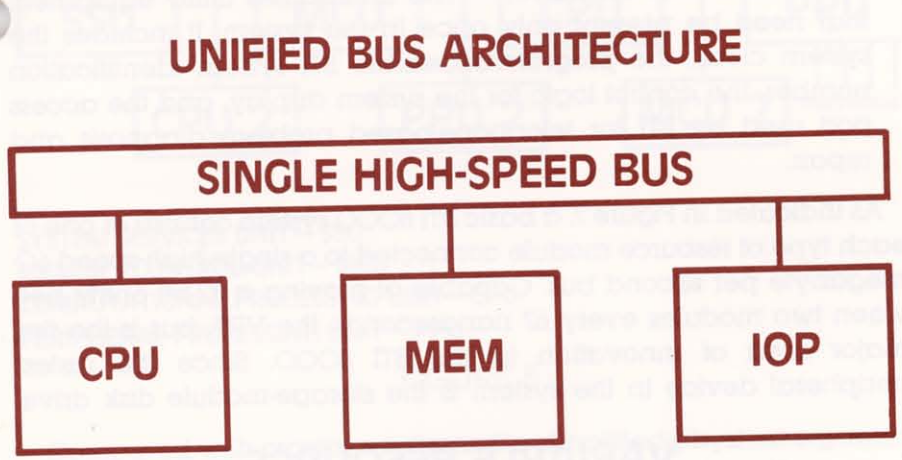


FIGURE 6

Expanding the computing capacity of a unified-bus computer by simply connecting a second CPU to the bus doesn't create, in theory, the interconnect overhead of crossbar organizations. Systems based on this architecture have been commercially available for a number of years, but none have been multiprocessor systems. The reason lies in the implementation details of those systems. The capacity of a unified-bus system is a function of the speed with which data moves across the bus. In order for a second CPU to increase the capacity of the system, the bus must have enough unused cycles to serve another CPU. Commercially-available systems have been built around intermodule buses with a data transport capacity of 2.5 to 14 megabytes of data per second. In actual practice this data bandwidth has not been capable of meeting the data

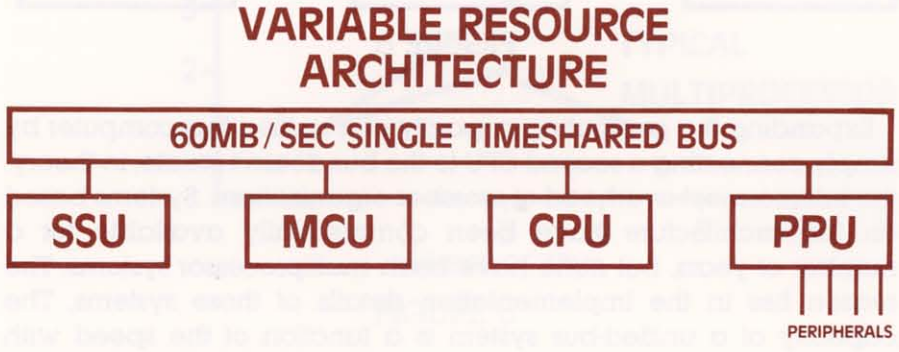
requirements of more than one CPU. As a result, unified bus systems have themselves been organized into computer families, each family member built around a single CPU within the family.

THE BTI 8000 AND VARIABLE RESOURCE ARCHITECTURE

The BTI 8000 is an advanced multiprocessor based on unified bus architecture. Its high-speed intermodule bus is capable of moving data between system modules at the rate of 60 megabytes per second. It is composed of four types of modules, three of which closely parallel those present in conventional systems. The modules serve the following purposes:

- **Computational Processing Unit (CPU)** — This unit is an instruction engine. It retrieves data elements and instructions from the system memory, performs operations upon them, and stores the results in memory. This unit serves the same function as the central processing unit in conventional architectures.
- **Memory Control Unit (MCU)** — This unit provides access to system main memory.
- **Peripheral Processing Unit (PPU)** — This unit is equivalent to the I/O Processor in the previous architecture diagrams. It is an intelligent interface which supports four data channels with an aggregate transfer rate of 18 megabits per second. Peripheral device controllers attach to the PPU. It manages transfers between the devices and memory without CPU involvement.
- **System Services Unit (SSU)** — This unit houses utility equipment that need be present only once in the system. It includes the system clock, the program-accessible BTI system identification number, the control logic for the system display, and the access port used by BTI for telephone-based problem diagnosis and repair.

As indicated in Figure 7, a basic BTI 8000 system consists of one of each type of resource module connected to a single high-speed 60 megabyte per second bus. Capable of moving a 32-bit entity between two modules every 67 nanoseconds, the VRA bus is the first major area of innovation in the BTI 8000. Since the fastest peripheral device in the system is the storage-module disk drive,



SYSTEM SERVICES UNIT–SSU
MEMORY CONTROL UNIT–MCU
COMPUTATIONAL PROCESSING UNIT–CPU
PERIPHERAL PROCESSING UNIT–PPU

FIGURE 7

which transfers data at 1.25 megabytes per second, the 60 megabyte per second capacity of the bus is more than adequate for a large complement of modules and devices. Typical bus transfer rates on competitive products range from 2.5 megabytes to 14 megabytes per second.

The ultra-high transfer rate of the VRA bus allows BTI 8000 systems to grow by the simple addition of three out of the four basic system modules (only a single SSU module is required). When the workload on a base system BTI 8000 exceeds the capacity of its single CPU, system computation capacity can be expanded by adding another CPU. Should the workload require more memory capacity or peripheral processing power, memory, MCUs, or PPUs can be added to provide the needed capacity. As indicated in Figure 8, BTI 8000 systems are expanded through the addition of resource modules of the appropriate type. The supplementary modules plug directly into the VRA bus. The actual number of CPUs, MCUs, and PPUs in a system can be varied based upon desired processing capacity — thus, the organization is called Variable Resource Architecture.

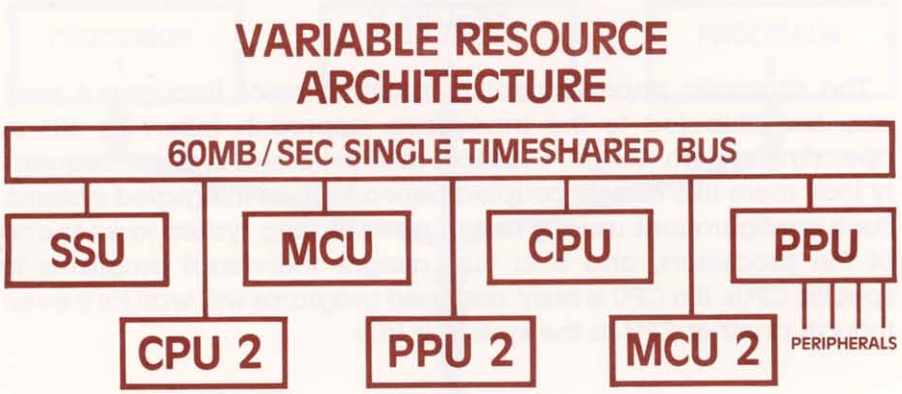


FIGURE 8

Compared with crossbar systems, the simplified physical organization of the BTI 8000 gives considerably improved multiprocessor throughput. Figure 9 depicts the theoretical availability of CPU power with various numbers of CPUs. The VRA organization provides 90% of the second CPU, 80% of the third, and so on. A six-CPU system has as much available processing power as five stand-alone single processor systems.

At the low end of the scale a single-processor BTI 8000 yields the computational power of an IBM 4331-class machine. At the high end of the scale the power is approximately two times the capacity of an IBM 4341-2. This growth range is achieved through the addition of resource modules to the base system. The BTI 8000 supports a maximum of 16 resource modules in any mix, so long as there is a minimum of one of each of the four basic module types. Although it is permissible and possible to do so, it is unlikely that a system will be configured with more than eight of any one module type.

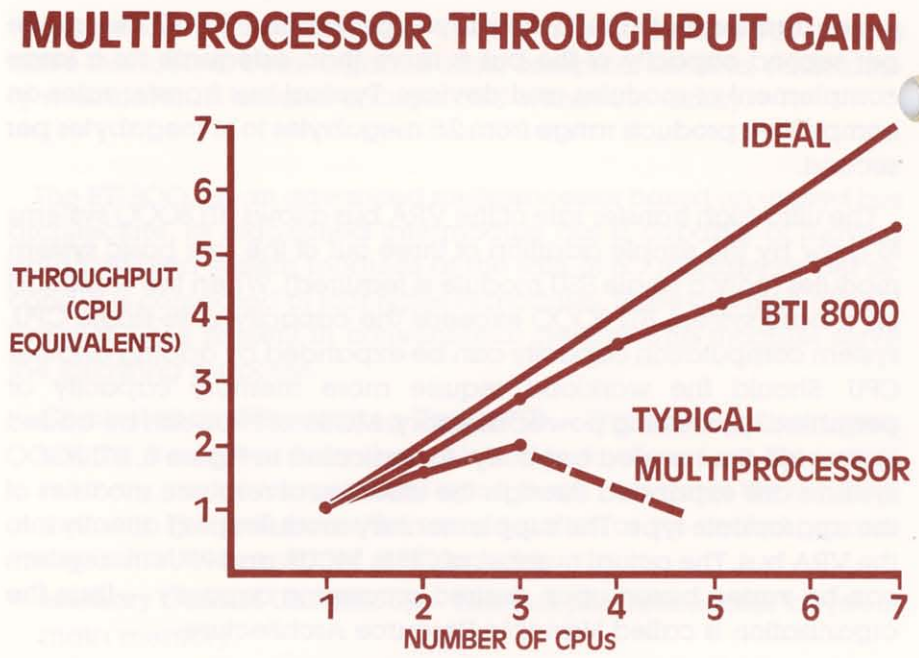


FIGURE 9

The dramatic improvement in multiprocessor throughput may also be attributed to the innovative approach taken by BTI in operating system design. Classical multiprocessor systems frequently look more like closely coupled networks than integrated systems. Such configurations usually assign all operating system tasks to one of the processors, and it in turn assigns individual programs to specific CPUs. If a CPU is busy, assigned programs will wait for it even though another CPU in the system is idle.

This type of operating system is called Master-Slave because the "Master" supplies operating system functions to the entire system. This arrangement ordinarily results in unbalanced use of processing resources. Figure 10 illustrates the results of such a workload imbalance. Processor 1 has four programs waiting for service, Processor

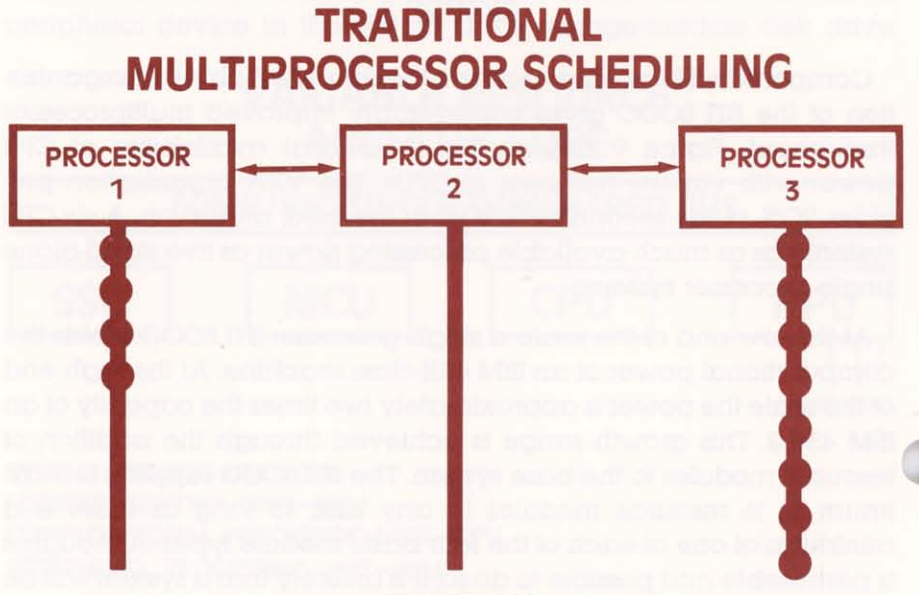


FIGURE 10

2 is idle, and Processor 3 has eight programs waiting. In this case, individual programs are assigned to specific processors when they begin execution and remain with that CPU, even if there is excess capacity elsewhere in the system. Processor 3 is the "Master" in this environment; supplying operating system functions to processors 1 and 2 has contributed to its overload.

Traditional multiprocessor scheduling is analogous to doing business at a bank where there is a customer line for each bank teller. The time spent waiting for a teller depends upon the transactions of people ahead of you in line. In a line where the customers have large, complex transactions, you will be served later than in the average line.

Most banks have eliminated individual teller lines in favor of the "express queue", as illustrated in Figure 11.

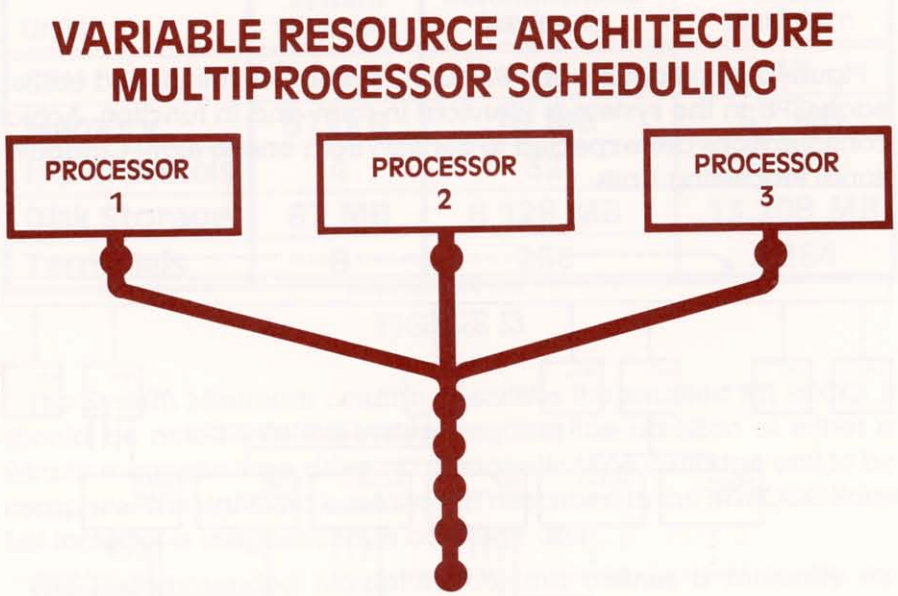


FIGURE 11

All customers wait in a single line, and when a customer reaches the head of the line he is served by the next available teller.

VRM, the BTI 8000 operating system, manages the allocation of system computational resources in much the same manner. All CPUs in the system are identical in function and are controlled by a single shared copy of VRM. CPUs function as instruction engines under this system organization, and do not "own" programs or memory. They are simply computational units used to serve processing needs. The system control task is carried out by VRM, which is designed to work on 1 to n CPUs. No single CPU is responsible for the control of the system — this is the second major innovation in Variable Resource Architecture.

All programs and system tasks are placed in a single, system-wide **Runnable Queue**. A CPU works on an individual task for a maximum of one quantum (about 100 milliseconds), or until the task requests an I/O operation — whichever happens first. If the quantum (or timeslice) expires, the state of the running program is saved in memory, and the program is placed back in the runnable queue. Its starting position in the runnable queue is assigned by VRM on the

basis of the processing characteristics of the current system job mix. The program will receive another timeslice as soon as all programs ahead of it in the runnable queue have been served. If the program requests an I/O operation it is placed in a wait queue until its I/O operation is complete. In either case the CPU that suspended the program then runs the portion of VRM that dispatches the next task from the front of the runnable queue, and begins operation on it. When the program suspended for an I/O wait receives its data, it will be placed back in the runnable queue.

Thus, the major operating system innovation in the BTI 8000 is dynamic, self-balancing multiprocessing. The number of CPUs in the system is totally transparent to the user — except that a given job mix will run notably faster on a system with added CPUs. For example, a two-processor BTI 8000 is a system that is nearly twice as powerful as a single processor BTI 8000.

HARDWARE CAPACITY AND GROWTH

Figure 12 is a diagram of a BTI 8000 system. As mentioned earlier, each CPU in the system is identical in form and in function. Actual configurations are expected to contain from one to eight Computational Processing Units.

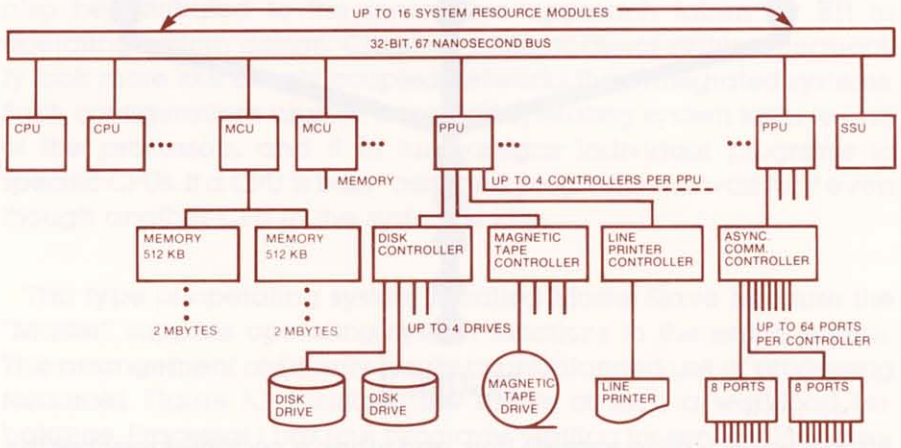


FIGURE 12

Each Memory Control Unit supports up to four megabytes of error-correcting memory in one-half megabyte increments. Although a maximum of eight MCUs may be configured, the maximum system memory capacity is 16 megabytes.

The System Services Unit contains those components which need only occur once in the system. A second, spare SSU may be placed in a system to provide a powered backup unit, but only one unit will be active.

Each Peripheral Processing Unit has four data channels, and four controllers, one of which may manage up to four disk drives in capacities ranging from 67 MB to 254 MB. All disk controllers support overlapped seek operations. Assuming a recommended maximum of eight PPUs per system, the maximum disk capacity of the BTI 8000 is over eight billion bytes of storage. This number will increase as higher density disks become available. Magnetic tape controllers

attach to PPU channels, and support up to four tape units. Each line printer controller supports one line printer at speeds ranging from 300 to 900 lines per minute.

The Asynchronous Communications Controller (ACC) provides RS-232-C support for asynchronous terminal devices. Each ACC can support eight to 64 terminal ports, in eight-port increments. Each ACC supports simultaneous asynchronous traffic from up to 64 ports, at rates of up to 19.2KB. The system can be configured with as many as 256 terminal ports.

Figure 13 summarizes the hardware growth capacity of the BTI 8000.

BTI 8000 SYSTEM CAPACITY

Units	System Minimum	Recommended Maximum	Physical Maximum
CPU	1	8	13
Memory	512KB	16 MB	52 MB
I/O Channels	4	32	52
Disk Storage	67 MB	8,128 MB	13,208 MB
Terminals	8	256	3,264

FIGURE 13

The System Minimum column describes the smallest BTI 8000. It should be noted that this system requires the addition of either a 9-track magnetic tape drive or a magnetic tape cartridge unit to be complete. The standard base system described in the BTI 8000 Price List includes a magnetic tape cartridge unit.

The Recommended Maximum column defines a mutually exclusive set of maximums on various hardware entities. A system must have at least one of each type of resource module, and the largest system has 16 modules. Therefore, it is impossible to configure a system with eight CPUs and the eight PPUs needed to attach 8 billion bytes of mass storage (one PPU supports a maximum of one billion bytes). There would be no room on the bus for the required SSU and MCU. It is possible, however, to support 256 terminals on a system with any of the other modules at the maximum, since all 256 terminals would fit on four I/O channels.

VARIABLE RESOURCE ARCHITECTURE AND FAIL-SOFT OPERATION

The BTI 8000 is specifically designed to fill the requirements of terminal-intensive information processing. High levels of system availability are critical in environments requiring on-line access to the computer. Variable Resource Architecture minimizes the impact of hardware failure by providing **fail-soft** system operation.

Each major system resource module may be duplicated within a particular configuration to provide fail-soft capability. Depressing the "BOOT" button on the system control panel causes the SSU to poll all devices attached to the bus. This message triggers module-based self-test operations throughout the system to determine the opera-

tional status of each resource module. If all modules report successful test completion, the system polls each controller for device configuration information. The data gathered are used dynamically to construct tables necessary to the operating system. This process is the functional equivalent of a systems generation (SYSGEN) on IBM equipment and prepares VRM to run on the available configuration. The entire operation takes less than 20 seconds and is entirely automatic, never requiring manual intervention or systems programming support.

If a module fails its self-test, the module location and type are displayed on the system Control Panel Display. The operator powers the system down, opens the cabinet, and removes the failing module. If there is another module of the same type in the system — e.g., the failed module is one of multiple CPUs — the operator simply closes the cabinet, powers the system up, and repeats the "BOOT" operation.

So long as the system finds one of each basic module type (SSU, CPU, MCU, PPU) in operating order, it comes up running and operates with the reduced hardware configuration until the removed module is replaced. As long as the proper "extra" or redundant resource modules are available, the problem diagnosis and reconfiguration takes place without the on-site services of a Field Service Engineer. The system is immediately available for normal use — it will simply have less overall capacity due to the absence of the failed module. More importantly, existing application software runs on the reduced configuration without program or command language changes or recompilation.

If a module malfunctions the system need be inoperative only for the length of time it takes to identify and remove the broken component. In addition, hardware purchased primarily for insurance against interrupted operation provides additonal capacity all the time, not merely when the system fails. BTI calls this feature **fail-soft** operation, since it cushions the user from the problems normally associated with hardware failure.

IMPLICATIONS OF VARIABLE RESOURCE ARCHITECTURE

The implications of VRA are wide ranging, both from the purchaser's view, and from BTI's perspective. The BTI 8000 owner has exceptional protection of his computer hardware investment. If his processing requirements expand, the system can grow in small, inexpensive increments. Additional BTI 8000 CPUs can be purchased for a cost of roughly 15% of the base system purchase price per CPU. From the smallest system to the largest, the BTI 8000 spans a ten-fold range in processing capacity. This provides users with the security of a computer family without the need for module or system replacement and without the need for conversions of any kind.

VRA also allows BTI to maintain a very high level of responsiveness to customer needs. In a single hardware implementation the BTI 8000 spans the growth range of a computer family. The largest BTI 8000 is composed of exactly the same modules as the smallest system, and all configurations run under exactly the same

operating system. BTI Field Service Engineers and Systems Analysts can provide support on all systems with equal facility. In short, an expert on one BTI 8000 is an expert on **all** BTI 8000s.

The modular hardware design of the system has major implications for future enhancements. The only portions of the BTI 8000 which are truly fixed over the long term are the bus itself, the resource module interface to the bus, and the CPU instruction set. In fact, even the CPU instruction set can change, so long as existing instructions are not eliminated. Literally any other hardware aspect of the system can be reimplemented to take advantage of technological changes in the state of the art without impacting the rest of the system. Furthermore, the functional organization of the hardware allows "new" modules and "old" modules to each perform at maximum capacity while co-existing in the same system.

At a fundamental level, this organization protects the BTI 8000 from hardware obsolescence. It allows entirely new technology to be incorporated into the system without implementing a completely new computer. For example, if a major breakthrough in semiconductor technology provides a large increase in component execution speed, BTI can take advantage of this advance as soon as it is commercially feasible. If the advance makes possible a new CPU with five times the power of the current CPU, the new CPU will plug into the bus as readily as existing modules. "Today's" CPU and "tomorrow's" CPU will run in the same system under control of the same operating system. The only impact on the user will be greater system capacity. In the same manner, faster, denser memory subsystems can co-exist with older slower devices, so long as each is supported by a separate memory control unit.

The BTI 8000 is the first truly evolutionary computer system. It is possible to purchase a system now, and to expect the same system — in an expanded configuration to meet increased processing requirements — to be operational in 1990. More important, state-of-the-art hardware can be readily added to the system, wherever it provides improved capability. Furthermore, applications software is totally insulated from the underlying hardware, so the computing resource itself can evolve while protecting an organization's investment in software, data, and training. Variable Resource Architecture takes the pain out of growth.

SYSTEM SOFTWARE OVERVIEW

The BTI 8000 is designed to meet the computing needs of business and education in the 1980s. Toward that end, the BTI 8000 Variable Resource Manager (VRM) utilizes the system's unique architecture to achieve the following goals:

- Provide secure, high-volume, terminal-oriented data processing
- Protect the purchaser's hardware and software investment
- Increase the effectiveness of the purchaser's data processing staff
- Provide high levels of system reliability and availability

The BTI 8000 includes a number of features which work in concert to meet these objectives. The most important of these features are described in the following sections of this document.

VIRTUAL MACHINE FACILITY

The BTI 8000 virtual machine facility isolates each user from the system hardware. This separation is provided by the Variable Resource Manager (VRM) under the general structure shown in Figure 14.

VIRTUAL MACHINE ENVIRONMENT

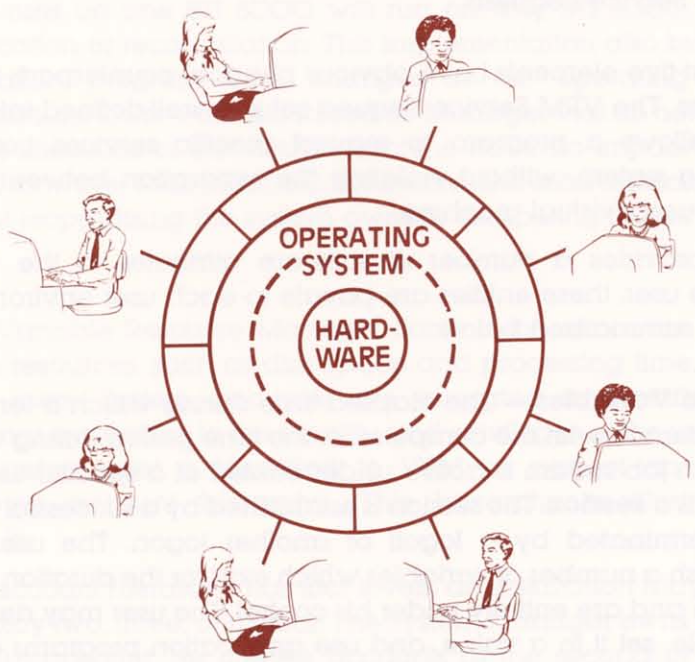


FIGURE 14

The center circle in Figure 14 represents the system hardware. The two concentric rings surrounding the hardware illustrate the BTI 8000 Variable Resource Manager. VRM is organized into two layers which shield the system user from the physical computer. The "inner" VRM layer manages the physical machine. All hardware is pooled and dynamically applied to the computing workload in a manner that is transparent to the system user. This portion of the operating system includes the push button configuration (SYSGEN) capability described earlier in this document.

The "outer" VRM layer deals with "process management". A process is a running program or system task which is managed as a run time entity by the operating system. Each batch or terminal-oriented user has an active associated process — either a user application program, a language compiler, or a system utility such as the command language processor. The VRM process management layer provides each process, and hence each system user, with its own dedicated, private environment. These private process environments are represented by segments of the outermost concentric ring in Figure 14. Each environment has all the attributes of a dedicated computer, and is called a virtual machine. The users associated with these virtual machines, represented by the outermost series of circles in Figure 14, interact with the system as if each had a private computer.

Programs for the BTI 8000 are written as if they were to execute on a physical computer with the following hardware attributes:

- CPU Instruction Set
- Program Counter
- General Purpose Register Set
- Status Register
- 512 Kilobytes of Memory
- VRM Service Requests

The first five elements have obvious physical counterparts in real machines. The VRM Service Request set is a well-defined interface which allows a program to request specific services from the operating system, without violating the separation between VRM and the user's virtual machine.

VRM provides a number of software attributes to the virtual machine user; these entities are private to each user environment, and are summarized below:

- **Session Variables** — The elapsed time during which a terminal user interacts with the computer, or the time period during which a batch job stream is active under control of a specific user account, is a **session**. The session is established by a successful logon and terminated by a logoff or another logon. The user can establish a number of variables which exist for the duration of the session and are entirely under his control. The user may define a variable, set it to a value, and use application programs or the command language to test the value and make processing decisions based on it.

- **Current Process** — A process is an active application or system service program such as a language compiler or utility program. Each terminal user or batch stream has a current process associated with it. Until another program is executed by the user, the system command language processor will be active in his virtual machine. The command language processor, which is called Control Mode, provides facilities to invoke application programs, compilers, or system utility programs.
- **Process List** — When a user invokes a program the command language processor (Control Mode) is suspended and its state is saved. When the invoked process completes execution, Control Mode is reactivated. It resumes execution in the state in which it was saved. It is possible for any number of processes to be suspended in this manner. Such suspended processes are stored in the process list of the user's virtual machine.
- **202 Logical Input/Output Units** — Each process has the capacity to support a maximum of 202 logical input/output units. Each logical I/O unit can be connected to a file or device in the real, as opposed to the virtual, machine. The actual assignment of physical files or devices to the virtual machine logical I/O unit occurs at execution time. The assignment can be predefined during program compilation and overridden at program invocation. This capability provides full program, device and file independence. Unless specific action is taken, the assignment of a logical I/O unit to a real device or file remains constant throughout the entire session. This feature is useful in multistep applications using the same set of physical files.

The BTI 8000 Virtual Machine Facility provides a standard programming environment for all users. The specifications of the virtual machine are constant, regardless of machine-to-machine differences in physical configuration. Because application programs are shielded from the hardware aspects of the computer, a program which runs on one BTI 8000 will run on **any** BTI 8000, without modification or recompilation. This implementation also buffers the application program from changes in the operating system. Modifications to the Variable Resource Manager that do not change the specifications of the virtual machine have no impact on user-written software. Thus, BTI 8000 hardware and software can evolve, without jeopardizing the system owner's computing investment.

MULTILEVEL ACCOUNT HIERARCHY

The Variable Resource Manager controls the allocation of finite system resources, such as disk space and processing time, among many users. System resources are allocated to specific virtual machines according to the identity and privileges of the user. Each valid system user is identified to VRM as part of an integral, multilevel account hierarchy. This hierarchy is illustrated in Figure 15.

The account hierarchy has four levels; an installation may choose to employ two, three, or all four. The System Manager owns the most powerful account. He creates accounts at the second or division level and allocates finite resources, such as disk space, connect time, and CPU time, among them. Division managers can, in turn,

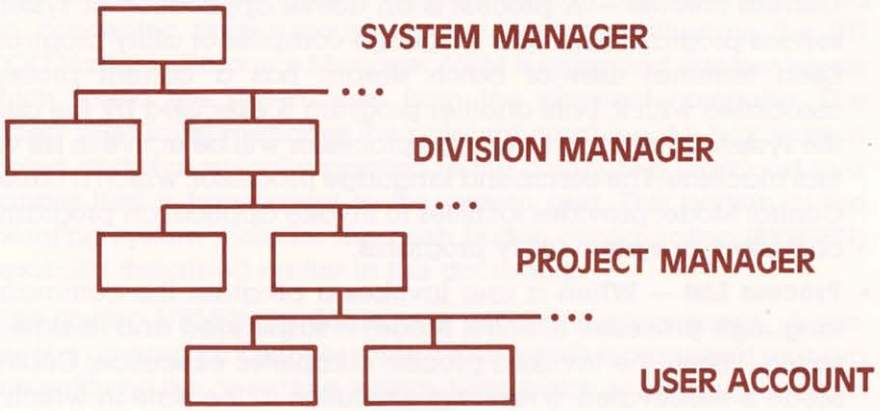


FIGURE 15

create subordinate project accounts and allocate resources to them. Establishing user accounts on the fourth level is the prerogative of the project manager. A user gains access to the system by identifying himself with a valid account, division, and project name, and an optional password.

Each account may be given a limited amount of connect time, CPU time, and disk space. VRM keeps cumulative usage data for each user and if he reaches the limit of any system resource, denies the user further access to that resource. A higher level account in his hierarchy must intervene to give the user more capacity. An installation may access the resource usage data to develop charges, or to analyze system utilization. If the System Manager chooses not to control system resources, users operate without limits, but usage data can still be made available for analysis.

Access to programs and data files is controlled by the account hierarchy. The system public library, associated with the highest level of the hierarchy, is automatically available to all users unless a manager at any level chooses to deny access to it to a subordinate account. Each account may have a private library of disk files and may grant other users the right to access specific files or the entire library. Each management level of the hierarchy has a predefined library which is automatically shared with subordinate users. The availability of implicit and explicit disk library access controls allows the System Manager to tailor powerful user environments, while protecting the privacy and security of sensitive data.

The account hierarchy, in concert with the virtual machine facility, provides full separation of each user from all other users. Because specific action must be taken to allow one user access to the library of another user, the hierarchy is passively secure. The System Manager tailors account capability to filter the needs of the user. At one extreme, an account can have full access to the entire system; at the other, a user (account) can be limited to the automatic invocation of a single application program. Any attempt to operate outside the limits of the account is prohibited by VRM.

AUTOMATIC DISK SPACE MANAGEMENT

Once the managers in the account hierarchy allocate disk space to users, the Variable Resource Manager assumes complete responsibility for the management of the mass storage resource. Disk space

on the BTI 8000 is organized and managed in 4096-byte blocks, corresponding exactly to the system's memory page size. All data transfers between main memory and disk move full blocks. Each disk block has a unique address, starting at zero and incrementing by one, used by VRM to compute its physical location.

All BTI 8000 disk space is dynamically managed by VRM. When a disk file is initially defined, it occupies a single block of data storage space. The file characteristics are entered in the directory of the account which owns the file. Addresses of all disk blocks not containing user or system data are stored in available space list. For example, when the first data record is written to a sequential disk file, VRM removes a disk block from the available space list, and assigns it to the data file. Additional records are packed into the first allocated disk block until it is full. At that time a second block is made available from free storage. This procedure continues as the file expands. When data is removed from a file, unneeded disk blocks are returned to the free space list. Controlled by VRM, this dynamic expansion and contraction of data files is automatic, and assures the effective utilization of mass storage capacity. Files never consume more space than actually required to store data.

When the number of used blocks approaches the account maximum, VRM informs the user that he has only a small amount of space left. He may free space elsewhere in his account library by removing files, or request that a higher level account manager increase his disk space limit.

The dynamic, automatic management of mass storage resource offers a number of operational advantages. There is no need for physical contiguity between sequential blocks of the same files. Data sequence is maintained through logical, rather than physical, ordering of data, so the entire disk capacity of the system can be used. Since any data block can be placed anywhere, preallocation of disk space is never necessary. Physical placement of files on the disk surface is not a user or manager concern.

When the disk controller detects an unusuable spot in the physical disk media, that block is removed from the available space list and its address is stored in a **bad blocks** list; the block is never assigned to a file. So long as a disk pack has fewer than 512 unusable blocks, the installation manager can choose the circumstances under which a pack with substandard media is copied and replaced.

The BTI 8000 approach removes most of the mass storage management burden from the installation's data processing staff. Programmers do not need to allocate disk space, or specify physical file placement. Unless required by the application, it is never necessary to copy files to new, bigger allocated files in order to expand them. If files become larger than anticipated, they simply grow dynamically, so it is never necessary to change application programs or job control descriptions to support larger files. The size of a specific file is limited only by the disk space limit imposed upon the account that "owns" the file, and by the total available space on the disk pack. VRM provides summary utilization information to aid the System Manager in allocating the disk resource to accounts.

DISK DATA RECONSTRUCTION

Many of the soft failures which occur on disk-based computer systems are the direct result of disk media failures. The BTI 8000 offers a unique solution to this problem. Every disk block on the system consists of two types of data. Figure 16 illustrates a BTI 8000 disk block.

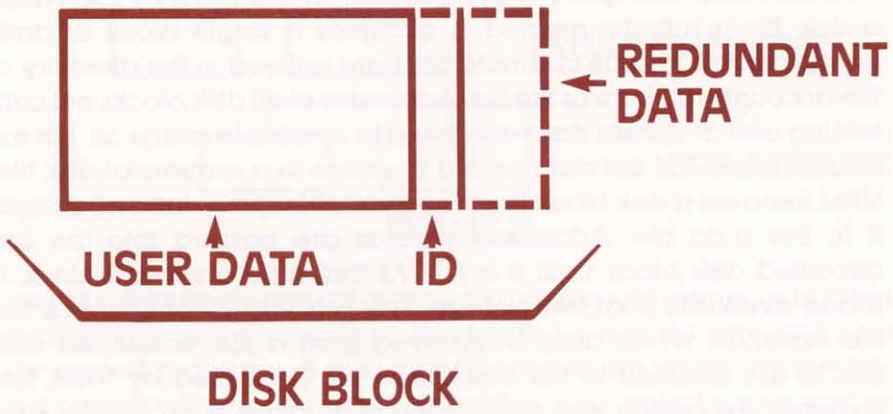


FIGURE 16

The first portion of the block contains user data, 4096 bytes in length, and is the only portion of the disk block available to the user's virtual machine. The remainder of the block contains system information, available to VRM and the system hardware. The first part of the systems area contains identification information specifying the account which owns the data, and the file of which it is a part. In addition, it defines the logical position of this block in the file. If the disk directory identifying the contents of the physical disk pack is destroyed, it can be reconstructed from the identification data associated with each data block.

The BTI 8000 disk controller is designed to help prevent system failure due to the inability to read a critical disk block. As data records are written the controller generates content-dependent redundant data, and appends it to the disk block. When a disk read failure occurs, the redundant data is used to reconstruct the damaged data. Burst bit errors of considerable length can be detected and corrected at the controller level without causing a read error. VRM places the address of the disk block which experienced the read failure in the **bad blocks** list, and moves the recovered data to a new disk block.

The recovery of otherwise unreadable data allows the BTI 8000 to continue operation in situations which cause a system failure on other computers. This feature dramatically reduces the number of soft system failures and results in better availability of the computing resource to its users. This feature is particularly important in highly visible, terminal-oriented applications.

STANDARD TERMINAL DEVICE SUPPORT

The BTI 8000 provides integrated support for RS-232-C terminal devices as a standard operating system feature. Terminal devices are accessible to the programmer through conventional high-level

language file verbs. Data is read from and written to a terminal as if the terminal were two sequential disk files. Device and file independence (logical I/O) of the virtual machine environment eliminate the need for special terminal support software at both the application and operating system levels. Any program on the system can execute in either batch or interactive mode without modification or recompilation. Programs which normally operate in batch mode can be invoked and debugged from the terminal; interactive programs can be executed from batch streams.

Integral terminal device support drastically reduces the cost of developing and maintaining interactive application software. The programmer controls the terminal directly from the application program, so experienced batch-oriented programmers can become proficient in the use of interactive devices with very little training. Because the systems level tasks normally associated with network definition and support are performed automatically by the Variable Resource Manager, the installation does not require the services of a communications software specialist. The application programmer is free to concentrate on the needs of the end user, while VRM maintains the terminal network.

COMMON COMMAND ENVIRONMENT

Control Mode, the command language processor, is the primary interface between the BTI 8000 and its users. Simple, English-language commands control program execution and the processing environment of the virtual machine. Serving the same function as a job control language (JCL) processor on a conventional computer system, Control Mode uses exactly the same syntax for both batch and terminal-oriented processing tasks. The only difference is the assignment of the standard session input and output devices. During batch program execution, standard input comes from a spooled input device (disk) and output goes to a spooled line printer. When the same program executes interactively, the RS-232-C terminal device is used for both standard input and output. The system makes no special distinction between batch and terminal based processing. The common, consistent command interface simplifies programmer training and eliminates the need for job control specialists. Control Mode is common to all BTI 8000s, regardless of hardware configuration.

COMMON FILE SYSTEM

The BTI 8000 provides a single, common, file management facility to users of COBOL, PASCAL/8000, FORTRAN 77, and BASIC/8000. Data files created in any of these languages are accessible from all the others. Where necessary, these languages have been syntactically enhanced to provide multikey, indexed file handling. The file system is invoked by standard language verbs rather than subroutine calls. Functionally, the data manipulation capabilities of the BTI 8000 file system are a superset of those defined in the I/O module of the 1974 COBOL standard, at full level 2.

The file system supports sequential, relative record, and indexed random file organizations. It is built upon self-optimizing mass storage structures which undergo dynamic expansion and contraction as data is added to and deleted from files. It is never necessary

to reorganize files to recover deleted space or to speed access. Depending upon the length of the key, access overhead for indexed files typically ranges from one to three disk reads. Data files can be defined with as many as 50 keys and are supported by a comprehensive set of utility programs.

The common file system for COBOL, FORTRAN 77, PASCAL/8000, and BASIC/8000 decreases the cost of developing and supporting application programs, as well as programmer training. Since data is accessible from all these languages, the implementation options of the application designer are increased. Programs can be written in the language appropriate to the task, and data can be independently managed without concern for the languages used to process it.

REENTRANT CODE AND SHARABLE DATA

The BTI 8000 is designed to support large numbers of interactive users. In terminal-oriented environments, multiple users may be running the same program, e.g., several clerks entering data through an order entry program, or verifying policy status in an insurance application. Optimizing the use of physical machine resources in this type of application, VRM provides only one copy of a program for any number of users.

Reentrant code can be shared among many users without endangering the processing integrity of any user. All BTI-supplied programs, including the language compilers and VRM itself, are reentrant. BTI compiliers always generate reentrant application code. It is never necessary to have more than a single copy of a program in memory, no matter how many users are executing that program. Since the context information relating to each user of a shared program is private, a processing failure impacting one user will have no effect on other users.

The BTI 8000 organizes programs and data files into 4096-byte blocks called pages. Pages required for active processing are moved from disk to main memory by the VRM virtual memory facility. A disk data block moved to main memory is immediately available for use by all active programs. As long as the data page is not modified, any number of users can share it. When a user modifies a shared page, VRM creates a private copy of that page and adds it to the context of the user who changed it. In cases where a number of users are updating the same data files, the application program employs semaphore or locking mechanisms to ensure that file updates occur in orderly sequence. When a data page in main memory is permanently updated by a program, the updated page is made available immediately to other users sharing it in memory. VRM writes the updated page to disk, but does not require write completion before allowing access to the updated copy in main memory.

Reentrant code and shared data have a dramatic impact on system performance in shared program and shared file applications. A single copy of the code portion of a program can serve any number of users. Data pages in main memory are available for immediate use by all active programs. The only nonsharable portion

of a program is its context. An environment supporting 10 users executing the same program requires a single copy of the code, shares all data blocks, and requires 10 contexts — one for each user. This arrangement uses a very small percentage of the main memory needed in unshared, non-reentrant implementations of the same program. These features are automatically applied to all programs, and require no programmer action. VRM maximizes the use of the main memory resource, without programmer or operator intervention.

ANTI-THRASHING VIRTUAL MEMORY

Virtual memory is a resource management scheme to improve the utilization of main memory. The memory image of an active program is broken into 4096-byte pieces called pages. The paged program image is placed on disk, and individual pages are moved into main memory as they are required to continue execution. Only those pages required to keep the program running reside in main memory at any given time; the inactive pages remain on disk. The system appears to have a main memory resource equal to the aggregate size of all active programs — thus the term **virtual memory**. Since a page is moved into memory when a running program requires it, this mode of operation is known as demand-paged virtual memory.

The memory management portion of VRM controls the movement of pages between disk and main memory. The process of moving a page into main memory is called paging. Figure 17 depicts the impact of increasing system workload on the paging rate of a virtual memory system.

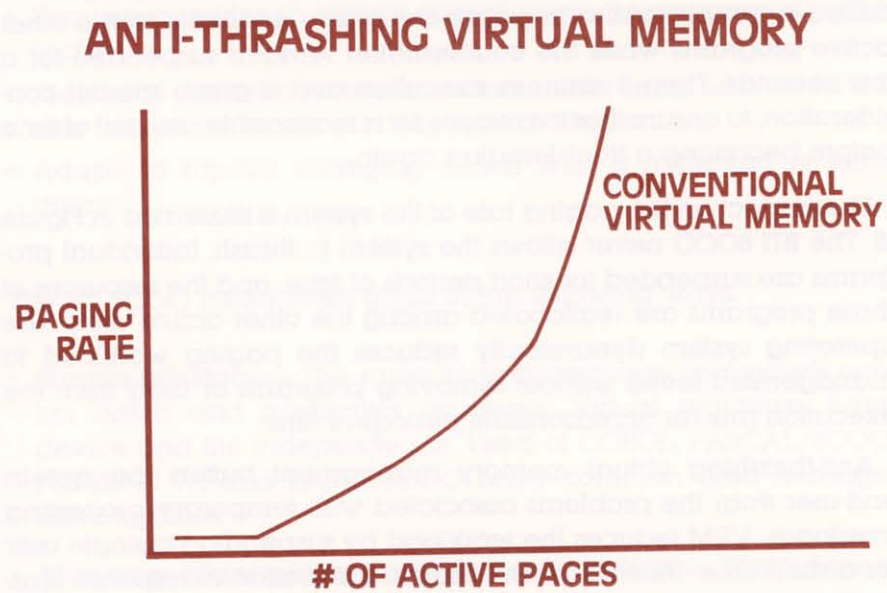


FIGURE 17

The horizontal axis of Figure 17 represents the total number of active pages required by all programs executing in the system. The vertical axis indicates the frequency with which the operating system must move a page between disk and main memory. The

paging rate starts out at zero, and gradually increases as the number of active pages increases until the number of active pages exceeds the amount of main memory.

When the paging rate on a virtual memory system becomes too high, the system is said to be thrashing. If a system does not have enough main memory to support its workload (temporarily or permanently) a thrashing condition develops. Then the system spends so much time paging that little effective processing is accomplished. When a program requires access to a page not in memory, the program is suspended until the new page becomes available. While the new page is being sought, the system attempts to process another program. If the paging rate is too high, all of the programs in memory will require an additional page to run. Each new page brought into memory overlays a page required by another program and a small increase in the number of active pages results in a large increase in the paging rate. The amount of effective processing done by a system in this state rapidly approaches zero.

When a conventional virtual memory system begins to thrash, the impact on the system user is dramatic. Response time to a terminal user becomes very slow. If the paging overload is heavy, the system appears to stop completely. The only way out of a thrashing condition is to reduce the paging rate by reducing the number of active pages. This usually requires the removal of a number of programs from the execution mix through manual operator intervention.

The BTI 8000 takes a different approach to the problem. The VRM memory manager detects imminent thrashing and stops it before it occurs. When the BTI 8000 reaches the thrash point, VRM reduces the number of active pages by temporarily suspending the program using the greatest number of main memory pages. This program is called a **troublemaker**. Its pages are made available to the other active programs while the troublemaker remains suspended for a few seconds. Then it resumes execution and is given special consideration, to ensure that it executes for a reasonable amount of time before becoming a troublemaker again.

The impact on the paging rate of the system is illustrated in Figure 18. The BTI 8000 never allows the system to thrash. Individual programs are suspended for short periods of time, and the resources of those programs are reallocated among the other active users. The operating system dynamically reduces the paging workload to management levels without removing programs or users from the execution mix for unreasonable periods of time.

Anti-thrashing virtual memory managment buffers the system end-user from the problems associated with temporary processing overloads. VRM reduces the workload by suspending a single user for a short time. Instead of wholesale degradation in response time to all users, the response time of a single user degrades. If a number of programs of about the same maximum size are running when the system becomes overloaded, each user will be penalized on a sequential basis. When a BTI 8000 is running in this mode, average response is far better than that provided by a conventional system while thrashing. Many users will not see any decrease in response time so long as their programs do not become troublemakers.

ANTI-THRASHING VIRTUAL MEMORY

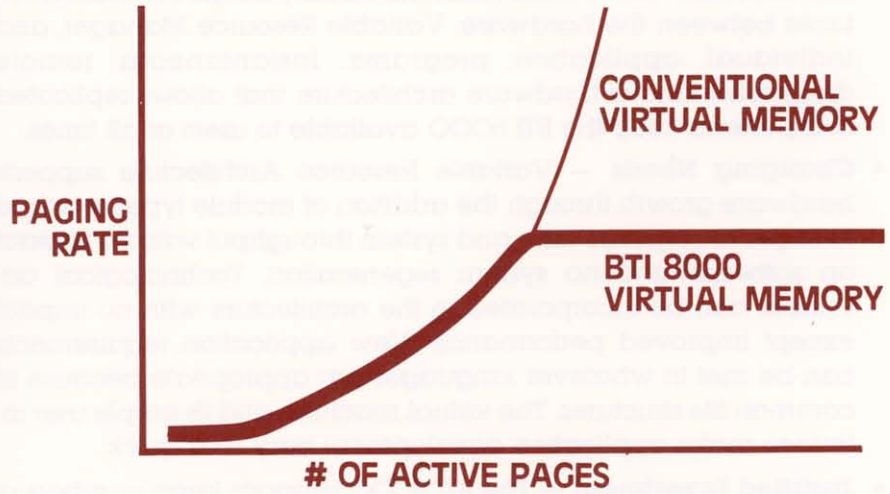


FIGURE 18

Thus, the BTI 8000 protects its users from severe response time degradation due to temporary processing overloads.

SYSTEMS SOFTWARE DESIGN IMPLICATIONS

The BTI 8000 provides a firm foundation for cost-effective computing in the 1980s. The system is designed to fill the following operational goals for the purchasing organization:

- Provides a simple interface for managing the information needs of its users.
- Requires a minimum staff for operations and management of the facility.
- Maintains a stable, secure environment for users who need access to their information at any and all times.
- Adapts to rapidly changing needs with a minimum of effort delay.

The BTI 8000 meets those goals in the following ways:

- **Simple Interface** — The same English-language commands control batch and interactive processes. Virtual machines have device and file independence. Users of COBOL, PASCAL/8000, FORTRAN 77, and BASIC/8000 have common data management facilities.
- **Minimum Management and Operations Staff** — The Variable Resource Manager (VRM) eliminates system programming support of the communications network, disk allocation and management, and operating systems generation. VRM automatically schedules batch processes and does operational tuning. Job control language and terminal interface programming are simple applications programmer functions not requiring systems staff support.

- **Stable, Secure Environment** — Scores of programmers and end-users on the system are secure from an error in any one user's virtual machine. The Virtual Machine Facility keeps inviolate interfaces between the hardware, Variable Resource Manager, and individual application programs. Instantaneous remote diagnostics and a hardware architecture that allows replicated components keep the BTI 8000 available to users at all times.
- **Changing Needs** — Variable Resource Architecture supports hardware growth through the addition of module types required to improve response time and system throughput with **no impact** on software and no system regeneration. Technological advances can be incorporated in the architecture with no impact except improved performance. New application requirements can be met in whatever languages are appropriate because of common file structures. The virtual machine and its simple user interface make application development easy and quick.
- **Justified Investment** — The BTI 8000 supports large numbers of interactive users at surprisingly small cost increments per user. Existing software can be moved quickly and easily to the system through the industry-standard high-level languages. Programs running on one BTI 8000 run on any BTI 8000 (larger or smaller) without modification or recompilation. New hardware components don't require program modification, nor do changes in hardware or software capacity. While doing its processing on a BTI 8000, a using organization can grow, shrink, or change with minimum impact. BTI has an excellent record of prompt maintenance to support system reliability.

The BTI 8000 is the computer of the '80s — a cost-effective system designed to meet tomorrow's information needs today.

Computerized On-line Service

BTI is successfully servicing over 2500 computers throughout the United States and Canada using computerized on-line service.

Fast Service is provided by a national service center manned round-the-clock 7 days a week. Skilled service engineers respond to telephone calls for service — usually within five minutes. A centralized diagnostic computer connected by telephone to the customer's site is the heart of the system.

Service Costs are held to a minimum by the use of such remote diagnostics rather than initial on-site service calls. A decade of experience has demonstrated that over 97% of all problems — hardware or software — can be identified in this manner. In most cases, the system owner can replace faulty hardware modules himself. Factory software support can be provided via telephone using the central service computer.

ABOUT BTI

Starting as a commercial timesharing service in 1968, BTI moved rapidly into the development and manufacture of interactive computer systems. Since 1971, BTI has delivered over 2500 Model 3000/4000/5000 Series 16-bit interactive-access systems. There are installations in 48 states of the U.S., in Canada, and in Europe. The BTI 8000 is a planned outgrowth of BTI's special experience in the manufacture and support of interactive computer systems.

BTI occupies a modern facility in Sunnyvale, California, with over 100,000 square feet of space. The facility houses over 400 employees in research and development, marketing, manufacturing, service, and administrative functions.

Corporate Headquarters:
870 West Maude Avenue
Sunnyvale, California 94086
(408) 733-1122

Regional Offices:

East
225 Old New Brunswick Road
Piscataway, New Jersey 08854
(201) 457-0600

Midwest
2401 Plum Grove Road
Palatine, Illinois 60067
(312) 397-9190

South
1155 Hammond Drive, Suite E5050
Atlanta, Georgia 30328
(404) 396-1630

West
977 Benicia Avenue
Sunnyvale, California 94086
(408) 749-0500

Sales offices in major U.S. cities.

United Kingdom
1433 Bristol Road South
Birmingham, England B32
2SU 021-477-3846

BTI
COMPUTER
SYSTEMS

A Datapro Report on

BTI 8000

Reprinted From

DATAPRO REPORTS ON MINICOMPUTERS

DATAPRO REPORTS ON MINICOMPUTERS is a management-oriented information service which covers all significant minicomputers, microcomputers, and small business computers. New and updated reports are published monthly. All opinions and evaluations contained in these reports are independent and objective, and represent the proprietary work of Datapro Research Corporation.

datapro

DATAPRO RESEARCH CORPORATION
1805 Underwood Boulevard, Delran, New Jersey 08075 (609) 764-0100

Palo Alto, CA (415) 467-6007 Phoenix, AZ (602) 263-7831 Washington, DC (301) 933-4020 Chicago, IL (312) 644-2000 Dallas, TX (214) 980-4525
A McGraw-Hill Company

BTI 8000

MANAGEMENT SUMMARY

Even in the early days of marketing the 4000, BTI felt that to reach the general EDP marketplace, a totally new system with substantially greater processing power and I/O capacity was needed. Therefore, while continuing with the development of the BTI 5000 and 5000/ES (see M11-089-101), BTI embarked on a program which culminated in the announcement of the BTI 8000 at the 1980 National Computer Conference.

The BTI 8000 is based on a 32-bit, 67-nanosecond bus serving multiple processors, controllers for main memory modules, a System Services Unit, and peripheral processors which in turn control I/O device controllers, an approach which BTI calls "Variable Resource Architecture." Computational Processing Units (CPUs), Memory Control Units (MCUs), Peripheral Processing Units (PPUs), and System Services Units (SSUs) can be plugged into the bus in any mix to match the requirements of the application. A minimum configuration requires at least one of each. The system's computational power, memory, and I/O resources are automatically pooled for efficient processing of the overall workload. If an application subsequently requires more computational power, memory, or I/O capacity, additional modules can be plugged into the bus. Conventional manual regeneration of the operating 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.

Background

BTI Computer Systems started out in 1968 as Basic Timesharing, Inc., a time-sharing service company ➢

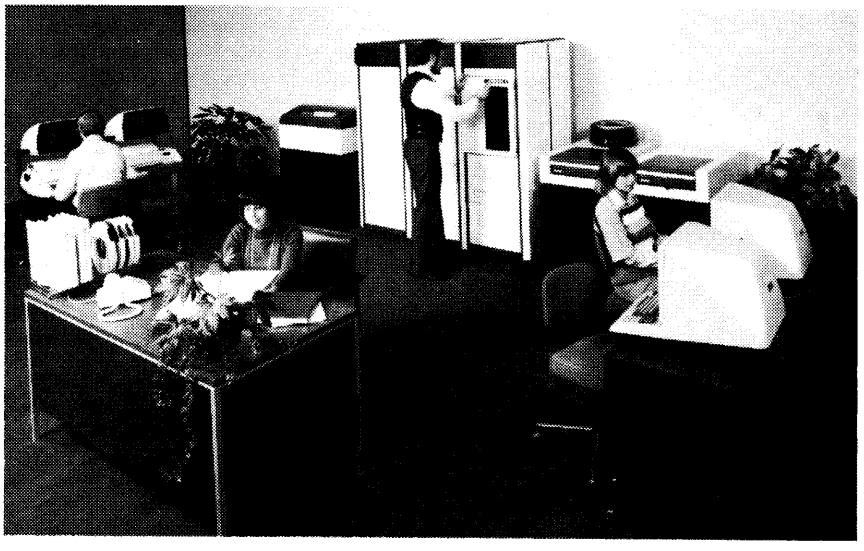
The BTI 8000 is a 32-bit, multiprocessor, multi-user, multilanguage, and multifunction system. Modular in configuration, the 8000 is designed around a central bus with a 32-bit-wide data path and 16 slots for plug-in attachment of system resource modules. The system is capable of supporting as many as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

MAIN MEMORY: 512K to 16M bytes
DISK CAPACITY: Up to 8 billion bytes
WORKSTATIONS: Up to 200 (interactive)
PRINTERS: Up to 900 lpm
OTHER I/O: Magnetic tape cartridge drives, magnetic tape reel-to-reel drive

CHARACTERISTICS

MANUFACTURER: BTI Computer Systems, Inc., 870 West Maude Avenue, Sunnyvale, California 94806. Telephone (408) 733-1122.

BTI Computer Systems started in the San Franciso 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 three product lines: two 16-bit single-processor systems capable of supporting up to 32 users, and a 32-bit, modular, multiprocessor system which can support as many as 200 active users. BTI's manufacturing facility is in Sunnyvale, California, and U.S. sales offices are in Piscataway and Cherry Hill, New Jersey; Washington, D.C.; El Monte, Los Angeles and Sunnyvale, California; Boston; Seattle; Denver; Atlanta; Cincinnati; Dallas; Minneapolis; Chicago; and St. Louis. BTI also has ➢



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

BTI 8000

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.

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. 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 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 and initially consisted of three models: the 4000/10, 4000/20, and 4000/30. The new CPUs 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 initally with ports for up to 16 users, with the 4000/20 and 4000/30 having expansion capabilities to 32 ports.

In March 1976, the 4000 Series was upgraded and redesignated as the Models 4000/15, 4000/25, and 4000/35. The most visible difference between the new 4000s 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.

Initially, an essential component of all time-sharing systems, user terminals, was not supplied by BTI. The company recognized that many asynchronous terminals with a data rate between 100 and 9600 bits per second and a standard RS-232-C interface are available directly to users, and passed on to its customers the potential savings of direct procurement. Similarly, any modem with compatible transmission specifications and an

a European subsidiary, BTI Computer Systems (UK), Ltd., with a sales office in Slough, England, and a service office in Birmingham.

MODEL: 8000.

DATE ANNOUNCED: May 1980.

DATE OF FIRST DELIVERY: Scheduled for mid-1981.

DATA FORMATS

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

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

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

INSTRUCTIONS: Machine instructions are all one word in length and reside on memory word boundaries. There are 174 machine instructions available to the user. The lowest 22 bits of most instructions specify an operand, while the next three higher bits are sometimes used to specify a register. Different methods of referencing operands are provided by the "address mode" field and 54 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: Semiconductor.

CYCLE TIME: 670 nanoseconds per 32-bit word, full cycle.

CAPACITY: Up to 16M bytes of main memory can be interfaced to the BTI 8000 via Memory Control Units (MCUs), with a single MCU controlling from 512K to 4M bytes of semiconductor memory. Additional memory is available in increments of 512K bytes. Memory is organized in pages of 4096 bytes. (Each MCU occupies 1 of the system's 16 basic module slots.)

CHECKING: ECC (Hamming code).

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

BTI 8000

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
MAGNETIC TAPE UNITS		
8310	Cartridge, 3M-type, 10M bytes/cartridge, 6400 bpi	DEI
8330	9-track, 800/1600 bpi, switch-selectable density, IBM/ANSI-compatible, 45 ips	*
PRINTERS		
8420	Line printer, 64- or 96-character set, 136 columns, 300 lpm	*
8425	Line printer, 64- or 96-character set, 136 columns, 600 lpm	*
8430	Line printer, 64- or 96-character set, 136 columns, 900 lpm	*
TERMINALS		
1410	80x24 CRT screen format, 5x7 character matrix, 64 displayable characters, TTY-style keyboard with numeric keypad, transmission rate to 19.2K bps	Hazeltine
1420	80x24 CRT screen format, 5x8 character matrix, 94 displayable characters (including lower case), dual-density, typewriter-style keyboard with numeric keypad, transmission rate to 19.2K bps	Hazeltine
1500	80x24 CRT screen format, 7x10 character matrix, 94 displayable characters, dual-density and reverse video, ANSI standard keyboard with numeric keypad, serial printer output, transmission rate to 19.2K bps	Hazeltine
1510	80x24 CRT screen format, 7x10 character matrixc; 94 displayable characters, dual-density, reverse video, screen protect, and block transmission (254 characters per block), ANSI standard keyboard with numeric keypad, serial printer output, transmission rate to 19.2K bps	Hazeltine
1800	Printing terminal; includes 9x7 character matrix, 132 columns, 150-cps impact printer, full ACSII 128-character keyboard, transmission rates to 110 to 9600 bps	Texas Instruments
	**Available from a number of vendors.*	

RS-232-C interface could be used for remote terminals. However, BTI does now offer, as options, a line of CRT terminals and printer 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 5000, which superseded the 3000 and 4000 and became BTI's mainstay 16-bit product line. The 5000 uses an upgraded version of the operating system proven on the 4000, and the CPU enables BTI to perform automatic remote fault diagnosis. The 5000's design allows it to be called and tested by a computer at BTI's service center without on-site assistance by the customer. BTI's diagnostic computers are also used to monitor a customer's system after a repair has been made and to carry out periodic

RESERVED STORAGE: The lowest n+9 pages (4096 bytes per page) on the system, where "n" is the number of Computational Processing Units present, are reserved for resident operating system use.

COMPUTATIONAL PROCESSOR

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

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

All resource modules automatically carry out self-tests at system start-up. On completion of its self-test, the SSU completes system start-up. If all modules are operative, the operating system is automatically configured to match the resources present. Faulty resource modules are identified with the aid of a front panel display. In multi-module 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, which is mounted on the top of the left-most system cabinet. The panel contains a readout of 10 alphanumeric characters for reporting system status and exception conditions, an alarm light, and 8 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,

BTI 8000

"health checks," looking, for example, at the incidence of soft (disk-read) errors which might 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.

The BTI 5000/ES, introduced in August 1979, is the entry-level system of the BTI 5000 product line. Its base configuration includes a 64K-byte CPU, 10 megabytes of on-line disk storage, a magnetic tape cartridge subsystem for application software backup, and a four-port communications controller/interface. Up to 262 megabytes of disk storage is available for the BTI 5000/ES, along with an additional capacity of 40 megabytes provided by four magnetic tape cartridge drives. A 9-track, 800/1600-bpi, IBM/ANSI-compatible magnetic tape drive is also available for the entry-level system.

BTI 8000

The 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 fail-soft. In a multi-module 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 60 megabytes per second. Up to 16 resource modules can be plugged into the bus. In addition to the CPU, MCU, and PPU modules, the system requires one System Services Unit (SSU), a microprogrammed processor that provides system control.

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

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: Fifty-four 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.

INSTRUCTION REPERTOIRE: 174 user-mode instructions, each one word long, include fixed-point, floating-point, and Boolean arithmetic; subroutine linkage; character string manipulation, and address mode instructions.

INPUT/OUTPUT CONTROL

I/O CHANNELS: Peripheral Processing Units (PPUs) are special-purpose processors which relieve CPUs of channel management overhead. Each PPU manages up to four independent I/O channel activities initiated by the CPUs, handling data transfers between memory and the peripheral devices. The PPUs' 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 900 lpm, and user communications facilities.

SIMULTANEOUS OPERATIONS: Up to 8 PPUs can be configured to a BTI 8000 system providing an input/output capacity of 32 channels. All peripheral devices interfaced to the respective number of channels provided by the PPUs can be active simultaneously accommodating multi-tasking operations.

CONFIGURATION RULES

Maximum configuration parameters for the BTI 8000 are as follows:

- **Up to 16M bytes of main memory,**
- **Up to 8 billion bytes of on-line disk storage,**
- **Up to 32 channels for peripheral devices, and**
- **Up to 200 active ports for terminals and modems.**

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

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

BTI 8000

system to match the resources available. The SSU contains a program-accessible system ID, a permanently assigned number which identifies the system in which the SSU is installed, which permits vendors of proprietary software packages control of which systems can run their packages by checking the system ID before executing.

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

The 8000 uses semiconductor memory with ECC and features a 670-nanosecond full cycle time (including Memory Control Unit operation). Read access time is under 400 nanoseconds. Memory is furnished in 512K-byte increments and is interfaced to the system via the MCUs. Minimum memory is 512K bytes, and the system will support up to 16M bytes of main memory. All memory present is treated by the system as an entity (even if interfaced through more than one MCU) organized in pages of 4096 bytes. In the event of a memory malfunction, the system eliminates the bad area on a page basis and reconfigures the available memory.

Mass storage for the BTI 8000 is provided by disk drives in formatted capacities of 67 and 254 megabytes. All drives use high-density, removable storage modules (packs). One disk controller can control up to four drives in any mix and can provide for overlapping seeks to minimize access times. A special error-correction technique substantially reduces the risk of data loss in the event of disk read problems. Mass storage data transfers take place one page at a time, and each page occupies one "block" of disk capacity. Blocks are stored on disk in a number of segments in such a way that an entire block can be reconstructed even if a segment becomes totally unreadable. The system "remembers" bad areas and dynamically reassigns block placements to work around them.

All system peripherals, including disk drives, are controlled by device controllers. Each Peripheral Processing Unit can support up to four controllers. Peripherals currently available for the 8000 include serial magnetic

MEMORY: Each Memory Control Unit supports up to 4M bytes of memory in units of 512K bytes. Memory connected to a given MCU must be of one type, but different MCUs can control different types of memory as BTI makes future memory offerings available.

DISK STORAGE: The Model 8205 disk controller used in the BTI 8000 supports up to four 67- or 254-megabyte disk drives.

MAGNETIC TAPE UNITS: A 9-track, 800/1600-bpi, 45-ips, reel-to-reel magnetic tape drive and a high-density cartridge tape unit can be configured to the BTI 8000 for loading and dumping data files and programs.

MASS STORAGE

67- AND 254-MEGABYTE DISK DRIVES: One 8205 disk controller supports up to four 8215 or 8225 disk drives in any mix, with overlapped seeks. Disk drives are storage module type. Access times are identical for all sizes. The average seek time is 30 milliseconds, and the average rotational delay is 8.3 milliseconds. The data transfer rate is 1.2 million bytes per second, and transfers to and from memory occur one full page (4096 bytes) at a time.

INPUT/OUTPUT UNITS

See the PERIPHERALS/TERMINALS table on M11-089-203.

COMMUNICATIONS CONTROL

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

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

SOFTWARE

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

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

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 assign-

BTI 8000

tape cartridge drives, 9-track open-reel magnetic tape drives, and three line printers with print rates of from 300 to 900 lines per minute.

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

The 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 his program to suit his convenience. The operating system is protected to ensure inviolate system operation despite any possibly harmful activities attempted by any user process or 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.

Software emphasis is on the commercial DP market stressing data protection and on-line terminal access. Software bundled with the system includes the operating system, Control Mode (the system's command language), and the following utilities: copy, sort/merge, help, loader, spooler, backup/recovery, operator/manager, interactive editor, debugger, plus one programming language. Sequential, relative and multi-keyed indexed sequential file access methods are supported. A file utility package (futil) is also provided as part of the bundled software. Languages offered by BTI include COBOL 74, FORTRAN 77, PASCAL/8000, and BASIC/8000.□

ment 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 log-on activity, the associated Peripheral Processing Unit places an interrupt signal on the bus. The first CPU to respond will handle the interrupt and post to the appropriate operating system tables.

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

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

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

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

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

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

The access control and status flags, including a "page referenced" flag, are carried into the page files of the CPUs, so that the system need not make an extra memory

BTI 8000

reference merely to update or examine them. The page referenced flag is used to identify the working set of a process as it executes, for scheduling purposes.

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

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

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

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

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

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

Three characteristics of this technique should be noted. First, the pages of a given process may be placed anywhere in paged memory. Second, a memory page that the operating system chooses to overlay with a new page will not first be written back to disk if it has not been altered since it was loaded in from disk. Third, frequently referenced pages, including pages referenced by more than one process, tend to remain resident, since the operating system's replacement algorithm tries to minimize disk access.

Demand-paging systems normally operate with a least-recently-used replacement algorithm; that is, the page chosen for overlaying is that which has "aged" the longest since being referenced by any process. This algorithm is entirely reasonable with a moderate load on a system, but invites "thrashing" when the load grows too large. The pages used by a given process during a specified period of time are its working set for that period. In a demand-paging system, the relationship between the total pages required to hold all active working sets and the total number of memory pages available determines the amount of disk activity on the system. As the page load grows, disk transfers become more frequent until all processes are reduced to their minimum working sets, below which they are incapable of executing any instructions without demanding a new page. Thereafter, any increase in load causes the system to spend almost all of its time in disk transfers. At this point, essentially no work is performed. The BTI 8000 modifies the conventional demand-paging alogrithm to prevent thrashing. When a demand occurs, the operating system selects the "least valuable process," based on a number of criteria, including the distinction between interactive and batch processes, and strips this process of the least recently used page of its working set, overlaying that memory page with the one demanded. As the overall load grows, this procedure is repeated until all processes are reduced to working sets close to minimum. At this stage, prior to the thrash point, the operating system identifies the process that is the most critical "troublemaker"—normally the one with the largest current working set. It then suspends this process for a certain period of time, rolling out its entire working set to free up memory for the rest of the load. The BTI 8000 process management algorithm avoids thrashing by making a dynamic transition from demand-paging to a modified multiprogramming technique.

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

LANGUAGES: The BTI 8000 supports four programming languages: COBOL 74, FORTRAN 77, PASCAL/8000, and BASIC/8000. All four have the following concepts in common:

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

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

BTI 8000

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

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

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

BTI 8000 FORTRAN extends the ANSI FORTRAN-77 standard with the following features:

- Debugging statements can be easily eliminated for compilation of production program version.
- Array subscript and computed GO TO expressions of real, double precision, or integer type.
- Interactive debug support.
- Symbolic names, 1 to 30 characters in length, in upper and lower case.
- Subexpression optimization.
- Variable length record I/O support.

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

- Full support for string data type,
- Loop state allows the user to accomplish repetition and decision in the same statement,
- Support of multi-keyed indexed sequential and relative file access methods,
- Case labels arranged in ranges,
- Compile-time expression evaluation for "CONST" declarations,
- Spawning and management of concurrent processes and generation and control of underprograms, and
- An interprocess communication capability.

BTI BASIC/8000 is an extended version of Dartmouth BASIC designed for creating, compiling, executing, and debugging programs. Important features offered by the extensions include improved file handling, string handling, and subrouting. The BASIC/8000 programming language includes the following:

- Function calls as a series of statements,
- String arrays,
- String handling,
- Subprogram calls with arguments,
- Variable names to 30 characters,
- Support of multi-keyed indexed sequential and relative files, and
- Interactive debugging.

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 the execute-only mode by the system owner. It can, however, be accessed for updates and maintenance by the software vendor through a special "proprietary software account." Under this feature, the system owner and users are permitted access to the program and to all system management privileges except the proprietary source code. The vendor, however, given telephone access to his proprietary software, can update and correct the package without the need of sending copies or interrupting users.

PRICING

POLICY: BTI offers the 8000 system on a purchase-only basis. The base system configuration is complete and includes the operating system, Control Mode, the utilities package, a file system, and one programming language. BTI warrants all hardware for 90 days. Software is licensed for use on one system, but discounts are offered for multiple installations by one customer. BTI-furnished software is maintained free for one year, and continuing maintenance is available on a yearly contract basis. Upgrades of BTI software are offered for a nominal handling fee to customers using the existing software.

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

Under the contract terms, BTI furnishes both parts and labor to correct all failures and to provide 7-day, 24-hour telephone service. Replacement parts are shipped from the factory by air freight, scheduled airline, or package express service to users, who replace them and return the failed

BTI 8000

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 the hardware configuration. Typical monthly charges covering both preventive and corrective maintenance are less than 1 percent of the purchase price.

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

EQUIPMENT PRICES

		Purchase Price	Monthly Maintenance
BASE SYSTEM			
8000	Includes Computational Processing Unit, Memory Control Unit, 512K bytes of memory, Peripheral Processing Unit, 67M-byte disk drive and controller, 10M-byte magnetic tape cartridge drive and controller, asynchronous communications controller, 8-port interface, System Services Unit, double-bay system cabinet with bus backplane, operator control panel, and system power supply	$107,000	$827
SYSTEM RESOURCE MODULES			
8110	Computational Processing Unit (CPU)	16,000	96
8130	Memory Control Unit (MCU)	5,000	30
8170	Peripheral Processing Unit (PPU)	8,000	48
8190	System Services Unit (SSU)	5,000	30
MEMORY			
8142	Memory module, 512K bytes of semiconductor memory	16,000	120
8144	Memory module, 1M bytes of semiconductor memory	28,000	210
8154	Memory power supply, supports up to 2M bytes of one MCU	7,500	56
MASS STORAGE			
8205	Disk controller for up to four 8215, 8225 disk drives (in any combination)	10,000	60
8215	67M-byte disk drive with one removable disk pack	13,500	135
8225	254M-byte disk drive with one removable disk pack	30,000	300
MAGNETIC TAPE EQUIPMENT			
8305	Magnetic tape controller for up to four 8310 or 8315 magnetic tape cartridge drives	4,000	22
8310	Single magnetic tape cartridge drive and housing with one magnetic tape cartridge (supports up to three additional 8315 drive units)	3,000	38
8315	Additional magnetic tape cartridge drives, installs in 8310 unit (up to three additional units can be installed)	2,500	30
8320	Magnetic tape controller for up to four 8330 drives	5,000	50
8330	9-track, reel-to-reel magnetic tape drive, 800/1600 bpi	9,000	120
TERMINALS			
1410	CRT terminal, 80 characters x 24 lines, 5x7 character matrix, 64 displayable characters, TTY-style keyboard with numeric keypad, transmission rates to 19.2K bps	900	—
1420	CRT terminal, 80 characters x 24 lines, 5x8 character matrix, 94 displayable characters (including lower case), dual intensity, typewriter-style keyboard with numeric keypad, transmission rates to 19.2K bps	995	—
1500	CRT terminal, 80 characters x 24 lines, 7x10 character matrix, 94 displayable characters, dual intensity and reverse video, ANSI standard keyboard with numeric keypad, serial printer interface, transmission rates to 19.2K bps	1,225	—
1510	CRT terminal, 80 characters x 24 lines, 7x10 character matrix, 94 displayable characters, dual intensity, reverse video, screen protect and block transmission, ANSI standard keyboard with numeric keypad, serial printer interface, transmission rates to 19.2K bps	1,395	—
1800	Printing terminal, 9x7 character matrix, 132 columns, 150-cps impact printer, full ASCII 128-character keyboard, transmission rates from 110 to 9600 bps	2,395	—
PRINTERS			
8415	Line printer controller for 8420, 8425, 8430 printers	5,000	30
8420	Line printer, 300 lpm	10,000	125
8425	Line printer, 600 lpm	13,000	163
8430	Line printer, 900 lpm (includes quietized cabinet)	18,700	234
8435	96-character set for 8420, 8425, 8430 printers	1,500	—
8440	Quietized cabinet for 8420 or 8425 printers	800	—
COMMUNICATIONS			
8510	Asynchronous communications controller, supports up to eight 8515 8-port interfaces	8,000	48
8515	8-port interface, EIA RS-232-C, at rates to 19.2K bps	2,000	12
ACCESSORIES			
8815	Cabinet extension (extends 8810 cabinet to a triple-bay configuration)	2,000	—
8816	Side cover	800	—
8850	System power supply (one included in 8810 cabinet furnished with base system)	3,000	30

BTI 8000

SOFTWARE PRICES

		License Fee*
8910	PASCAL/8000, on cartridge tape	$5,000
8911	PASCAL/8000, on reel-to-reel tape	5,000
8920	ANS 77 FORTRAN, on cartridge tape	5,000
8921	ANS 77 FORTRAN, on reel-to-reel tape	5,000
8930	BASIC/8000, on cartridge tape	5,000
8931	BASIC/8000, on reel-to-reel tape	5,000
8940	ANS 74 COBOL, on cartridge tape	5,000
8941	ANS 74 COBOL, on reel-to-reel tape	5,000

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

BTI 8000
32-Bit Multiprocessor System

General System Specifications

June 1981

HARDWARE ARCHITECTURE

Hardware resources for computation, memory and I/O are provided by plug-in modules, operating in parallel. Quantity and mix of resource modules can be configured as required to satisfy system application. Resources are automatically allocated to active processes by monitor software.

RESOURCE MODULES

Four Types:

Computational Processing Unit (CPU)
Memory Control Unit (MCU)
Peripheral Processing Unit (PPU)
System Services Unit (SSU)

SYSTEM CONFIGURATION

Minimum: 1 each CPU, MCU, PPU, SSU. Additional CPUs, MCUs, PPUs as required up to a total of 16 modules. (Only 1 SSU can be active. Practical maximum of any other type of module is 8.)

Due to wide variations in possible configurations, prospective users should contact BTI Sales Offices for specific configuration details.

BUS STRUCTURE

Distributed logic, based on passive bus with 32-bit wide data path (plus address, control and parity lines). Bus accepts up to 16 resource modules. Transfers between resource modules are synchronous and occur at a rate of 60 megabytes per second (67 nanoseconds per 32-bit word).

COMPUTATION

Performed by one or more CPUs, operating in parallel. CPU is 32-bit processor with eight 32-bit, general-purpose, program-accessible registers. Additional registers for monitor status, process status and program counter.

Arithmetic: 32- and 64-bit integer; 64-bit floating point.

Instructions: 174 user-mode instructions (1 word long).

Addressing: 21 addressing modes which reference operands in registers, in memory, and the instructions themselves. Operand can be a single or double word, a byte, or a bit-field from 1 to 32 bits. Addressing modes directly support compiler data structures, including stack, queue, and linked-list, with arbitrary size data elements. All-hardware memory mapping: virtual to physical memory address conversion performed in one bus cycle (67 nanoseconds).

MEMORY

Controlled by one or more MCUs, operating in parallel. Each MCU controls up to 4 Mbytes of memory.

Memory: Semi-conductor, 667 nanosecond full-cycle time (including MCU operation). Read access time is 867 nanoseconds including 2 bus transfers and byte parity check.

Configuration: Furnished in 512 Kbyte increments. Minimum memory 512 Kbytes; maximum per MCU is 4 Mbytes. (System will support 16 Mbytes of memory, using multiple MCUs.) System treats all memory as single entity, organized in pages of 4096 bytes. System 'strikes out' malfunctioning area of memory on page basis and automatically reconfigures available memory.

INPUT/OUTPUT

Controlled by one or more Peripheral Processing Units (PPUs), operating in parallel. PPU is microprogrammed processor, with four channels for peripheral device controllers. Transfers between PPU and controllers are via two 8-bit paths, one for data, the other for control and status. All four PPU channels combined have a maximum bandwidth of 24 megabits/sec.; one of the four channels may take up to 10 megabits/sec. of the total bandwidth.

System I/O Capacity: Minimum 4 channels; maximum (8 PPUs) 32 channels.

MASS STORAGE

Disk drives are storage module type, offered in formatted capacities of 67 to 254 Mbytes. One disk controller supports up to four drives, in any mix of capacities, with overlapped seeks. Up to 16 drives can be used per system. Maximum file size is equal to total formatted capacity of a drive.

Drive Specifications: Average seek time 30 milliseconds; average rotational latency 8.3 milliseconds; transfer rate 1.209 Mbytes/sec.; rotation speed 3600 rpm.

Storage Technique: Mass storage data transfers effected on page basis, stored as one block on disk. Unique multiple segment storage technique permits reconstruction of page even if a segment becomes totally unreadable. System reassigns block placements if bad disk areas encountered.

PERIPHERALS

Peripherals include IBM/ANSI compatible 9-track (800/1600 bpi) magnetic tape and 3M-type cartridge magnetic tape (10 Mbytes per cartridge, at 6400 bpi). Also choice of line printers from 300 to 900 lpm and hardcopy and video display terminals.

USER COMMUNICATIONS

Controlled by Asynchronous Communications Controller (ACC) operating from PPU. ACC controls up to eight 8-port (RS-232-C) interfaces; 64 ports total. Maximum rate for any port is 19.2 Kbaud. User programs have control over interface pins and terminating character selection to allow programming of any asynchronous protocol. Multiple ACC units may be attached for larger configurations.

SYSTEM SERVICES

Provided by SSU (only one SSU is necessary). SSU is microprogrammed processor providing following functions:

1) Operator control panel with system control pushbuttons, including one-button sysgen, and 10-character display of system status and diagnostic test results;

2) Master clock, drives bus at 67 nanosecond cycle;

3) Program-accessible time-of-day clock, increments in milliseconds, includes battery backup;

4) Internal interrupt timer;

5) Program-accessible permanent system ID number;

6) Remote (dial-up) diagnostic facility, for access by factory diagnostic computer. (Facility may be disabled by operator.)

7) Intelligent bootstrap (see auto sysgen, below);

8) Automatic power fail restart;

9) Thermal overload detection.

SYSGEN

All resource modules automatically carry out self-test at start up (initiated by one button). On completion of its self test, SSU initiates sysgen. If all modules are operative, operating system is automatically configured to match resources present.

FAIL-SOFT

Faulty resource modules are identified with the aid of the front panel display. In multi-module configuration, faulty module can be removed and system restarted (one-button sysgen).

SOFTWARE ARCHITECTURE

All users operate in separate virtual machine environments. Programs (source and object) are independent of hardware configuration. User workspace is 512 Kbytes per process. Address space for I/O services for user's process is separate from workspace.

Demand Paging: Real memory pages are allocated to user processes' virtual memory requests as governed by most valuable, least valuable algorithm. Entire page of words 4096 bytes is available to programmer.

System will support up to approximately 200 simultaneous processes (interactive and batch) depending on amount of memory and number of CPUs installed. User processes can generate and communicate with other processes to handle heavy workloads in parallel.

Control Mode: Two levels of on-line assistance. DO-files and user-defined variables allow command-language programming, including conditional branching.

File System: Supports multi-key indexed, relative record, and sequential organizations.

Utilities: Editor, linking loader, universal copy program, sort/merge, symbolic debugger, integrated spooling programs, help program.

Programming Languages: COBOL (ANS 74 plus extensions), BASIC/8000, FORTRAN (ANS 77 plus extensions), PASCAL/8000.

Specifications are subject to change without notice.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1105-R0581

BTI 8000

32-Bit Multiprocessor System

Price List

July, 1981
U.S. Domestic Prices

INTRODUCTION

The BTI 8000 32-Bit Multiprocessor System is completely modular in configuration. System configurations and prices are built upon a "base system". Customers may add or substitute any modules or peripherals listed on the following price schedule in order to arrive at the desired system configuration. This price list includes the configuration and price of the base system and prices for all add-on items. For guidance on determining a system configuration to satisfy a specific application, please consult a BTI sales representative.

BASE SYSTEM

8110	Computational Processing Unit	
8130	Memory Control Unit	
8142	Memory Module, 512 Kbytes of semi-conductor memory	
8154	Memory Power Supply and Card Cage	
8170	Peripheral Processing Unit	
8190	System Services Unit	
8205	Disk Controller	
8215	67 Megabyte Storage Module Drive with one removable 8217 Disk Pack	
8305	Cartridge Magnetic Tape Controller	
8310	Single Cartridge Magnetic Tape housing and Drive with one 8317 Tape Cartridge. (One cartridge stores 10 Mbytes)	
8510	Asynchronous Communications Controller	
8515	8-Port Interface (EIA RS-232-C compatible, rates to 19.2 Kbaud)	
8810	System Cabinet (Double bay; includes bus backplane, operator control panel, one system power supply)	
8901	Base system includes license to use the following BTI-furnished software: operating system, control mode, utilities (including editor, linking loader, universal copy program, sort/merge, and symbolic debugger), file system, integrated spooling programs, help program.	
	Price for complete base system	$102,000

SYSTEM EXPANSION OPTIONS

SYSTEM RESOURCE MODULES

8110	Computational Processing unit (CPU).	$ 16,000
8130	Memory Control Unit (MCU). Supports up to 4 Mbytes of memory.	5,000
8170	Peripheral processing Unit (PPU). Supports up to 4 peripheral device controllers.	8,000
8190	System Services Unit (SSU).	5,000

MEMORY

8142	Memory Module, 512 Kbytes of semi-conductor memory	$ 16,000
8144	Memory Module, 1 Mbyte of semi-conductor memory	28,000
8154	Memory Power Supply (supports up to 2 Mbytes on one MCU)	7,500

DISK STORAGE

8205	Disk Controller (for 8215, 8225 Drives; supports up to 4 drives, in any combination.)	$ 10,000
8215	67 Mbyte Storage Module Drive with one removable 8217 Disk Pack	13,500
8225	254 Mbyte Storage Module Drive with one removable 8227 Disk Pack	30,000

MAGNETIC TAPE

8305	Cartridge Magnetic Tape Controller for 8310, 8315 Drives (controls up to 4 drives)	$ 4,000
8310	Single Cartridge Magnetic Tape Housing and Drive, with one 8317 Magnetic Tape Cartridge. (8310 module accommodates up to three additional 8315 drive units)	3,000
8315	Additional Cartridge Magnetic Tape Drive; installs in 8310 module. Up to three 8315 units may be added for total of four drives.	2,650
8320	Magnetic Tape Controller for 8330 Drive (supports up to 4 drives)	5,000
8330	9-Track Magnetic Tape Drive, IBM/ANSI- compatible (800/1600bpi, switch selectable)	9,000

LINE PRINTERS

8415	Line Printer Controller for 8420, 8425, 8430 Printers. One printer per controller	$ 5,000
8420	Line Printer, 300 lpm (136 column, 64 character, heavy duty)	10,000
8422	Line Printer, 220 lpm (136 column, 96 character, heavy duty)	10,000
8440	Noise reducing cabinet, add	800
8425	Line Printer, 600 lpm (136 column, 64 character, heavy duty)	13,000
8427	Line Printer, 440 lpm (136 column, 96 character, heavy duty)	13,000
8440	Noise reducing cabinet, add	800
8430	Line Printer, 900 lpm (136 column, 64 character, heavy duty. Includes noise-reducing cabinet.)	18,700
8432	Line Printer, 660 lpm (136 column, 96 character, heavy duty. Includes noise-reducing cabinet.)	18,700

SYSTEM EXPANSION OPTIONS, CONTINUED

COMMUNICATIONS

8510	Asynchronous Communications Controller (supports up to eight 8515 8-Port Interfaces)	$ 8,000
8515	8-Port Interface (EIA RS-232-C, at rates to 19.2 Kbaud for any or all ports)	2,000

USER TERMINALS

BTI provides direct maintenance support for all of its products excepting terminals, which are serviced by the terminal manufacturer or its authorized agent.

Terminals purchased (in any quantity) together with the purchase of a system are subject to a 15% discount from the list price shown. No other discounts apply.

Four models of video display terminals available. All have 80-character, 24-line screen format, and may be used at rates to 19.2 Kbaud.

1410	5 × 7 character matrix, 64 displayable characters. TTY-style keyboard with numeric pad.	$ 900
1420	5 × 8 character matrix, 94 displayable including lowercase. Dual intensity. Typewriter style keyboard with numeric pad.	995
1500	7 × 10 character matrix, 94 displayable characters. Dual intensity and reverse video. ANSI standard keyboard with numeric pad. Serial printer output.	1,225
1510	7 × 10 character matrix, 95 displayable characters, Dual intensity, reverse video, screen protect and block transmission. ANSI standard keyboard with numeric pad. Serial printer output.	1,395

A printing terminal is also available.

1800	9 × 7 character matrix, 132 column, 150 CPS impact printing. Full ASCII 128 character keyboard. 110 to 9600 baud transmission speed.	2,395

SYSTEM ACCESSORIES

All orders below $100.00 must be accompanied by payment.

CABINETS

8815	Cabinet Extension. Extends 8810 cabinet to triple bay configuration. Further 8815 extensions may be added as required. (Includes blank front panels, but not side covers.)	$ 3,000
8816	Side Cover. (Fits 8810 Cabinet, 8815 Extension, either side.)	800
8850	System power Supply (one included in 8810 cabinet furnished with base system.)	3,000

STORAGE MEDIA

8217	Disk Pack, for 8215 67 Mbyte Drive (formatted)	$ 750
8227	Disk Pack, for 8225 254 Mbyte Drive (formatted)	1,250
8317	Magnetic Tape Cartridge, for 8310, 8315 Drives	50
8332	Magnetic Tape Reel, for 8330 Drive (2400 feet)	25

SYSTEM ACCESSORIES, CONTINUED

LINE PRINTER ACCESSORIES

8442	Ribbon for 8420, 8425, 8430 Line Printers	$ 50

REPLACEMENT AIR FILTERS

—	Filter for 8215 Disk Drive; part no. 2000-0055	$ 10
—	Filter for 8225 Disk Drive; part no. 2000-0056	10
—	Filter for System Cabinet; part no. 4100-0026	10

TERMINAL COMMUNICATIONS

8540	Terminal or modem cable for connection to user port. Male connector DBM-25P at both ends. Length 25 feet.	$ 50
8542	Extension cable: extends port connections. Terminated with male connector DBM-25P at one end and female connector DBM-25S at the other end. Length 25 feet.	50
8550	Male connector set, DBM-25P, with hood.	10
8560	Female connector set, DBM-25S, with hood.	10
8562	Data Cable, 12 conductor, 22 AWG, 100 foot roll.	35

CLEANING ACCESSORIES

—	Magnetic tape head cleaning cartridge for 8310, 8315 drives, part no. 9000-0188	$ 15
—	Alcohol pads (Texpads). Box of 100 pads, part no. 4200-0002	16
—	Cleaning tissue (Kimwipes, small). Box, part no. 4440-0002	1

INSTALLATION

Installation services consist of physical installation of system, system check-out, and acceptance tests, on-site training in PC board installation and use of diagnostics. Unless specifically contracted for, the connection of any hardware to in-house communications lines, telephone lines and/or user terminals is not part of the installation.	$ 1% of total product purchase price
Minimum charge for any on-site installation.	375

SOFTWARE

BTI software is licensed for use on one system. Discounts are offered for multiple installations by one customer. BTI-furnished software is maintained free of charge for one year. Continuing maintenance is available on a yearly contract basis. Upgrades of BTI software are offered for a handling charge to customers using the existing software.

		License Fee $ *
8901	Operating system, control mode, utilities (including editor, linking loader, universal copy program, sort/merge, and symbolic debugger), file system, integrated spooling programs, help program.	
8910	PASCAL/8000, on disk pack.	5,000
8911	Same as 8910, on open reel tape.	5,000
8912	Same as 8910, on cartridge tape.	5,000
8920	FORTRAN (ANS 77 FORTRAN with extensions), on disk pack.	5,000
8921	Same as 8920, on open reel tape.	5,000
8922	Same as 8920, on cartridge tape.	5,000
8930	BASIC/8000, on disk pack.	5,000
8931	Same as 8930, on open reel tape.	5,000
8932	Same as 8930, on cartridge tape.	5,000
8940	COBOL (ANS 74 COBOL with extensions), on disk pack.	5,000
8941	Same as 8940, on open reel tape.	5,000
8942	Same as 8940, on cartridge tape.	5,000

*Included in base system price.

Initial language selection will be shipped on disk along with 8901. All languages purchased at a later date will be shipped only on magnetic tape.

TRAINING

Two students will be trained in each course at no extra charge with each system purchase. Charges for **additional** students are listed below.

BTI 8000 SYSTEM INSTRUCTION

(per additional student) $ 750

This is a week-long, laboratory-oriented course for people who are already fluent in a high-level programming language (i.e., COBOL, FORTRAN, PASCAL, or BASIC). Students will learn how to design, write, and debug terminal-oriented programs in a higher-level language using BTI 8000 software facilities. Approximately 40% of the course will be devoted to hands-on instruction.

SYSTEM MANAGEMENT AND OPERATIONS

(per additional student) $ 750

This week-long course is for System Managers who are responsible for operation of the BTI 8000. The course covers system resource allocation, the account structure, and machine room operations. Students will learn how to set-up an account structure to fit the particular needs of their installation. They will also learn how to establish proper backup procedures.

(Courses are conducted at BTI Headquarters. Price does not include transportation, etc.)

DOCUMENTATION

Prices for additional copies only. Documentation is supplied free of charge with system purchase.

Manuals and booklets listed below are subject to a discount of 25% when purchased in quantities of 10 or more.

All orders below $100.00 must be accompanied by payment.

8705	Site Preparation Guide	$ 5
8710	System Fundamentals	20
8720	System Utilities	15
8725	Manager's Manual	5
8730	Operator's Manual	5
8732	Cooperative Maintenance Manual	50
8735	Terminal Communications Guide	8
8750	BASIC/8000 Language Reference Manual	15
8755	PASCAL/8000 Language Reference Manual	15
8756	PASCAL/8000 User's Guide	10
8760	FORTRAN 77 Language Reference Manual	25
8761	FORTRAN 77 User's Guide	12
8765	COBOL Language Reference Manual	40
8766	COBOL User's Guide	15
8780	Manual Binders, 3-Ring	3

Prices are F.O.B. Sunnyvale, California, and do not include travel and freight expenses for on-site installation or applicable state and local taxes. Prices are subject to change without notice.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in USA
1186-R0781

BTI 8000

32-Bit Multiprocessor System

System Utilities

- Copy
- Convert
- Debug
- Help
- Helpmake
- Linking Loader
- Sort/Merge
- EDIT/8000

COPY

The COPY utility will create a duplicate of a single random access file, command file, or sequential access file, or concatenate data from up to 100 sequential access files on a single sequential access file. Random access files will be copied in the entirety. Subfiles within a sequential access file may be copied selectively and data may be appended to the end of a sequential access file. Blocking and deblocking of records can also be performed using the copy utility.

By prepositioning the pointers in input files it is possible to skip records at the beginning of a file, and to treat subfiles in a sequential access file as separate input files. Input parameters may specify that only certain portions of an input file are to be copied.

Data may be appended from one or more sequential files to an existing sequential access file by prepositioning the pointers in the output file to end-of-data before calling COPY.

COPY can write random access files onto sequential access devices in a format which allows them to be copied back to disk in their original form. Upon request, COPY will compare the input file(s) with the output file to verify that the copy operation was successful and accurate.

CONVERT

The CONVERT utility is a specialized copy program which permits converting specified fields in the input records from one data format to another. It further permits blocking and deblocking of records. Declared fields also may be used 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, and 32-bit integer to and from 8-, 16-, and 24-bit integer formats.

DEBUG

The high level language DEBUG utility is designed to permit debugging of a program by specifying breakpoints and tracepoints, displaying the values of memory locations, and executing the program one or several statements at a time, or at normal speed. Execution may be traced either at the source statement level or at the machine instruction level. A program need not be recompiled to debug it since all of the information needed by DEBUG is included with its memory image in the file created by the Linking Loader.

With DEBUG, the execution of a program can be traced and its variables examined. User defined symbols in the program are passed to DEBUG by the compiler. Thus, program execution can be followed using the source listing from the compiler. A symbol in any module of the program can be referenced at any time and its value changed.

DEBUG permits single-stepping through a program, executing one source statement or machine instruction each time, or running the program at full speed and stopping only at breakpoints.

Up to 32 breakpoints and tracepoints can be defined. An instruction breakpoint causes DEBUG to stop execution of the program when an attempt is made to execute the specified instruction, and to advise that the breakpointed instruction has been reached. A value breakpoint causes DEBUG to advise of a change in the contents of the specified memory location.

An instruction tracepoint is similar to an instruction breakpoint but does not stop execution of the program before the specified instruction; it simply advises that the instruction was executed. A value tracepoint causes DEBUG to advise of any change in the contents of the specified memory location.

DEBUG may be used in an on-line session, or driven from a file of commands to be executed as a batch session.

HELP

The HELP utility is designed to provide assistance to users of BTI-supplied programs. In addition, HELP

files can be created for application programs written by the user.

The HELP information is organized into sections of information called topics, which are fitted together in an outline format. Subjects are normally divided into 1) a topic containing general information, and 2) sub-topics "underneath" the general one that contain specific information.

The following topics are included, when appropriate, in the HELP information of every BTI-supplied program.

Parameters	— a concise description of the parameter line syntax
Defaults	— the default values for parameters and parameter arguments
Commands	— a general description of interactive commands
Errors	— the error messages produced by the program
News	— the version number of the program, new features with the current release, etc.
Bugs	— the known bugs in the program
Intro	— an introduction to the program for an unfamiliar user
Examples	— some common examples of using the program
Hints	— methods for tasks the program is commonly asked to do
Terms	— an explanation of any unusual vocabulary in the program

The HELP utility delivers information in a variety of ways. Details can be reviewed, using keywords associated with the desired subject. It can be used to browse through topics using the outline structure, either for general interest, or to find specifics for which keywords are not known. Also, hardcopy listings can be generated by the HELP utility to give a short reference guide on a selected subject.

HELP may be used interactively; alternately, all the desired information may be requested through a single command line. HELP information requested during a batch session is routed to the line printer; information requested during an on-line session can also be printed.

HELPMAKE

The HELPMAKE utility is a compiler which generates a HELP file that is readable by the HELP utility. The input is a file of commands and text which is created using the EDIT Utility. Topics, subtopics and the relationship among them can be specified.

The HELPMAKE utility checks the input for errors and produces a HELP file which is saved under the file identifier specified. This file may then be accessed through the HELP utility.

LINKING LOADER

The Linking Loader is used to combine separately compiled or assembled object modules into a runnable program, resolving external references among them and allocating memory. One or more input files may be specified to the Linking Loader, each of which is an object binary file which contains one or more object modules. The resultant CODE file consists of the memory image of the runnable program, plus pointers and other information which is used by the high-level language DEBUG utility.

Upon request, only specified modules from an object binary file will be included in the CODE file. If desired, an input file may be treated as an object library. Modules from a file so designated are included in the runnable program only if they are needed by some module which is already part of the program.

A memory allocation map and external symbol table may be requested. They are useful in using the high-level language DEBUG utility. They can be written to a disk file or a line printer.

SORT/MERGE

The SORT/MERGE utility consists of two programs, SORT and MERGE, which provide the capability to sort and/or merge records from up to thirty-two input files to produce sorted data on a single output

file. Each of the programs is run as a stand-alone utility. The two programs are similar in function, but the SORT program must be used when records within the input files need to be sorted before the files are merged. SORT is also used when records in a single input file are to be sorted. The MERGE program should be used to save time when records within each of the input files to be merged are already ordered in the same desired sequence.

The input files to SORT/MERGE may be any sequential access files. Both of the programs read records from the input files in the order in which these files were declared, so that in the case of duplicate records, the record from the earlier-declared input file is written to the output file before the record from the later-declared input file. Duplicate records may optionally be directed to a second output file, or may be effectively ignored and not written to any output file.

Two output files are permitted; the second file, if specified, is used only for the output of duplicate records. Output files need not be of the same type as input files. Records may be of fixed or variable length, blocked or unblocked, with a maximum record size of 32,000 bytes and no practical limit to the number of records.

Up to sixteen sort or merge keys, each with its own collating sequence, may be defined. Collating sequences may be ascending or descending. A special collating sequence for one or more of the keys may also be defined.

A summary of the sort or merge operation, including statistics, is written to the user terminal, line printer, or a specified file. This summary includes all parameters entered, all data fields defined, all sort or merge keys specified, input and output devices declared with the number of records read from or written to each, the total number of records sorted (SORT only), the first 72 bytes of each duplicate record (if requested), and any error messages generated.

EDIT/8000

EDIT/8000 is the standard editor for the BTI 8000 and will operate on all types of terminals. The program is line oriented and is designed for the input, editing and formatting of text files, programs, and data files. EDIT/8000 can create and edit files of Control Mode commands to be executed as command files or batch sessions.

EDIT/8000 provides the ability to: add lines of code anywhere in the file; delete any number of unwanted lines; change a string throughout the file; move blocks of code within or between files; duplicate and replace lines; and modify characters within a line.

Retyping of frequently used information can be eliminated by transferring information between programs or files. Programs composed of standard material can be assembled from a number of files or programs, saving operator time.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS
870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1201-R0781

COBOL

```
000170     02  FILLER PIC X(15) VALUE SPACES.
000180     02  LITERAL1 PIC X(50) VALUE "TEST RESULTS OF TRANSACTION DEM
000190-        "O NUMBER TWO".
000200 01  HEADING2.
000210     02  LITERAL2 PIC X(120) VALUE "THIS TEST IS DESIGNED TO TEST
                                        EN MODES INPUT, OUTPUT, AND I-O FOR RELATIVE FILE
                                        VALUE ZEROS.
                                        VALUE 12345678901234567
                                        Z".
000280     02  ALPHANUM PIC X(14) VALUE "!#$%&'()-^\@[/".
000290 PROCEDURE DIVISION.
#00000 000300 PARAGRAPH1.
#00000 000310     OPEN OUTPUT P-FILE1.
#00008 000320     WRITE P-FILE1-REC FROM HEADING1 AFTER ADVANCING PAGE.
#00016 000330     WRITE P-FILE1-REC FROM HEADING2 AFTER ADVANCING 2 LINES.
#00028 000340     MOVE "TEST ONE OPENS 3 RELATIVE FILES (SEQUENTIAL, RANDOM AND
000350-        " DYNAMIC) IN OUTPUT MODE AND WRITES 10 RECORDS ON EACH"
000360         TO P-FILE1-REC.
#0002C 000370     WRITE P-FILE1-REC AFTER ADVANCING 4 LINES.
#0003A 000380     OPEN TRANSACTION IO-FILE1, IO-FILE2, IO-FILE3.
#00052 000390     BEGIN-TRANSACTION OUTPUT IO-FILE1, IO-FILE2, IO-FILE3.
#00066 000400     PERFORM PARAGRAPH10 VARYING REC-NUM FROM 1 BY 1
000410         UNTIL REC-NUM = 10.
#0007A 000420     END-TRANSACTION.
#0007C 000430     CLOSE IO-                    IO-FILE3.
000440
#0008E 000450     MOVE "TEST TWO OPENS THE THREE FILES IN INPUT MODE AND READS
000460-        "THE 10 RECORDS WRITTEN IN TEST ONE" TO P-FILE1-REC.
#00094 000470 PARAGRAPH2.
#00094 000480     WRITE P-FILE1-REC AFTER ADVANCING 4 LINES.
#000A2 000490     OPEN TRANSACTION IO-FILE1, IO-FILE2, IO-FILE3.
#000BA 000500     BEGIN-TRANSACTION INPUT IO-FILE1, IO-FILE2, IO-FILE3.
#000CE 000510     PERFORM PARAGRAPH11 VARYING DUMMY-1 FROM 1 BY 1
000520         UNTIL DUMMY-1 = 10.
#000E2 000530     END-TRANSACTION.
#000E4 000540     CLOSE IO-FILE1, IO-FILE2, IO-FILE3.
#000F8 000550 PARAGRAPH3.
#000F8 000560     MOVE "TEST THREE OPENS THE THREE FILES IN I-O AND REWRITES TH
000570-        "E 10 RECORDS" TO P-FILE1-REC.
#000FC 000580     WRITE P-FILE1-REC AFTER ADVANCING 4 LINES.
#0010A 000580     OPEN TRANSACTION IO-FILE1, IO-FILE2, IO-FILE3.
#00122 000590     BEGIN-TRANSACTION I-O IO-FILE1, IO-FILE2, IO-FILE3.
#00136 000600     PERFORM PARAGRAPH12 VARYING DUMMY-1 FROM 1 BY 1
000610         UNTIL DUMMY-1 = 10.
#0014A 000620     END-TRANSACTION.
#0014C 000630     CLOSE IO-FILE1, IO-FILE2, IO-FILE3.
#00160 000640 PARAGRAPH4.
#00160 000650     MOVE "TEST FOUR OPENS THE THREE FILES IN INPUT MODE AND READ
000660-        "S THE 10 REWRITTEN RECORDS" TO P-FILE1-REC.
#00164 000670     PERFORM PARAGRAPH2.
#00168 000680 END-PARA.
#00168 000690     CLOSE P-FILE1.
#0016E 000700     STOP RUN.
000000
#00170 000000 PARAGRAPH10.
#00170 000000     MOVE REC-NUM TO RELKEY-1, RELKEY-2, RELKEY-3.
#00178 000000     WRITE IO-FILE1-REC FROM WRITE-LINE.
#0018A 000000     WRITE IO-FILE2-REC FROM WRITE-LINE.
#0019C 000000     WRITE IO-FILE3-REC FROM WRITE-LINE.
#00180 000000 PARAGRAPH11.
#00180 000000     MOVE DUMMY-1 TO RELKEY-1, RELKEY-2, RELKEY-3.
#001B8 000000     READ IO-FILE1 INTO P-FILE1-REC.
#001C8 000000     WRITE P-FILE1-REC AFTER ADVANCING 2 LINES.
#001D6 000000     READ IO-FILE2 INTO P-FILE1-REC.
#001E6 000000     WRITE P-FILE1-REC.
```

COBOL

FEATURES

- High-Intermediate ANSI X3.23-1974
- Interactive Debug Facility
- Full Indexed I/O Support
- Transaction Handling For Concurrent I/O
- Extended ACCEPT And DISPLAY Capabilities
- Intrinsic Functions: SIN, COS, LOG, MIN...
- Level 2 SORT

IMPLEMENTATION LEVEL

The BTI 8000 COBOL language conforms to the American National Standards Institute (ANSI) X3. 23-1974 specification at the high-intermediate level with extensions. The nucleus and eleven functional processing modules defined in the COBOL standard are implemented by BTI at the following ANSI levels:

FUNCTIONAL MODULE	IMPLEMENTATION	NOTES
Nucleus	Level 2	Level 1 INSPECT; no ENTER
Table Handling	Level 2	
Sequential I-O	Level 2	No RERUN or OPEN REVERSED
Relative I-O	Level 2	No RERUN
Indexed I-O	Level 2	No RERUN
Sort-Merge	Level 2	
Report Writer	Null	
Segmentation	Level 1	
Library	Level 1	
Debug	Null*	Debugging lines supported
Inter-Program Communication	Level 2	
Communication	Null**	

* Static and Interactive debugging facilities are BTI extensions.

** Communications functions integral to the operating system are accessible through COBOL verbs.

MODULE CHARACTERISTICS, EXCEPTIONS AND EXTENSIONS

Nucleus (level 2):
Full facilities for the internal processing of data (qualification, punctuation characters, data-name formation, connectives, and figurative constants) are provided.

Nucleus exceptions: DATE-COMPILED is scanned in the Identification Division, but the paragraph is not replaced. The compilation listing page header contains the actual date compiled. The format 1 ACCEPT statement does not allow the FROM *mnemonic-name* phrase, and the DISPLAY statement does not allow the UPON *mnemonic-name* phrase, as only level 1 semantics are supported. Only level 1 of the INSPECT statement is supported. The ENTER statement is not supported.

Nucleus extensions (BTI): Lower case letters, added to the standard character set, are treated as if upper case except in nonnumeric literals. Identification Division paragraphs can be in any order. In the Environment Division the Configuration Section is optional, as are the SOURCE-COMPUTER and OBJECT-COMPUTER paragraphs. When multiple redefinition is used the REDEFINES clause allows redefinition of last name on the same level. Data description includes a USAGE type of COMPUTATIONAL-1 or COMP-1 to describe single or double word two's-complement signed binary data, and COMPUTATIONAL-3 or COMP-3 to describe packed decimal internal representation of numeric data. Operands of certain Procedure Division statements may reference a fixed list of functions with an optional argument list. The optional END PROGRAM statement denotes the end of the Procedure Division. The ACCEPT statement allows multiple operands and includes syntax for specifying CRT screen control information, as does the DISPLAY statement. The apostrophe is an alternative delimiter for nonnumeric literals.

Table Handling (level 2):
Defining variable-length tables of data items in as many as three dimensions, specifying ascending or descending keys, and searching a dimension for an item meeting a given condition are provided.

Table Handling extensions (BTI): Subscripts and index-names may be intermixed.

Sequential I-O (level 2):
The FILE-CONTROL and I-O-CONTROL of the Environment Division, the FD entries of the Data Division, and the OPEN, CLOSE, READ, WRITE, REWRITE, and USE statements of the Procedure Division are supported except as noted. The SAME RECORD AREA clause in the I-O-control paragraph is supported. OPTIONAL files and the RESERVE clause in a FILE-CONTROL entry are acceptable. The EXTEND option of an OPEN verb is supported.

Sequential I-O exceptions: Neither the MULTIPLE FILE TAPE clause, nor any form of the RERUN clause, is supported in the I-O-CONTROL paragraph. In the FILE-CONTROL entry the RESERVE clause is checked for syntactic correctness and otherwise treated as commentary. The REVERSED clause of the OPEN verb is not supported. In the CLOSE verb the REEL or UNIT WITH NO REWIND clause and the FOR REMOVAL clause are treated as comments. CLOSE WITH NO REWIND prevents page advance on printer files, and has no effect on other files. In an FD entry the LABEL RECORD and VALUE OF clauses are treated as commentary.

Sequential I-O extensions (BTI): The file control SELECT clause allows specification of the *external-file-name* as a literal or data item. An OPEN mode and two Procedure Division statements support orderly file-sharing between concurrent users.

Relative I-O (level 2):
The FILE-CONTROL and I-O-CONTROL of the Environment Division, the FD entries of the Data Division, and the OPEN, CLOSE, DELETE, READ, WRITE, REWRITE, START and USE statements in the Procedure Division are supported except as noted. DYNAMIC accessing, SAME RECORD AREA, READ NEXT and START are also supported. The RESERVE clause is acceptable and syntax-checked although it has no effect on the object program.

Relative I-O exceptions: Same as noted under "Sequential I-O exceptions".

Relative I-O extensions (BTI): The file control SELECT clause allows specification of the *external-file-name* as a literal or data item. An OPEN mode and two Procedure Division statements support orderly file-sharing between concurrent users.

Indexed I-O (level 2):
The FILE-CONTROL and I-O-CONTROL of the Environment Division, the FD entries of the Data Division, and the OPEN, CLOSE, DELETE, READ, WRITE, REWRITE, START and USE statements in the Procedure Division are supported except as noted. In addition, DYNAMIC accessing, ALTERNATE KEYS, SAME RECORD AREA, READ NEXT, and START are supported. The RESERVE clause is acceptable and syntax-checked although it has no effect on the object program.

Indexed I-O exceptions: Same as noted under "Sequential I-O exceptions".

Indexed I-O extensions (BTI): The file control SELECT clause allows specification of the *external-file-name* as a literal or data item. An OPEN mode and two Procedure Division statements support orderly file sharing between concurrent users.

Sort-Merge (level 2):
One or more files can be sorted, two or more files merged, once or a number of times during the execution of a program.

Sort-Merge exceptions: The SORT and SORT-MERGE forms of the SAME AREA are not accepted.

Report Writer (null):
There is no report-writing capability in the initial version of the COBOL compiler.

Segmentation (level 1):
The segmentation of procedures allows the user to communicate with the compiler to specify overlay requirements in the object program.

Segmentation exceptions: All independent segments must physically follow the fixed permanent segments in the source program.

Library (level 1):
Text previously stored in a library can be copied into a source program.

Library exceptions: A COPY sentence must be the last entry in area B of a source record.

Library extensions (BTI): A *text-name* that is not a COBOL word may be specified as a non-numeric literal.

Debug (null):
Two level 1 debug facilities, the conditional compilation of debugging lines ("D" in indicator area) and the WITH DEBUGGING MODE clause of the SOURCE-COMPUTER paragraph, are supported.

Debug extensions (BTI): Two separate techniques are available for debugging COBOL programs: the Static Debug Facility using the standard level 1 language features described above, and the Interactive Debug Facility, a powerful runtime debugging monitor unique to BTI 8000 COBOL.

For static debugging the user invokes the compiler in debugging mode by the WITH DEBUGGING MODE clause in the SOURCE-COMPUTER paragraph of the Environment Division, or by the /DEBUG option in the invoking Control Mode (BTI control language) command. For the duration of the compilation Procedure Division statements with a "D" in column 7 are executed rather than treated as comments. Thus, the user can write DISPLAY statements, data file print sequences, a STOP statement under control of an IF statement, or other statements to aid in program analysis and error detection. When properly placed in the Procedure Division such statements can remain in the source program throughout its life, and can be invoked in either interactive or batch mode since no operator intervention is required.

The Interactive Debug Facility (IDF) does not require debugging lines inserted in the source program. It interacts with the user and the runtime interpreter by alternately soliciting a command and acting upon it, until a STOP RUN source statement is encountered or the user enters an EXIT or QUIT command. IDF prompts the user for each command with a message telling the current position in the object program. The user can define breakpoints and tracepoints for statements and data items from which the IDF creates a "Points of Interest List". Thus, the user can follow the execution of an object program on a statement basis, and he can examine current values of Data Division variables. IDF execution doesn't require the detailed advance planning of static debugging, separate compilations to activate or deactivate the facility, or any extra memory.

Inter-Program Communication (level 2):
Facilities are provided for programs to transfer control from one to another at object code execution time and to share data. Level 2 includes transfers among programs whose names may not be known at compile time.

Inter-Program Communication Extensions (BTI): The CALL statement allows literals in the USING phrase. It also allows identifiers in the USING phrase to be described with level numbers 01 through 49 and level 77 as long as they do not require subscripting or indexing.

Communication (null):
Device and file independence are key features of the BTI 8000 operating system, Variable Resource Manager. A terminal device is accessible to the programmer through conventional high-level language verbs, and data is read and written to terminals as if it were on a disk file. Thus, any program can execute in interactive or batch mode without modification or recompilation. Batch programs can be interactively debugged, and interactive programs can be executed, when the user desires, as batch jobs. Because the programmer manipulates a terminal directly in an application program, the cost of programmer training and of developing interactive applications is substantially cut. Network definition and support are automatic functions of the Variable Resource Manager. Communications support on the BTI 8000 is far superior to that of standard COBOL.

continued...

ADDITIONAL FEATURES:

Command Language: Control Mode, the BTI 8000 command language processor, is the user's interface for controlling program execution and his virtual machine environment. The same simple English-like commands control all user functions, including the invocation and execution of the COBOL compiler, object programs it produces, file utilities and other utilities.

File System: A single, common data management facility is provided for users of COBOL, PASCAL, FORTRAN and BASIC/8000. Sequential, relative and indexed file structures are supported. Data files created in any language are fully accessible to all other languages. Data manipulation capabilities are functionally equivalent to full level 2 in the I-O module of the 1974 COBOL standard.

Runtime Frequency Analysis: The runtime interpreter includes an option that causes collection in an indexed file of program frequency-of-execution statistics. At execution end the file contains a record of the number of times each statement in a program, and any programs called by it, was executed. A utility lists the file, so the user can analyze and initiate changes to tune the program(s).

COBOL LANGUAGE SYNTAX

The BTI 8000 COBOL language syntax charts are available as a separate document.

BTI COMPUTER SYSTEMS
870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed U.S.A.
1205-R0781

BTI 8000

32-Bit Multiprocessor System

PASCAL/8000

BTI

PASCAL/8000

BTI's PASCAL/8000 is based on the powerful and popular programming language PASCAL, specified by Niklaus Wirth at the ETH, Zurich, in 1971. The specifications were the subject of a user manual and report by Kathleen Jensen and Dr. Wirth, published in 1974. BTI PASCAL/8000 has the features that have made PASCAL popular, as well as significant extensions to improve PASCAL's effectiveness:

- Based on standard PASCAL
- Multi-key ISAM
- Access to over 100 extended operating system functions
- Relaxed order of declarations
- Interactive, source-level DEBUG capability
- New data types: BINARY and STRING
- Statement labels of any size
- Unique LOOP statement
- OTHERWISE clause and numeric ranges as labels supported in enhanced CASE statement
- Dynamic-length strings with supporting functions

The foremost advantage offered by BTI's PASCAL/8000 is access to a powerful file system. Standard PASCAL provides only sequential I/O, while PASCAL/8000 provides standard procedures which manipulate multi-key ISAM files. Files that are accessible to PASCAL/8000 programs are in standard BTI 8000 format and may be manipulated by programs written in COBOL 74, FORTRAN 77, and BASIC/8000. PASCAL/8000 programs can INSERT, DELETE, READ and UPDATE records in data files which may have several indices. Data files may be processed in any indexed sequence, through the use of a read key sequential procedure.

PASCAL/8000 programs can be made more readable than those written in standard PASCAL. Standard PASCAL allows descriptive identifiers of any length, though they cannot contain punctuation characters. PASCAL/8000 identifiers may contain any number of underline characters to clarify their meaning. For example, the standard PASCAL identifier 'YEARENDTOTAL' may become the PASCAL/8000 identifier 'YEAR_END_TOTAL'.

PASCAL/8000 enhances the CASE statement, one of standard PASCAL's most powerful flow of control statements. Traditionally, the CASE statement evaluates an expression and transfers control to the one statement, among many, whose label has the same value as the expression. When programs define a series of numbers or characters to be the labels associated with a statement, standard PASCAL requires the programmer to laboriously write each value of the series. PASCAL/8000 allows the programmer to simply use a single label, which appears as a range of values, with only the high and low values of the series specified.

In addition, the PASCAL/8000 CASE statement eliminates a class of data-dependent errors which cause standard PASCAL programs to fail. If the expression in a standard PASCAL CASE statement does not evaluate to one of its labels, the program terminates in an unrecoverable error state. The PASCAL/8000 programmer may employ the OTHERWISE clause to direct processing flow when this situation occurs, in lieu of a fatal error.

LOOP is an elegantly simple statement. Any combination of statement lists and WHEN clauses may be mixed in one LOOP statement, giving the programmer unparalleled freedom to direct processing flow.

For advanced users, PASCAL/8000 provides access to over 100 operating system functions, including:

- Interprocess communication
- Spawning of underprograms
- Interrogation of account limits
- Creation, deletion and saving of files
- Manipulation of underlying system file structures
- Synchronization of cooperating process

FUNCTIONS

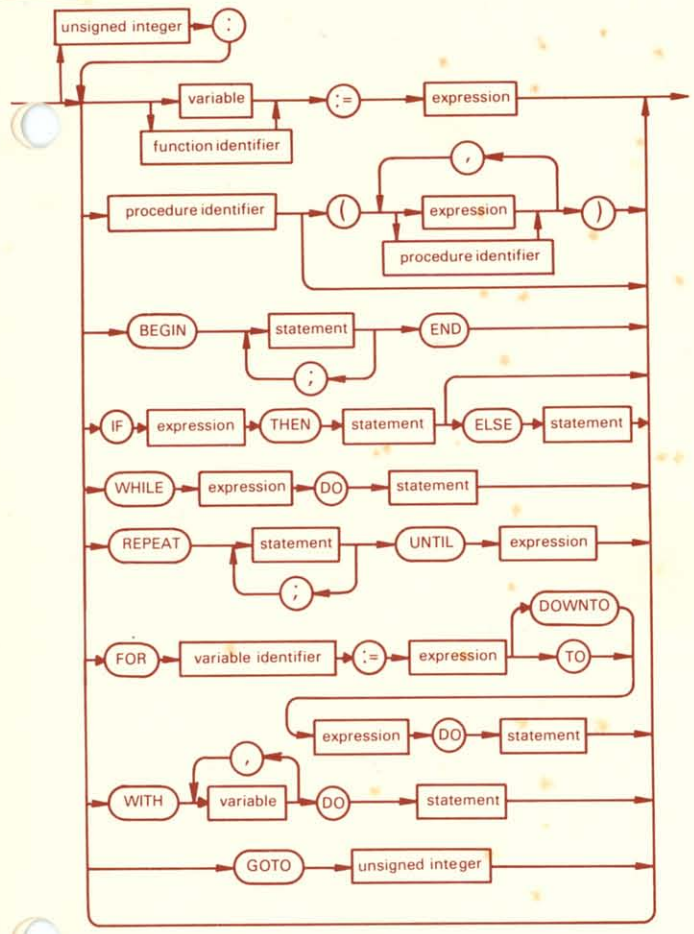
PASCAL/8000 offers all the mathematical, trigononmetric, Boolean, transfer and memory management functions and procedures which are present in standard PASCAL. Additionally, PASCAL/8000 offers these extensions:

RETURN	causes immediate exit from a block. Multiple RETURN statements provide multiple exits from a block.
LENGTH	returns the current length of a dynamic string variable.
ABORT	cancels the remainder of program execution.
TIME	returns the current system time.
DATE	returns the current system date.
RANDOM	returns output from the random number generator.

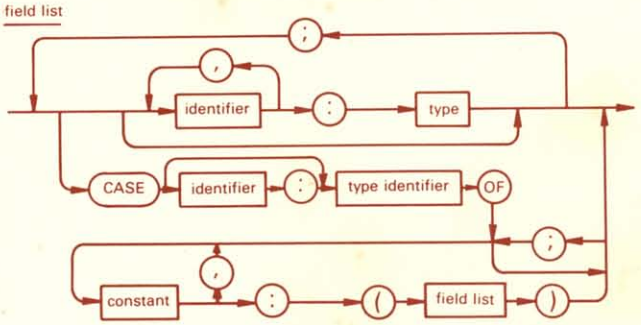
PROGRAM DEVELOPMENT ENVIRONMENT

PASCAL/8000 source programs may be created and maintained through the use of the text editor, EDIT/8000. The BTI 8000 DEBUG utility allows breakpoint operations, run-time tracing, and single step execution at the source program level. Trace and single step operations display source program lines as the associated code is executed. Data elements may be referenced and manipulated by their programmer-defined names. Breakpoints may be established by referencing source language procedure names. DEBUG allows the PASCAL/8000 programmer to perform comprehensive debugging without any knowledge of assembler language.

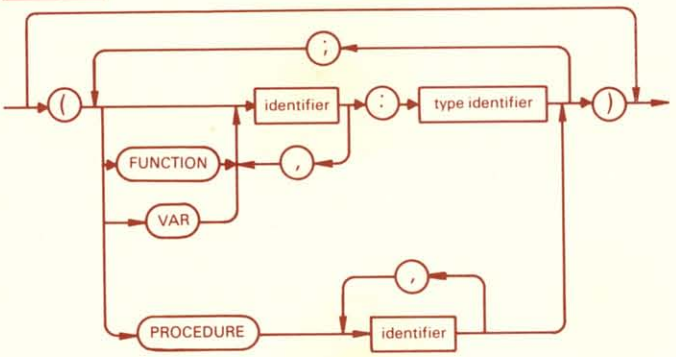
statement



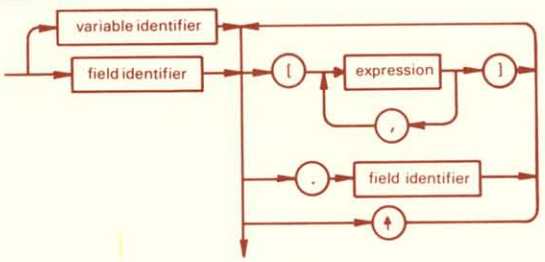
field list



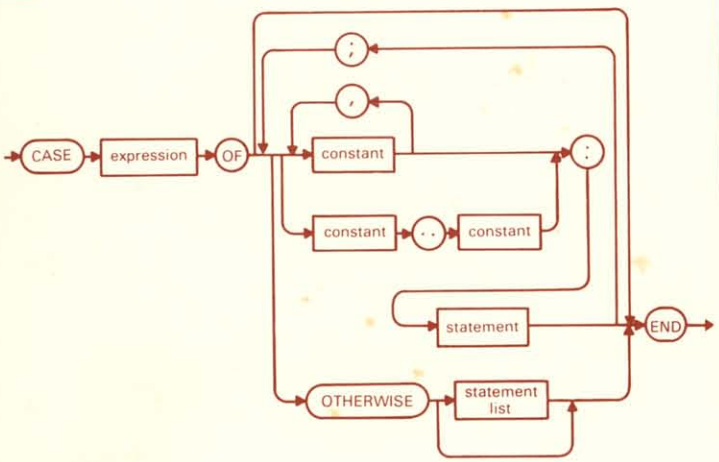
parameter list

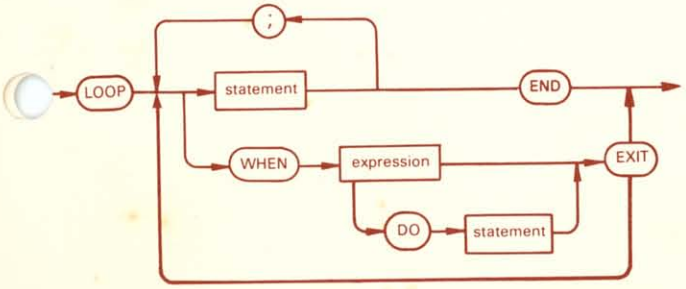


variable

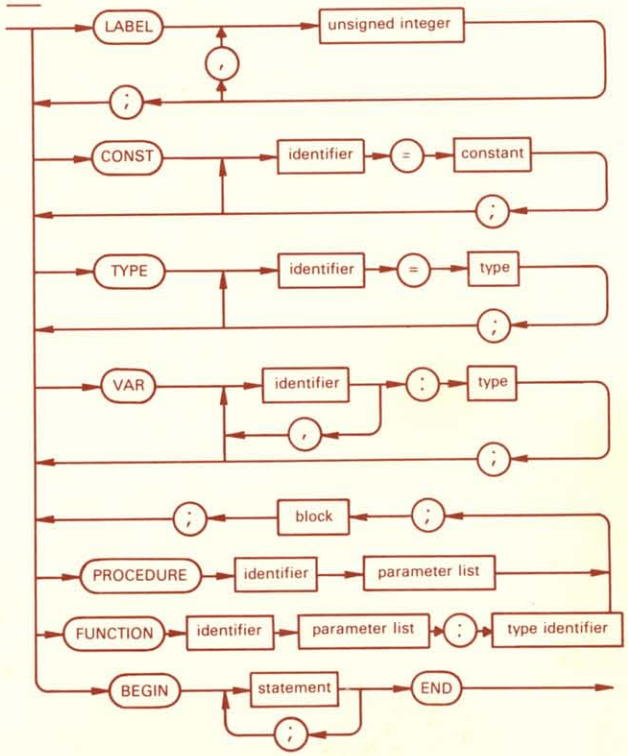


CASE

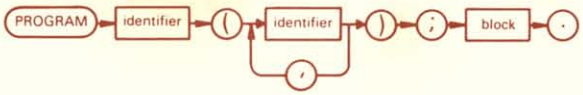




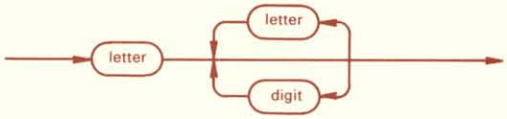
block



program

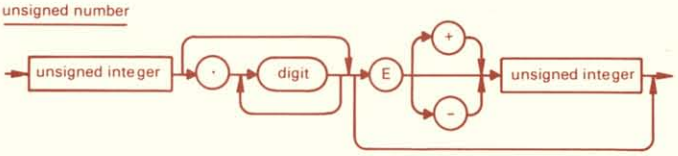


identifier

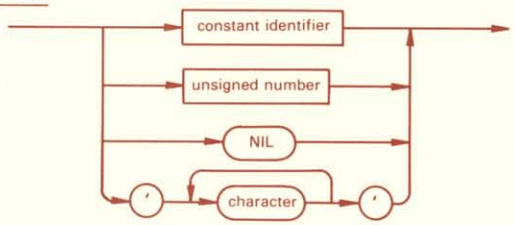


unsigned integer

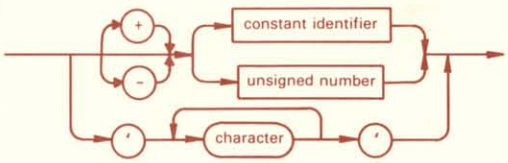
unsigned number



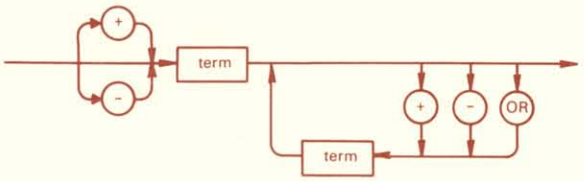
unsigned constant



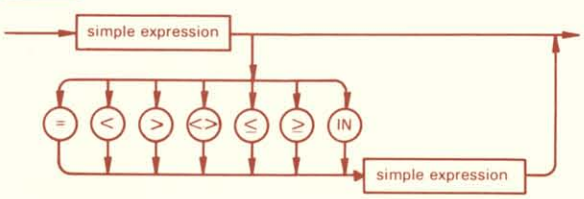
constant



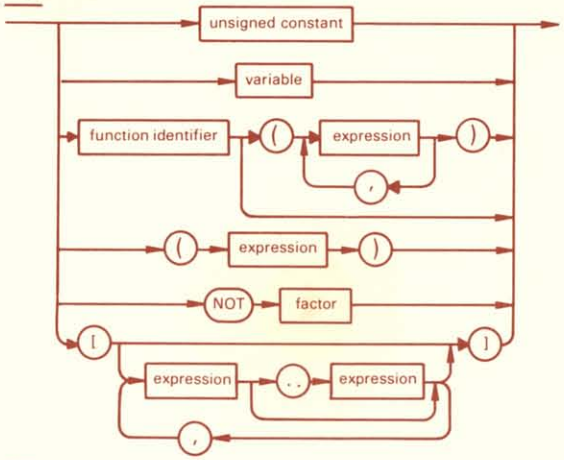
simple expression



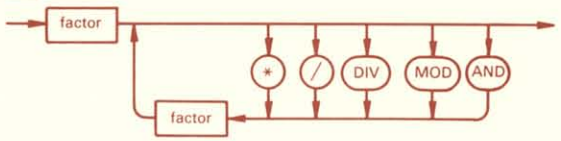
expression



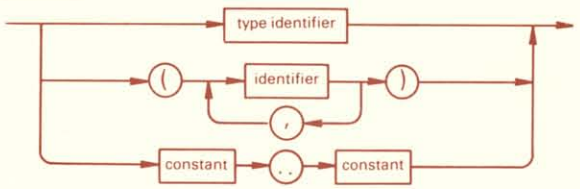
factor



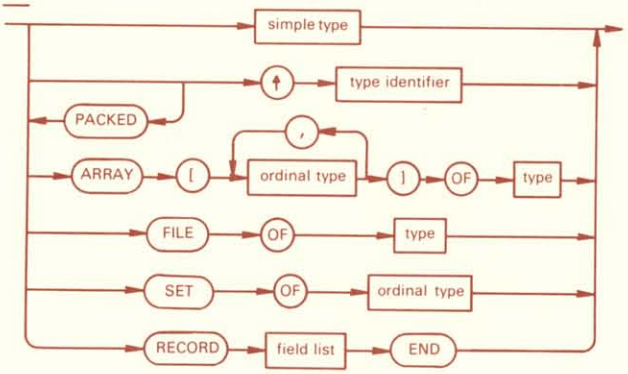
term



simple type



type



These diagrams have been reproduced with the publisher's permission from Appendix D, pages 116-118 of Jensen and Wirth, **PASCAL User Manual and Report (2nd ed)**, Springer-Verlag, 1975.

BTI COMPUTER SYSTEMS
870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1187-F0581

8200
Disk Storage Options
for
BTI 8000
32-Bit Multiprocessor Systems

Model 8225 Drive

Features

- Choice of 67, or 254 Megabytes of Formatted Storage Capacity
- Up to four drives per controller.

The BTI 8200 Series Disk Drives provide formatted capacities of 67 or 254 megabytes for high-speed data storage and retrieval.

The Model 8215 Drive, with a formatted capacity of 67 megabytes uses removable, 5-high disk packs. Two of the five disks in each pack are protective. The remaining three disks provide six recording surfaces, five of which are used for data storage. The sixth is used for servo positioning, rotational position sensing and data timing information.

The Model 8225 Drive, with a formatted capacity of 254 megabytes, uses removable, 12-high disk packs. Each pack contains two protective disks, 19 surfaces for data storage, and 1 surface for servo positioning, etc.

Both 8200 Drives require a Model 8205 Controller, which supports up to 4 drives in any combination of capacities.

To ensure reliability, extensive testing is performed at every manufacturing level from receiving inspection to finished product. Tests include component burn-in, board testing, and system testing. Finally, all drives are exercised under computer control for at least two weeks prior to shipment.

BTI COMPUTER SYSTEMS

Specifications

Model 8215, 67 Megabyte Disk Drive

Seek Time	6 milliseconds (1 cylinder movement) 30 milliseconds average 55 milliseconds (Maximum)
Average Rotational Latency	8.33 milliseconds
Rotational Speed	3600 rpm
Pack Capacity	67 megabytes, formatted
Data Transfer Rate	1.209 megabytes/sec

Disk Pack Characteristics

Number of Disks	5 (2 protective, 3 usable)
Usable Surfaces	6 (5 data, 1 servo)
Diameter	14 inches (35.6 cm)
Coating	Magnetic Oxide

Power Requirements

Voltage	120 VAC, 60 Hz, single phase 220/240 VAC, 50 Hz, single phase
Current	120 VAC: 8.9 amps operating 30 amps starting (15 sec) 220/240 VAC: 5.2 amps operating 14 amps starting (15 sec)
Power	757 watts average
Heat Dissipation	120 VAC: 2984 BTU/hour 220/240 VAC: 2860 BTU/hour

Physical

Dimensions	36.2″ H × 22″ W × 36″D (92 cm H × 55.9 cm W × 91.4 cm D)
Weight	340 lbs. (154.5 Kg)

Model 8225, 254 Megabyte Disk Drive

Seek Time	6 milliseconds (1 cylinder movement) 30 milliseconds average 55 milliseconds (Maximum)
Average Rotational Latency	8.33 milliseconds
Rotational Speed	3600 rpm
Pack Capacity	254 megabytes, formatted
Data Transfer Rate	3600 rpm: 1.209 megabytes/sec

Disk Pack Characteristics

Number of Disks	12 (2 protective, 10 usable)
Usable Surfaces	20 (19 data, 1 servo)
Diameter	14 inches (35.6 cm)
Coating	Magnetic Oxide

Power Requirements

Voltage	208/230 VAC, 60 Hz, single phase 220/240 VAC, 50 Hz, single phase
Current	208/230 VAC: 8.7 amps operating 39 amps starting (12 sec) 220/240 VAC: 9.2 amps operating 41 amps starting (10 sec)
Power	1200 watts average
Heat Dissipation	208/230 VAC: 4983 BTU/hour 220/240 VAC: 5153 BTU/hour

Physical

Dimensions	36.2″ H × 22″ W × 36″D (92 cm H × 55.9 cm W × 91.4 cm D)
Weight	550 lbs. (250 Kg)

General (all models)

Operating Temperature	60° to 90°F (15.5° to 32°C)
Humidity	20 to 80%, noncondensing

Specifications subject to change without notice.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

1175-R0681
Printed in U.S.A.

8310
Magnetic Tape Cartridge Option
for
BTI 8000
32-Bit Multiprocessor Systems

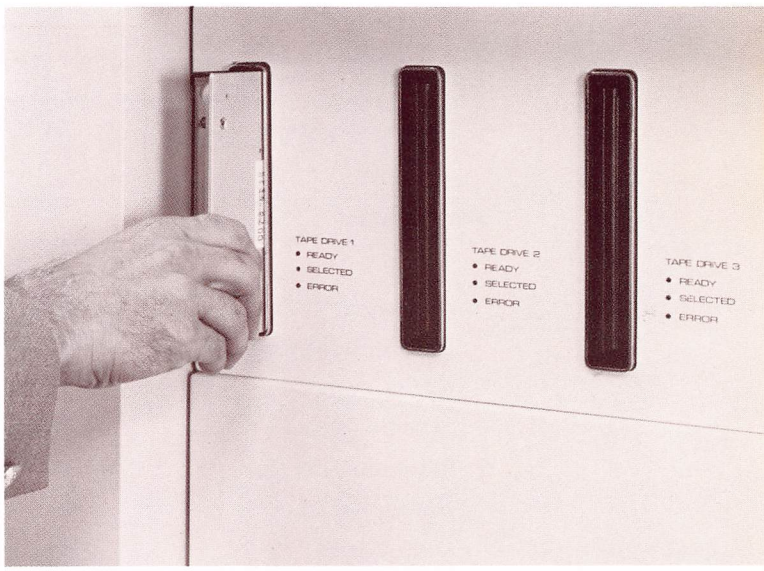
Features

- Compact off-line storage of files and programs
- Economical medium for distribution of application software
- Convenient facility for moving software on and off the system without interrupting operation
- Easy way to upgrade BTI 8000 System Software

The Model 8310 Magnetic Tape Cartridge Drive affords BTI 8000 Multiprocessor System users with a convenient, simple, and efficient means of moving software on and off the system without interrupting its operation. With the Magnetic Tape Cartridge Drive, users have a high degree of software mobility. Not only can the cartridge be used for off-line storage, but it provides a medium for transferring data, files, accounts, and volumes between BTI 8000 systems, including proprietary application software.

Specifically designed for high density recording, the Model 8310 Magnetic Tape Cartridge Drive uses Modified Frequency Modulation (MFM) encoding to achieve its extremely high recording density of 6400 bpi. A single cartridge — only 6″ x 4″ x ½″ — stores approximately 10 Mbytes total.

The Model 8310 Magnetic Tape Cartridge Drive has several features which are responsible for its high data reliability. In combination with the system software, the cartridge tape reads all data after it is written. Any record that contains a dropout or fails any of several format or data consistency checks is automatically erased and rewritten. The specific failure is reported by the drive's controller to the operating system, which informs the user's program of the error. A physical SAFE switch on the cartridge prevents accidental overwriting of data already recorded.



Configurations

The Model 8310 Magnetic Tape Cartridge Drive requires a Model 8305 Magnetic Tape Controller. One 8305 Controller will support up to four drives. The Model 8310 Drive in its basic configuration contains one tape drive, but it may be expanded by installing Model 8315 drive units, to a two, three, or four drive configuration. The additional drives may be installed at the time of initial purchase or subsequently at the customer's site.

BTI COMPUTER SYSTEMS

Specifications

Physical

Dimensions	Rack Mounting, 19″W x 10½″H; (483 mm x 267 mm)
Cartridge	6″ x 4″ x .5″; (152 x 102 x 12.7)
Recording Medium	.25″ (6.4 mm), Mylar Tape
Cartridge Model Number	8317

Environmental

Operating Temperature	60° F to 80° F (15° C to 27° C)
Humidity	20-80%, noncondensing
Cartridge Storage	
Temperature	40° F to 110° F (4.4° C to 43.3° C)
Humidity	10-90%, noncondensing

Note: Cartridges must acclimate to the drive environment before attempting to read or write data.

Electrical

Power Requirements	120V 60 Hz or 240V 50 Hz; Power consumption 150 watts

Performance

Speed	30 ips (rewind 90 ips)
Operating Mode	Modified Frequency Modulation
Recording Density	6400 bpi
Heads	Triple gap read/write/erase
Transfer Rate	24,000 characters/second
Recording Format	Encrypted
Number of tracks	4
Data Blocks	Any length to 131,072 characters
Formatted Capacity	Approximately 10 Mbytes total
Error Checks	Read after Write, CRC

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East 225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest 2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South 1341 West Mockingbird Lane, Dallas, TX 75247 (214) 630-2431
West 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122
United Kingdom 1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS
870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1173-F0580

8330
Magnetic Tape Option
for
BTI 8000
32-Bit Multiprocessor Systems

Features

- Dual density operation at 800/1600 cpi
- IBM/ANSI compatible recording format
- Durable, tension arm construction
- Extensive, off-line testing facilities

The Model 8330 Magnetic Tape Drive is available for use with any BTI 8000 System. Featuring an IBM/ANSI compatible recording format and 45 inches-per-second (ips) operating speed, this 9-track, open-reel drive offers switch-selectable packing densities of 800 (NRZI) and 1600 (Phase Encoded) characters per inch (cpi). Data may be read or written in blocks of up to 16,384 ASCII characters.

BTI's 8330 Tape Drive represents the highest level of quality and reliability. The simplified mechanical layout design provides for minimal wear of critical parts. Tape handling is gentle; the oxide touches only the head and a reversing idler. In addition to lengthening tape life, a durable tension arm construction for tape buffering ensures quiet operation.

The Model 8330 Drive has an elaborate test panel for exercising, testing, and adjusting the drive while it is off-line. Because of this panel, users do not need separate testing facilities for their drives. Moreover, the off-line operation means that valuable computer time is not required to run the tests.

With the test panel, users can initiate forward and reverse tape motions at either normal (45 ips) or high (150 ips) tape speeds. Users can also initiate a write test. The panel provides indicators for load point, end of tape, and data available. An additional indicator monitors excessive skew, and can be used to help realign the read/write head.

Configurations

To operate, the Model 8330 Tape Drive requires a Model 8320 Controller. One controller can support up to four drives. The drive and controller can be mounted directly in a standard BTI 8000 system cabinet. (Depending on individual configurations, cabinet expansion may be required. See your BTI representative for details.)

BTI COMPUTER SYSTEMS

Specifications

Physical

Dimensions	Rack Mounting, 24.5"H × 19"W × 11"D (622 mm × 483 mm × 279 mm)
Weight	90 pounds (40.9 kg)
Reel Size	10.5 inches, 2400 feet (267 mm, 61 m)

Environmental

Operating Temperature	60°F to 80°F (15°C to 27°C)
Humidity	20-80%, noncondensing

Note: The same requirements apply for storage of magnetic tape reels.

Electrical

Power Requirements	120 VAC, 60 Hz, single phase, standard 240 VAC, 50 Hz, single phase, optional
Power Consumption	480 watts maximum 325 watts nominal

Performance

Data Density	800/1600 cpi, switch-selectable
Number of Tracks	9 Read after Write
Format	NRZI/PE IBM Compatible
Tape Velocity	45 ips maximum
Rewind Speed	150 ips nominal
Start/Stop Time	15 ms + 1 ms at 25 ips Inversely proportional to tape speed
Data Blocks	To 16,384 ASCII Characters

Specifications subject to change without notice.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1174-F0181

8400
Line Printer Options
for
BTI 8000
32-Bit Multiprocessor Systems

A noise-reducing, acoustic cabinet is a standard feature on the 900 lpm printer, shown here, and is optional for the 300 and 600 lpm printers.

Features

- 300, 600, or 900 lpm Models Available
- Excellent Quality Impact Printing
- Multiple Printing—Up to Six Copies

To provide customers with high-speed data output and excellent quality printing, BTI offers a selection of three heavy-duty band printers with 300, 600, or 900 lpm print speeds (64 character print set).

Each of the Series 8400 Printers has been developed to provide precise printing and reliable operation. Moving parts are separated by non-metallic surfaces to eliminate metal-to-metal contact and reduce wear. In addition, the printers are packaged to promote air flow for adequate cooling.

All models feature 64 or 96 character print sets, and printing is done in 10 character-per-inch (cpi) format. For multiple form printing, hammer mechanisms produce clear, sharp impressions on up to six copies. Vertical alignment can be regulated via the controller or with an optional paper tape unit.

To ensure simple operation, necessary controls and adjustments are kept to a minimum. The start-stop button enables printing to begin when data is received and can be used to instantly interrupt printing if the operator desires. All printers have a two-digit status display to aid problem identification.

For consistent line spacing, a fast acceleration/deceleration servo-controlled motor advances the paper smoothly. Movement past the print station is monitored by a photoelectric paper motion detector. If motion problems do occur, printing will stop automatically to prevent loss of data.

BTI offers an optional noise-reducing acoustic cabinet for the 300 and 600 lpm printers. This cabinet comes as a standard feature on the 900 lpm printer.

Each of the Series 8400 Printers requires a Model 8415 Controller.

BTI COMPUTER SYSTEMS

Specifications

Performance

Print Speed	Model 8420, 300 lpm, 64 character set Model 8422, 220 lpm, 96 character set Model 8425, 600 lpm, 64 character set Model 8427, 440 lpm, 96 character set Model 8430, 900 lpm, 64 character set Model 8432, 660 lpm, 96 character set
Print Mechanism	Band
Paper Advance	16.5 ms single space 20 inches/second slew rate
Characters per Line	132 column maximum at 10 cpi
Line Density	6 or 8 lines/inch, switch selectable
Character Set	64 ASCII standard, 96 optional
Horizontal Spacing	10 cpi
Print Mode	Rear Impact
Sound	71 dBA (pedestal) 67 dBA (noise-reducing cabinet)

Physical

Dimensions	44.5″ H × 34″ W × 24″D (113 cm H × 86.4 cm W × 61 cm D)
Weight	300 lbs. (136 Kg)

Power Requirements

Voltage	104–127 VAC, 60 Hz, single phase 216–257 VAC, 50 Hz, single phase 8–10 amps operating
Power	1000 to 1300 watts

Environmental

Operating Temperature	60°F to 80°F (15°C to 27°C)
Humidity	20 to 80% noncondensing

Specifications subject to change without notice.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1155 Hammond Drive, Suite E5050, Atlanta, GA 30328 (404) 396-1630
West	977 Benicia Avenue, Sunnyvale, CA 94086 (408) 749-0500
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in USA
1172-R0681

1000 Video Display Options
for
BTI 8000
32-Bit Multiprocessor Systems

Features

All four BTI Video Terminals:

- Enable immediate, on-line access to the computer
- Are fully self-contained and compact
- Feature easy-to-read screens with excellent character resolution

BTI offers a choice of four CRT-type terminals for use with BTI 8000 Multiprocessor Systems.

All four models incorporate a 12-inch diagonal, non-glare screen with P4 phosphor white-on-black display. The screen format is 80 characters per line and 24 lines per display, yielding a screen capacity of 1920 characters. The terminals accept all 128 ASCII codes, and include cursor addressing and sensing. They may be used at seven baud rate settings: 110, 300, 1200, 1800, 2400, 4800, 9600, and 19,200 baud.

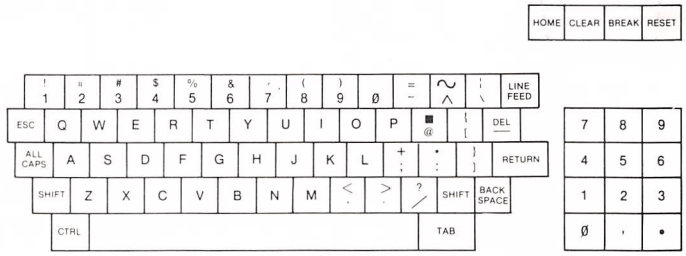
The four models differ in displayed character resolution, displayable characters, keyboard layout and display facilities. These differences are summarized in the display comparison table. Models 1500 and 1510 additionally include an auxiliary output for a serial printer.

Display Comparisons	1410	1420	1500	1510
Character resolution	5x7	5x8	7x10	7x10
Displayable characters	64	94	94	95
Lower case	no	yes	yes	yes
Keyboard layout	TTY	Typewriter	ANSI	ANSI
Numeric pad	12-key	15-key	12-key	12-key
Dual intensity	no	yes	yes	yes
Reverse video	no	no	yes	yes
Serial printer output	no	no	yes	yes
Screen protect	no	no	no	yes
Block transmission (254 characters per block)	no	no	no	yes

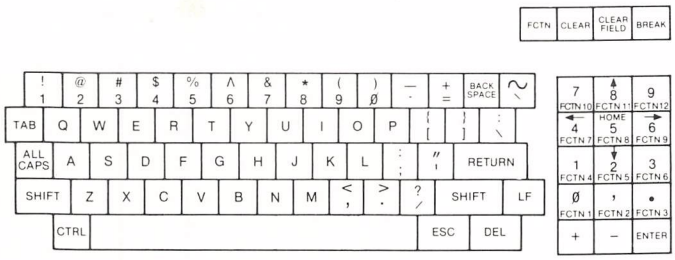
BTI COMPUTER SYSTEMS

Keyboard Layouts

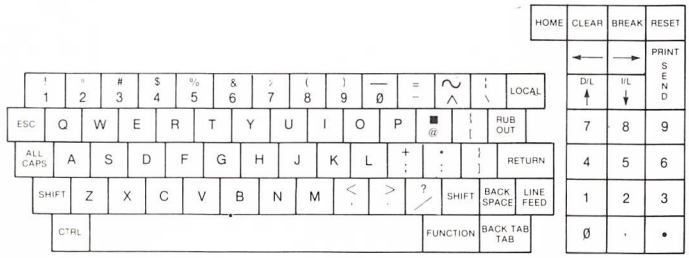
BTI 1410: TTY-STYLE KEYBOARD



BTI 1500: ANSI STANDARD KEYBOARD



BTI 1420: TYPEWRITER-STYLE KEYBOARD



BTI 1510: ANSI STANDARD KEYBOARD

Specifications

Dimensions (all models)	Height 13.5 in (34.3 cm); width 15.5 in (40 cm); depth 20.5 in (52.1 cm)
Weight	1410, 1420: 26 lb (12.7 kg) 1500, 1510: 35 lb (15.9 kg)
Environmental	Temperature: 50° to 104°F (10° to 40°C) Humidity: up to 95% relative, non-condensing
Power	Supply: 115v, 60 Hz Consumption: 1410, 1420 - 60 watts nomianl 1500, 1510 - 115 watts nominal

Service

All display terminals come with a full 90-day warranty. Hardware support is provided by TRW Communications Systems and Services.

Terminals still under warranty will be repaired by TRW free of charge. For terminals no longer under warranty, TRW offers a choice of either a maintenance agreement or on-call service. Customers choosing on-call service will be billed for both time and materials.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East 225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600

Midwest 2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190

South 1341 West Mockingbird Lane, Dallas, TX 75247 (214) 630-2431

West 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

United Kingdom 1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1176-F0580

1800
Hardcopy Terminal Option
for
BTI 8000
32-Bit Multiprocessor Systems

Features

- 132 column, 150 character per second impact printing
- Superior quality matrix printing at a low cost

BTI provides a microprocessor based, multi-copy impact terminal for use with BTI 8000 Multiprocessor Systems.

Fully self-contained, the hardcopy terminal offers both rear and bottom paper feed and can be operated on a desk or stand. The terminal features a 9 x 7 matrix/character font for superior print quality and prints up to 150 characters per second.

Format and other operating parameters are stored in non-volatile memory, and can be configured directly from the keyboard. This ensures user flexibility in a number of different applications.

A three digit L.E.D. display on the Terminal Status Control panel indicates the printer's next position, the terminal status and configuration parameters, or the appropriate error code when an error condition exists.

The keyboard, which resembles that of a standard typewriter, features a full ASCII 128-character set with 18 key numeric pad. All alphanumeric functional keys have automatic repeat.

Printing can be done in either standard or compressed format. Using the compressed format (16.5 characters per inch), 132 column printing will fit on 8 and one-half inch paper. On 14 and seven-eights inch paper, the compressed format will produce up to 218 columns of print.

Other standard features include:

1280 character I/O buffer
Adjustable width carriage for 3 to 15 inch paper
6 or 8 lines per inch
Selectable Auto Perforation Skip
Operator-programmable form length in non-volatile memory
Paper-out and paper-jam indicator
Produces one original and up to five copies
110 to 9600 baud transmission speed
EIA RS-232-C serial loop interface

BTI COMPUTER SYSTEMS

Specifications

Power Requirements

Voltage:	120 VAC, 60 Hz, Single Phase, standard 240 VAC, 50 Hz, Single Phase, optional
Power:	50 watts max. idle 75 watts average printing 150 watts max. executing form feed

Physical Dimensions

Size:	Width–26.0 in. (660.4 mm) Depth–21.0 in. (533.4 mm) Height–8.25 in. (209.5 mm)
Weight:	40 pounds (18.18 Kg) excluding options

Acoustic Noise

Level:	Less than 60 dB (A weighted) measured 3.0 feet (0.9 meters) directly in front under free field conditions while printing at 150 characters per second

Environmental (Operating)

Temperature:	41 °F (5 °C) to 104 °F (40 °C)
Relative Humidity:	5% to 90% (no condensation)
Altitude:	To 10,000 feet (3046 m)

Printer

Method:	Wire matrix impact
Speed:	150 cps
Pattern:	9 x 7 dot matrix
Character Set:	95 ASCII plus 33 control character graphics plus parity error symbol
Characters per line:	132 max.
Character Spacing:	10 per 1 in. (25.4 mm)
Compressed Format:	16.5 characters per inch, 132-column printing on 8½-inch paper, up to 218 columns
Line Spacing:	6 or 8 per 1 in. (25.4 mm)

Printer (Continued)

Paper Drive:	2 Pinfeed tractors (4 pin)
Paper Feed:	Rear and bottom
Paper Width:	3.0 in. (76.2 mm) to 14.875 in. (377.8 mm)
Paper Type:	Continuous feed, fanfold, or multi part (original + 5 copies)
Ribbon:	60 yards (54.8 m) or 40 yards (36.58 m), auto reversing
Linefeed Time:	30 milliseconds
Paper Slew Rate:	7.5 in. (190.5 mm) per second
Adjustments:	Forms width, thickness, and alignment
Form Length:	11 in. (279.4 mm)
Detection:	Paper out, carriage jam

Keyboard

Type:	Full ASCII with 18 key numeric pad
Layout:	Typewriter
Rollover:	N-Key
Indicators:	Terminal and Communications status

Communications

Interface:	EIA RS-232-C
Type Transmission:	Asynchronous
Code:	USASCII
Speeds:	110, 300, 1200, 2400, 4800, 9600 Baud
Parity:	Transmit odd, even, mark, space Check Odd, even none
Receive Buffer:	1280 characters
Line Control:	Auto answer, auto disconnect, printer ready/busy
Identification:	21-character answer back memory

Option Features

Machine-Mounted Paper Catch Tray, or
Terminal Stand, or
Stand-Mounted Paper Catch Tray, or
Terminal Stand with Stand-Mounted Paper Catch Tray

Service

All hardcopy terminals come with a full 90-day warranty. Hardware support is provided with Texas Instruments Incorporated (TI). Terminals still under warranty will be repaired by Texas Instruments free of charge at the customer site. For terminals no longer under the initial 90-day warranty, TI offers an extended coverage plan.

Corporate Office: 870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122

Regional Offices:

East	225 Old New Brunswick Road, Piscataway, NJ 08854 (201) 457-0600
Midwest	2401 Plum Grove Road, Palatine, IL 60067 (312) 397-9190
South	1341 West Mockingbird Lane, Dallas, TX 75247 (214) 630-2431
West	870 West Maude Avenue, Sunnyvale, CA 94086 (408) 733-1122
United Kingdom	1433 Bristol Road South, Birmingham, England B32 2SU 021-477-3846

Sales Offices throughout the United States

BTI COMPUTER SYSTEMS

870 West Maude Avenue • Sunnyvale, California 94086 • (408) 733-1122

Printed in U.S.A.
1177-F0580