■ *CORPORATE PROFILE*

Tandem's Struggle to Break Out of Its Niche

BY JOHN ECKHOUSE

Tandem Computers Inc. appears to be having trouble coping with the transition from corporate child prodigy to mature adult.

Besides slowing growth, the Cupertino company cannot seem to shake its image — despite revenues of more than half a billion dollars a year — as only a niche marketer of reliable minicomputers that virtually never stop running.

After watching revenues double almost every year during its first seven years, growth slowed to "only" 50 percent in 1982, then 34 percent in 1983, 27 percent last year and 18.6 percent in the first nine months of this fiscal year.

"Our first pause in growth was a trauma for our employees," said Gerald Peterson, vice president of international marketing and product development at the Cupertino minicomputer company. "There had to be some mental re-setting and I must admit that some employees left to go to new start-up firms out of frustration."

More discouraging to old-timers, who once thought the company was immune to bad news, is that net income is up only 9.3 percent so far this year and fell 74 percent in the latest quarter.

Judged against other computer companies, however, Tandem is still growing at a good clip. While it may have a little trouble in the near term, most observers see Tandem as a computer industry powerhouse over the long run.

"I don't think they will ever see 100 percent growth again, but I don't see why they can't sustain 25 percent to 30 percent annual growth," said David Wu, analyst at Montgomery Securities in San Francisco. "They are hiring new people at the vice presidential levels who will help the transition to their new, mature level of growth."

Pigeonholed

Carol Muratore of Prudential Bache Securities says it may take 12 months to 18 months before Tandem returns to predictable earnings growth, but she is quite optimistic that the company is positioning itself "for a long and prosperous life" if only it can burst out of its niche.

Tandem pioneered sales of fault-tolerant computers that virtually never fail and used that advantage to win sales from far larger computer companies such as IBM. Banks, brokerages and airlines who lose customers and sizable amounts of money when their computers are "down" swamped Tandem with orders for its systems.

Not everyone can afford to rewrite software to run on Tandem computers and not every customer needs a totally fault-tolerant system, however, so Tandem is trying to get away from being pigeonholed.

Tandem's "non-stop" computers also offer modularity: A business can start with two central processors and when its needs expand simply wheel in another Tandem processor — up to 4080 in a network. Customers do not have to buy a different computer and software when they need to expand or buy excess computer capacity that will sit idle until the company grows into it.

"But too often people think of us as only a niche player in fault-tolerant computers," said Lawrence McGraw, vice president of marketing and service support. "That's our biggest marketing problem."

A recent market survey confirmed his worry. Potential customers thought the company's only advantage was reliability and knew little of its product modularity, which allows a small Tandem minicomputer system to grow to a size larger than IBM's biggest mainframe.

"We just can't seem to get that across," said James Treybig, Tandem chief executive and co-founder.

More Products Due

To change its image and broaden its product line, Tandem has been very aggressive with new hardware and software product introductions, including a smaller and less expensive entry-level system, during the past year and plans even more in coming months.

"Don't tell our development guys this, but I think our product line is pretty solid now — I think our biggest challenge is marketing," McGraw said. Yet despite its stature as a Fortune 500 company, Tandem still faces credibility problems when it competes for sales with IBM.

At least this is a real challenge, compared to the phantom competitors Tandem used to face. After Tandem's phenomenal early success selling highly reliable computer systems, venture capitalists poured about $250 million into new startups who planned to compete in the same market.

"Nobody had products, but all were running ads and scouting for sales and that hurt us in the marketplace by confusing customers," Treybig said. The point is moot now, for virtually every potential competitor is either out of business or out of money.

The only major exception is Stratus Computer Inc., which had less than one-tenth the revenues of Tandem last year. IBM Corp. recently agreed to market Stratus fault-tolerant systems, but many analysts say that will not hurt Tandem.

Coexisting With IBM

"Ironically, it helped Tandem by alleviating the fear that IBM was developing its own fault-tolerant system, which might have made customers hold off purchases," said Jeff Canin, analyst at Hambrecht & Quist in San Francisco.

Mid-life maturity also helped Tandem change its attitude toward behemoth IBM from one of confrontation to coexistence. Tandem's sales force acts less hostile toward IBM and the company works hard to make its computers as compatible as possible with IBM's.

"That's different than trying to kick IBM's ass or should I say behind, but we must think about our customer's needs," Treybig said.

He acknowledges the company needs to work harder to land new accounts, but said Tandem is well situated for the future because most new computer applications are in the $20 billion market — on-line transaction processing — the company serves.

About 30 percent of Tandem's sales come from financial, brokerage and banking institutions and another 20 percent from manufacturers. Peterson says these percentages should remain stable, but he sees rapid growth in three other areas: retail point-of-sale use to verify credit, computer-integrated manufacturing to control inventory and production on the factory floor, and telecommunications.

Omri Serlin, head of market researcher Itom International in Los Altos, thinks Tandem may be headed for some difficulty if it expects to win these new customers.

"I'm not tremendously optimistic; I think Tandem has consistently misread the market," he said. "Their products are not attractive enough to attract attention outside of their existing customer base."

Direct Contacts

Most consumers probably come in direct contact with Tandem's computers every day. For example, Tandem computers run Wells Fargo Bank's automated tellers; gasoline pumps that accept debit cards at many Mobil, Chevron and Exxon gas stations; Federal Express' Zap Mail; Chemical Bank's home banking system; Western Union's electronic mail; GTE Sprint's long distance telephone service; credit card authorizations at May Co. department stores, and even typesetting in the newspaper you are reading.

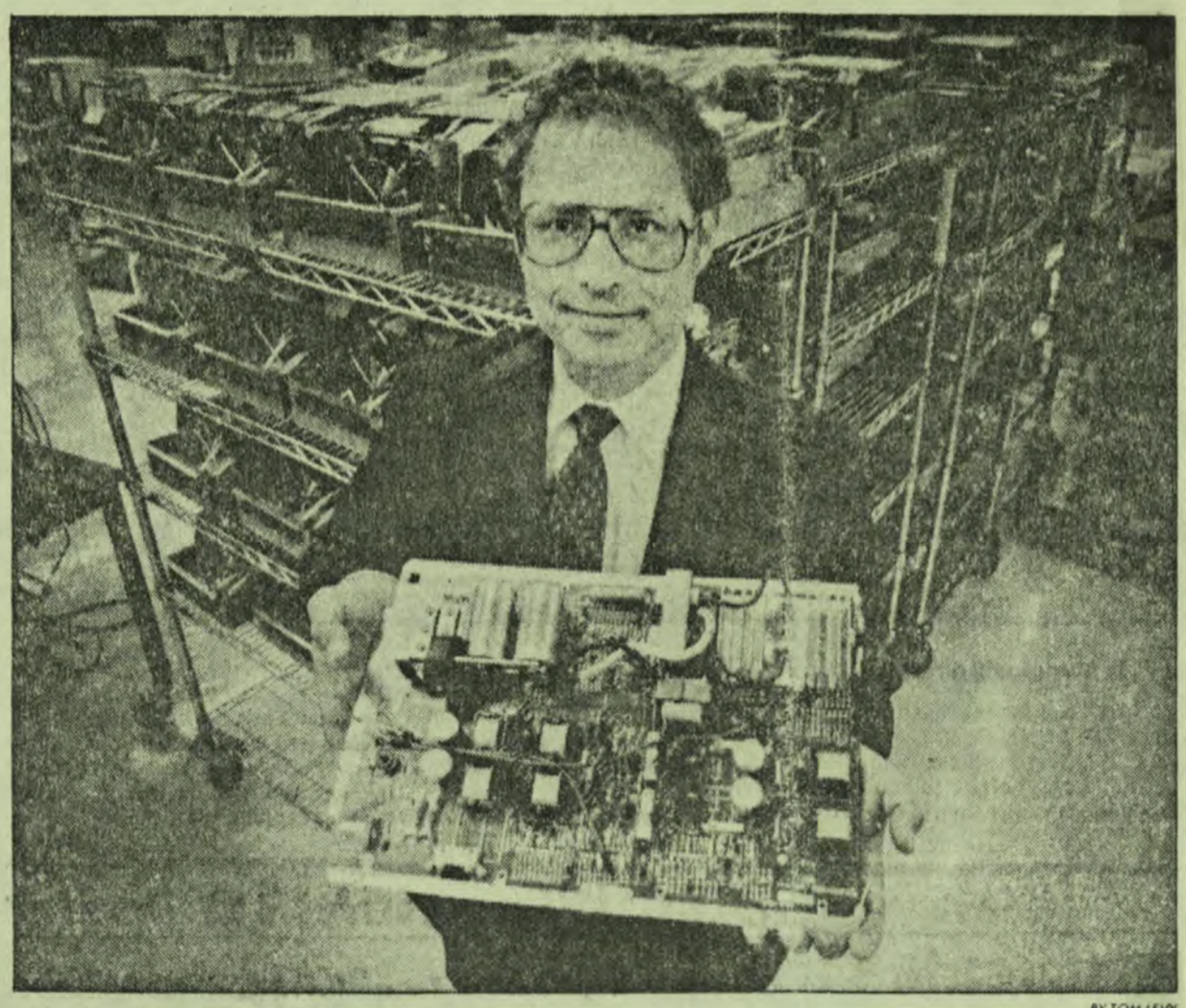
To expand its market, Tandem is counting on its Alliance program of developing partnerships with outside software companies. It is working with Michigan Bell to market that telephone company's application for collecting delinquent bills and with Scandinavian Airlines to sell its airline reservation system software that works on Tandem computers.

About half of Tandem's computer sales to new customers involved software developed by Alliance partners in the first full year of the program. Tandem signed up 21 new software firms last quarter and now has about 85 partners.

A major constraint to profitability is controlling costs. Tandem ran into a problem there last quarter when it bet on higher sales and lifted a hiring freeze.

"In retrospect we should not have hired anyone," Treybig said. To cut expenses and meet Tandem's "first priority" of increased profitability, the firm recently ordered virtually all of its 5515 employees to take a week of mandatory vacation and Treybig sent a message telling them to work harder because of the tough financial times.

"Companies with a high rate of growth have to worry about fundamentals," Treybig said. "With slow growth we have to worry also about details and efficiency."



BY TOM LEVY

Chief Executive James Treybig with a component in Tandem Computer's Cupertino plant

TANDEM COMPUTERS INC. / AT A GLANCE

■ **Business:** Founded in 1974, Tandem sells highly reliable, modular minicomputer systems for use in on-line transaction processing. Its primary customers are financial institutions, manufacturers, telecommunications companies and retailers who cannot afford to have their computer systems fail.

■ **Headquarters:** Cupertino. Subsidiaries in 18 countries.

■ **Financial Review (in millions of dollars):**

Year ended Sept. 30	Revenue	Pct. change	Net income	Pct. change
1985*	$450.3	18.6%	$23.3	9.3%
1984	532.6	27.3	42.9	39.3
1983	418.3	34.0	30.8	3.2
1982	312.1	49.8	29.9	12.5
1981	208.4	91.2	26.5	148.4

** first nine months only*

■ Total assets:	$545 million	■ Stock's 52-week high-low:	28⅝-13½
■ Long Term Debt:	$2.7 million	■ Stock price:	15⅞
■ Employees:	5515		

Golden-Rule, Open-Door Policies

Through explosive growth and sudden downturns, one thing remains constant at Tandem Computers: people-oriented management.

The golden rule, according to James Treybig, co-founder and president of the Cupertino company, is that "all people are good."

"I've never been disappointed once in the results of my belief in people in the 10 years I've been here," Treybig said. That may not preclude someone being fired for poor performance, but it means that Tandem gives each employee an amount of respect and independence unusual even in the innovative management environment found in Silicon Valley.

Communication among employees is a key to the success of Treybig's management style. His appointment book — and his door — have always been open for any employee who wants to schedule time to speak to him and he encourages all other managers to behave similarly.

When Tandem recently completed its latest five-year business plan, the contents and the company's updated management philosophy were personally communicated to all 5500 employees in half-day meetings conducted around the world by members of Tandem's 20-person executive staff. Treybig also hosts a monthly television show on the company's 65-location closed circuit TV network.

Informal communication is just as highly prized, whether it occurs at the weekly Friday afternoon beer busts, in the company swimming pool or through the company's extensive electronic mail system.

Computer Communication

"Electronic mail is the new open door," Treybig said. Nearly all employees have their own computer terminals and are encouraged to use them to communicate with any other employee around the world.

Besides standard business correspondence, Treybig receives half a dozen messages a day from employees. For example, an eight-year veteran of the company's Austin facility, frustrated at lack of response from management there, recently asked Treybig for help in getting a transfer to Cupertino approved. Treybig is considering the request.

A new chief financial officer issued a restrictive travel policy and then quickly changed it after being swamped by several hundred complaints sent via electronic mail from employees around the world.

Besides communication, Tandem has been a leader in providing now-common benefits such as six-week paid sabbaticals to each employee every four years, stock options for all employees, and recreational and health facilities.

A major challenge is whether Treybig's philosophy can continue to survive as the company expands.

"We are struggling to give some structure to what is now becoming a big company without screwing up," said Lawrence McGraw, vice president of marketing and service support. He knows better than to go too far, though.

"When hiring I turn down people too used to structure, bureaucracy and rigidity — I'm too worried they may fail here," he said.

— John Eckhouse

LEVEL 1 - 3 OF 3 STORIES

August 12, 1985, Monday

DISTRIBUTION: Business/Computer Editors

LENGTH: 206 words

HEADLINE: TANDEM-2; New memory board for NonStop TXP system boosts main memory capacity and reduces cost per megabyte

DATELINE: CUPERTINO, Calif.

BODY:

Tandem Computers Inc. (OTC:TNDM) Friday announced a new memory board for NonStop TXP systems that reduces the cost per megabyte by 35 percent and doubles the TXP maximum main memory capacity from 128 megabytes to 256 megabytes in a 16-processor system. The new board utilizes 256KB MOS RAM chips to provide eight megabytes of storage on a single board. It will allow each NonStop TXP processor to directly access 16 megabytes of physical main memory -- double the current capacity. The increased memory capacity provided by the new board will enhance performance in applications with high transaction volumes by reducing the number of times the CPU must access a disc storage device for information. The eight-megabyte board is available immediately and is priced at $39,200. It can be mixed with existing two-megabyte memory boards in NonStop TXP systems.

Tandem Computers Inc. manufactures and markets parallel processing fault-tolerant computer systems and networks for the on-line transaction processing marketplace. The company is headquartered at 19333 Vallco Parkway, Cupertino, Calif. 95014.

CONTACT: Tandem Computers Inc., Cupertino
Gina Burr, 408/725-7455 or Pat Becker, 408/725-6035

LEVEL 1 - 2 OF 3 STORIES

Business Wire

August 12, 1985, Monday

DISTRIBUTION: Business Editors/Computer Writers

LENGTH: 471 words

HEADLINE: TANDEM-COMPUTERS -1; Unveils C, Pascal, Cobol85 programming languages and a new easy-to-use command language

DATELINE: CUPERTINO, Calif.

BODY:

Tandem Computers Inc. (OTC: TNDM) announced two additional programming languages, C and Pascal, for developing applications for NonStop systems. It also announced Cobol85, a proposed ANSI standard programming language, that provides all of the programming productivity extensions defined by the new standard. The company also unveiled Tandem Advanced Command Language, a powerful yet easy-to-use interface to NonStop systems. The new languages will enhance programmer productivity and increase the number of applications that run on Tandem systems. Applications that are written in C or Pascal for use on other computers can now be quickly transported to NonStop systems. ''Languages are the key to application portability across operating environments,'' stated Dennis McEvoy, vice president of software development. ''C is particularly important because it provides our customers with a bridge from UNIX to the NonStop system environment. With C, our customers can take applications developed for UNIX-based systems and easily transport them to the Tandem environment, gaining the benefits of our parallel processing, fault-tolerant system architecture and distributed database features.'' All three new application languages support large applications that can have up to 2 megabytes of instruction code manipulating up to 128 megabytes of data. In addition to the new programming languages, Tandem also offers COBOL74, FORTRAN, BASIC, MUMPS and TAL. All prices are the U.S. list, and consist of an initial license fee and a monthly license fee. C and Pascal for NonStop II and NonStop TXP systems are priced at $1000 per system with a monthly license fee of $225 per system. Pricing for NonStop EXT systems is $500 per system with a monthly license fee of $115 per system. Prices include run time libraries. First shipments of C will be during fourth calendar quarter 1985; first shipments of Pascal will be during first calendar quarter 1986. COBOL85 for NonStop II and TXP systems is $1000 per system with a monthly license fee of $300 per system. Pricing is $500 per system for the NonStop EXT with a monthly fee of $150 per system. The run time library is $500 per system for NonStop II and TXP systems and $250 per NonStop EXT system, with a monthly fee of $100 per system. First shipments will be during first calendar quarter 1986. TACL is available at no charge to current licensees of Tandem's GUARDIAN 90 operating system. First shipments of TACL will be during fourth calendar quarter 1985. Tandem manufactures and markets parallel processing computer systems and networks for the on-line transaction processing marketplace.

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MISWeek Aug 7 1985

Fault-Tolerance Is Tandem's Ace In Siemens Bid

By SELMA FRIEDMAN

UNION, N.J.—Tandem Computers Inc.'s fault-tolerant processors and Wang Laboratories Inc.'s poor system service and lack of suitable manufacturing software were among key considerations that won Tandem a $700,000 contract from Siemens Hearing Instruments Inc. here over the biggest names in computerdom.

The $20-million-a-year Siemens firm signed on the dotted line for a Tandem fault-tolerant mainframe, rejecting its installed Wang system and other proposals from vendors that included Wang, International Business Machines Corp., Digital Equipment Corp.—which slugged it out with winner Tandem—Stratus Computers Inc. and Prime Computer Inc.

The frequent recurrence of electrical power problems at the Siemens location mandated fault-tolerant computers, something none of the bidders except Tandem and Stratus could provide, said Dan Dragomirescu, data processing manager.

"In our area, electrical power goes down an average of once a week, sometimes two or three times a day," Dragomirescu said. "When the system goes down, we need about two hours to recover all the databases and files. In view of our plan to double our production and to grow to about 500 employees in two to four years, we cannot afford to have a two-hour recovery time."

"And if new locations are on-line to such a system, they would all go down at the same time. So, we looked for a system that could handle this," he added.

Instant Access A Factor

Another reason for switching, he added, was the need for instantaneous access to up-to-the-second data, both locally and from facilities around the country.

Dragomirescu said, "It is difficult for us to get up-to-date information from yesterday, let alone sooner than that. Since fast turnaround time is vital for us, and is the main reason a dealer would order from us, an on-line system is crucial."

Among the Siemens' DP manager's other reasons for rejecting the losing proposals were unsatisfactory price/performance ratios, non-upgradable systems—the IBM System/38—unsuitable software and his preference for software-based rather than hardware-based fault tolerance.

He also cited a lack of professionalism by Prime Computer's sales department. All the vendors' proposals included workstations, printers, tape drives and other peripherals.

Total cost of the contract with Tandem for hardware and software for about 15 users, according to Dragomirescu, was around $700,000; he expects that, to handle future expansion, the figure might go up to around $1 million. The company will gradually move from the old system to the new one; he hopes to have the new Tandem system up and running in one and two years from now.

Applications

According to Dragomirescu, Tandem's winning proposal calls for an initial configuration of two NonStop II minicomputers. "In six months to a year, we will add two more TXP 32-bit low-end mainframes," he said. "We are also getting two 4120 disk drives, a tape drive, workstations and printers. In addition, Tandem's proprietary Guardian operating system is designed as a local area network; we do not have to add extra software to link the equipment."

Right now, Siemens is using two Wang VS/80 minicomputers, each running different applications and communicating with each other, said Dragomirescu. "We do daily batch transfers between them, because I have to keep them updated," he said.

One VS/80 runs word processing, accounts payable, general ledger, inventory management and the order entry program; the other runs accounts receivable, monthly reporting for sales allowances, invoicing for different product lines and a separate dealer promotional business development system. The second VS/80 also runs the insurance and warranty programs.

Wang proposed a number of options for new hardware and software, but did not meet with success for a number of reasons, according to Dragomirescu. It first suggested two VS/85 minicomputers, then two VS/100 minis, or one VS/100 and one VS/85.

Wang also suggested that Siemens could take one of the previous configurations and order its VS/300 supermini now, for later delivery. The VS/100 is "a good machine, but not fault-tolerant," he said. "Basically, it is only a more powerful and faster VS/80. Also, there is a wait, and we wouldn't get it for about one year."

Another problem with Wang for him was that "manufacturing applications packages are new for them; they tried to get a third party involved, but the software they offered wasn't powerful enough."

Siemens also wanted a good relational database management system and was not satisfied with Wang's solution. "They proposed their own, Pace, which they would integrate with the MCBA file system application-oriented environment. Since they hadn't done that before, we would be like a beta site for them, and we didn't want that," he said.

Dragomirescu also was not satisfied with his experience with Wang service. "They don't seem to send qualified people who know much about the system; they get training from the user, and we have to wait three days. Then a few months later, if we need service, they send a new trainee," he said.

Siemens' current Wang system has one gigabyte of mass storage, on various hard disks—four from Control Data Corp. and three, purchased earlier, from Wang. As an example of what he claimed were Wang's higher prices for equivalent capacity, Dragomirescu mentioned Siemens' four CDC 9766 300-megabyte hard disk drives, which cost a total of $24,000, and three hard disk drives it had earlier purchased from Wang—one Phoenix 90-Mbyte fixed/removable disk drive and two 75-Mbyte removable drives. The latter three, he said, "together have less storage and cost about $10,000 more than those from CDC."

He also cited one Wang 300-line-per-minute (lpm) band printer and one Dataproducts B-600 600-lpm band printer, with a DLP 4400 controller, which his company has. He purchased the printer and controller together, from Manchester Equipment, an original equipment manufacturer for Wang, and said that they cost less than the Wang printer.

IBM Proposed S/38 Mini

In its bid, IBM proposed a System/38 minicomputer and Mapics software for manufacturing operations which, according to Dragomirescu, "we rejected because it was not fault-tolerant, it was mainly designed as a batch system, it didn't have a relational database management system and the System/38 is not upgradable to anything else."

IBM also suggested a 4381 mainframe and Copics manufacturing software. "We rejected that too," he said, "because, in order to run this, you need the CICS environment. And for that you need an experienced CICS person to set up the system and run it. In fact, you probably need two, and how much will that cost you?" It also was not a fault-tolerant system and Dragomirescu felt that "it was more expensive for what you get, compared to, say, DEC or Tandem."

DEC came close to being selected, with its proposal for two VAX 11/785 clustered minicomputers, with Maxcim manufacturing and accounting software from NCA. DEC also proposed to integrate these packages with its DECstar shop-floor control package.

DEC's cluster could be considered a non-stop system in some respects, Dragomirescu said, "but if you don't have enough processors in a cluster, it will not continue processing. In the case of the VAX, two processors aren't enough to continue processing work non-stop in case one of the processors fails, despite what they say. There should be at least three. You can fool the system by configuring the system with two processors having three nodes—your disk controller can be a third node," he said. He added that the two processors do not duplicate each other and run different programs, so whatever was on the processor that went down would be lost.

Stratus's System Weighed

The only other vendor to propose a fault-tolerant system was Stratus. Although the price was reasonable, its system was hardware-based, he said, so that if a software error were made, "it will continue processing and won't correct it until you catch it. With Tandem, the operating system can be made to take care of this by software."

Another contender for Siemens' business was Prime Computer Inc., which proposed to work with a software developer that, according to Dragomirescu, "had nice manufacturing and accounting packages." However, he said, although he had "heard nice things about Prime's machine, they did not show enough interest in the sale. For example, when they were supposed to give a demonstration, they showed up a month later."

In addition, their offering was not fault-tolerant, but since their prices were "not that high, we could probably have gotten around that by buying a second processor from them and keeping a copy of the database on it," he said. But that would not be an easy solution, he added, and would require keeping a processor costing a few hundred thousand dollars sitting idle.

Since the Tandem mainframe is fault-tolerant, no one component will bring the system down, which is vital for Siemens, Dragomirescu said. "If the power goes down, the internal memory of the system is backed up by a dual battery pack for between two and six hours, depending on the size of the installation." Its fault-tolerance is a function of both hardware and software, "mainly software," he added.

Another important point in favor of Tandem's winning proposal was the inclusion of software and its readiness to integrate third-party manufacturing and accounting packages to run on Tandem's database management system.

To give end-users greater flexibility, the Tandem workstations will have a voice input option as an alternative to the keyboard, in the form of a plug-in board, Dragomirescu said. In addition, he hopes to be able to modify the company's existing Wang terminals to make them compatible with the new Tandem equipment.

Another reason for moving to Tandem, rather than staying with Wang is that "With the current Wang VS/80 system, the number of users we have on the system gives us an unacceptable response time—which can be as bad as four or five minutes. And the VS/300 is a year away."

The company has about 34 Wang terminals locally, some of which are used for word processing. "Since word processing on Wang is pretty good," he added, "we will keep one of the VS/80s to run that."

Siemens has another manufacturing plant in California, with three Wang remote intelligent terminals and two remote dot matrix printers under the control of the terminals. These terminals communicate with New Jersey via a 4800-baud modem and a dedicated line.

Tandem also committed to acting as the primary contractor for the entire project. "We have only one contract with Tandem and we get six man-months support, as we need it, which might be programs, systems analysis to make the whole thing run, conversion of our files, integration of the packages, etc.," he said.

Siemens employees will receive training on how to use the system from company and Tandem staff; the software vendor will also provide some training.

As part of the deal, Siemens will allow Tandem to visit the site with prospective customers—at Siemens' convenience—something that DEC had also requested. In addition to simply allowing visitors, however, DEC wanted Siemens to serve as a beta-test site for new products, something the company refused to do.

Before deciding on Tandem, Dragomirescu also spoke with Tandem users he'd found on his own.

". . . although he (Dragomirescu) had "heard nice things about Prime's machine, they did not show enough interest in the sale. For example, when they were supposed to give a demonstration, they showed up a month later."

"They (Wang service department) don't seem to send qualified people who know much about the system; they get training from the user. . . Then, a few months later, if we need service, they send a new trainee."—Dan Dragomirescu, DP manager, Siemens Hearing Instruments Inc.

3270 terminal emulation board, or IBM 3278/3279 Emulation Adaptor, are supported.

The NIU-74 is priced from $5425 and the NIU-78 is priced from $4900, depending on the configuration. Both units are available 30 days ARO, the company said.

Pathway Design Wins Ruling Over Tandem

WELLESLEY, MASS. — A U.S. District Court has ruled in favor of Pathway Design Inc. in a May 1984 trademark infringement suit filed by Tandem Computers Inc.

Tandem charged that the company name "Pathway Design"—founded in February 1983—was confusing customers with Tandem's "Pathway" applications development tool, introduced in October 1979.

Not Competitive

The U.S. District Court for the Northern District of Calif., in San Jose, found that Tandem failed to sufficiently demonstrate buyer confusion, and although Pathway Design's and Tandem's products may be used in the same user environment, they are not technically related nor competitive.

Pathway Design develops and markets micro-to-mainframe connection software and network gateways. Tandem's Pathway product enables systems programmers to more easily develop screens and manage terminals with a Tandem system.

The court ruled that the word "pathway" is commonly used in the data communications industry, often as a descriptive term signifying a connection through which data passes between computers.

According to a Pathway spokeswoman, the court decided that Tandem's use of the Pathway trademark is not well-recognized, having not advertised its Pathway product since 1980.

But a Tandem spokeswoman said that although the company has not done any media advertising, the product has been advertised through promotional literature. She added the court ruled no company may use the pathway trademark exclusively.

—Karin Rotzinger

Computer Systems News 8/5/85 p12

LEVEL 1 - 1 OF 3 STORIES

August 5, 1985, Monday

DISTRIBUTION: Business Editors

LENGTH: 838 words

HEADLINE: TANDEM-COMPUTERS; Announces two color workstation models, cluster controller and enhanced 3270 emulation

DATELINE: CUPERTINO, Calif.

BODY:

Tandem Computers Inc. (OTC:TNDM) Monday announced four new products that increase the functionality of Tandem terminals and workstations: two color models of the DYNAMITE workstation, the 6600 cluster controller, and enhanced EM3270 software. DYNAMITE multifunction workstations can operate as either system terminals or as stand-alone MS-DOS based personal computers for local processing. The new color DYNAMITE models, with an optional bit-mapped graphics card, allow text and graphic information to be displayed in up to 16 colors. Used as a system terminal, the new models display text in white-on-black, or black-on-white in reverse video. Third-party, MS-DOS compatible software products can be run on the new color models, providing the user with access to a wide variety of existing programs. Both models support a unique dual-mode monitor that can display both text and graphics data simultaneously on the same screen. The optional bit-mapped graphics card supports three screen resolutions: standard 320 by 200 pixels, 640 by 200 for medium resolution and 800 by 300 pixels for high-resolution graphics. According to Gerald L. Peterson, Tandem vice president of product management, ''Color display is becoming more important in the general business environment. The new color models offer all the standard and optional features that are available with the other DYNAMITE workstations, plus the ability to highlight and define text and graphic information in up to 16 different colors.'' The DYNAMITE 6548 workstation comes with dual 360-kilobyte (KB) floppy disk drives; and the DYNAMITE 6549 workstation comes with one 360KB floppy disk drive, and one 10-megabyte Winchester hard disk drive. A graphics option card is required for color graphics operation. Both models come with 14-inch color screens, 256KB of memory (expandable to 640KB), an MS-DOS operating system, a serial printer interface, GW-BASIC, the ability to run Tandem 653X terminal software, and the ability to transfer files between a Tandem host computer and DYNAMITE workstations. 6600 Cluster Controller The 6600 intelligent cluster controller allows clustering of terminals to reduce communication line costs and to share expensive communication resources, such as phone lines and modems. The 6600 controls communications between a Tandem host computer and up to eight terminals, workstations, or IBM PCs, and one printer. The 6600 can support any combination of Tandem 653X terminals or DYNAMITE 654X workstations, IBM PCs, or PC-compatibles. These devices might otherwise be connected to a remote host computer via separate communications lines and modems, which can be expensive and can mean that the host computer is using more processing power to manage communications. A 6600 controller might be used in a field office with four to eight terminals to more efficiently communicate order entry or inventory control information to a host computer at a headquarters office. Or, the controller might be used in a large manufacturing facility to support devices on the manufacturing floor that are far from a host computer.

Enhanced IBM 3270 Emulation Software Tandem also announced enhancements to the company's EM3270 emulator. Enhanced EM3270 software now permits Tandem users, from a single terminal, to access IBM 3270 applications on up to six IBM host computers that communicate using either SNA or binary synchronous (bisync) protocols. Users of Tandem 653X terminals, DYNAMITE 654X workstations, or IBM PCs, can also run IBM 3270 and Tandem applications at the same time; and they can now alternate between IBM SNA and bisync hosts through the use of menus activated by a ''HOST'' key. EM3270 software gives users of Tandem devices or IBM PCs connected to a Tandem host on-line access to 3270 applications on an IBM or IBM-compatible host computer, by enabling Tandem devices (or IBM PCs) to act like an IBM 3270 device. Availability and Pricing Information All products are available now. Prices below are quoted in U.S. dollars for single quantity orders. The DYNAMITE 6548 workstation is $3,790 and the 6549 is $4,790. A field upgrade to color for existing DYNAMITE users is $995. The graphics board required for color products is priced at $575. The 6600 controller is $3,450, for a four-port configuration. An 8-port version is available for $4,250. Enhanced EM3270 has a per processor license fee of $500 for new licensees, and is available at no charge for existing Tandem users who wish to upgrade from the previous version of EM3270 to the enhanced version, providing they have Tandem's GUARDIAN 90 operating system software. Tandem Computers Inc. manufactures and markets computer systems and networks for the on-line transaction processing market. The company is headquartered at 19333 Vallco Parkway, Cupertino, Calif. 95014. The telephone number is 408/725-6000.

CONTACT: Tandem Computers Inc., Cupertino
Corinne DeBra, 408/725-7574

LEVEL 1 - 1 OF 3 STORIES

Business Wire

August 5, 1985, Monday

DISTRIBUTION: Business Editors

LENGTH: 838 words

HEADLINE: TANDEM-COMPUTERS; Announces two color workstation models, cluster controller and enhanced 3270 emulation

DATELINE: CUPERTINO, Calif.

BODY:
Tandem Computers Inc. (OTC:TNDM) Monday announced four new products that increase the functionality of Tandem terminals and workstations: two color models of the DYNAMITE workstation, the 6600 cluster controller, and enhanced EM3270 software. DYNAMITE multifunction workstations can operate as either system terminals or as stand-alone MS-DOS based personal computers for local processing. The new color DYNAMITE models, with an optional bit-mapped graphics card, allow text and graphic information to be displayed in up to 16 colors. Used as a system terminal, the new models display text in white-on-black, or black-on-white in reverse video. Third-party, MS-DOS compatible software products can be run on the new color models, providing the user with access to a wide variety of existing programs. Both models support a unique dual-mode monitor that can display both text and graphics data simultaneously on the same screen. The optional bit-mapped graphics card supports three screen resolutions: standard 320 by 200 pixels, 640 by 200 for medium resolution and 800 by 300 pixels for high-resolution graphics. According to Gerald L. Peterson, Tandem vice president of product management, ''Color display is becoming more important in the general business environment. The new color models offer all the standard and optional features that are available with the other DYNAMITE workstations, plus the ability to highlight and define text and graphic information in up to 16 different colors.'' The DYNAMITE 6548 workstation comes with dual 360-kilobyte (KB) floppy disk drives; and the DYNAMITE 6549 workstation comes with one 360KB floppy disk drive, and one 10-megabyte Winchester hard disk drive. A graphics option card is required for color graphics operation. Both models come with 14-inch color screens, 256KB of memory (expandable to 640KB), an MS-DOS operating system, a serial printer interface, GW-BASIC, the ability to run Tandem 653X terminal software, and the ability to transfer files between a Tandem host computer and DYNAMITE workstations. 6600 Cluster Controller The 6600 intelligent cluster controller allows clustering of terminals to reduce communication line costs and to share expensive communication resources, such as phone lines and modems. The 6600 controls communications between a Tandem host computer and up to eight terminals, workstations, or IBM PCs, and one printer. The 6600 can support any combination of Tandem 653X terminals or DYNAMITE 654X workstations, IBM PCs, or PC-compatibles. These devices might otherwise be connected to a remote host computer via separate communications lines and modems, which can be expensive and can mean that the host computer is using more processing power to manage communications. A 6600 controller might be used in a field office with four to eight terminals to more efficiently communicate order entry or inventory control information to a host computer at a headquarters office. Or, the controller might be used in a large manufacturing facility to support devices on the manufacturing floor that are far from a host computer.

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their agreement expires, the company said.

represent the turning point in the
SEE FIRST, PAGE 6

Wang Vet Details CCI Drive To Top

By BILL DOOLEY and MARSHA JOHNSTON FISHER

NEW YORK—In his first press conference as president and chairman of Computer Consoles Inc. (CCI), John F. Cunningham declared his intent here last week to place struggling CCI in a leading position in the market where computing and communications will ultimately converge.

The former Wang Laboratories Inc. president also disclosed he will not seek reelection to the board of directors of his former employer, due to what he said was a possible conflict with CCI's business interests.

"This company (CCI) is a leader in both the high-performance computing field, as well as the processing and communications areas and has products which are as good, if not better, than the major competitors in each of the markets it serves," Cunningham said.

"When you think CCI, I'd like you to think of us as computing, communications and information. I would venture to say
SEE CUNNINGHAM, PAGE 11

John F. Cunningham at New York press conference last week.

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IBM, PAGE 38

'800' Service Door Opens To ATT Rivals

By ALEX MARKELS and JONATHAN WEBER

CUPERTINO, Calif.—Tandem Computers Inc. and Integrated Technology Inc., a Plano, Tex.-based startup company, have announced an agreement to develop and market a sophisticated signaling and computer data base system to Bell operating companies and long distance carriers.

The move marked the beginning of what could become a fierce competition to provide
SEE TANDEM, PAGE 32

MisWeek Aug 28, 1985 p1

Tandem Plots BOC Data Base

CONTINUED FROM PAGE 1

common carriers with certain highly specialized hardware and software they would need in order to economically offer end users a wide variety of "intelligent network" services, such as enhanced "800" toll-free services.

Initially the two companies will focus their efforts on a system they said would allow other carriers to compete with AT&T in the provision of lucrative 800 services. AT&T, the only current source for these services, has not disclosed the amount of revenue they yield, but it is widely believed to be in the multibillion-dollar range.

Competitive long-haul carriers, all eager to provide 800 services, were thwarted in this business effort last January when U.S. District Court Judge Harold Greene ruled AT&T was not required to share its 800 data base and signaling network.

Consequently, the Bell operating companies must develop their own 800-service data bases to provide access to other common carriers. In addition, the BOCs all plan to deploy common channel signaling networks for the provision of 800 and a variety of other network services, including integrated services digital network (ISDN) services.

The long-haul carriers, for their part, plan to deploy similar systems in order to be able to offer proprietary 800 features, such as the routing and auto-response options currently offered by AT&T. In addition, Judge Greene has yet to rule on exactly what routing capabilities the RBOCs will be permitted to provide to long-haul carriers. If Greene restricts the BOC services, the long-haulers also will have to develop their own systems.

Prior to announcement of the Tandem/ITI product last week, AT&T Technologies was believed to be the only company close to offering such a system for sale to the RBOCs and other common carriers. Some long distance companies have suggested that AT&T was stalling on making the system commercially available in order to protect its 800-service monopoly.

The system offered by Tandem and ITI will consist of the Tandem NonStop computers and operating system working in conjunction with system software, interface software and hardware, and signal transfer point (STP) switches from ITI. The signaling system will conform to the signaling system 7 standard that has been endorsed by the CCITT, the multinational standards organization. ITI said it was the only company that had an operational pilot of the system, and that it was demonstrated to the American standards committee T1-X1 last week. The STP hardware is procured by ITI from United Technologies.

BOC Tests Scheduled

The system will be implemented and tested by several undisclosed Tandem BOC customers during the third quarter of 1985, and ITI's vice president of research, Larry Dayhoff, said a nationwide network for an undisclosed long distance company would be in service by the second quarter of 1986.

Dayhoff also said the company has been in close contact with several BOCs to acquire and compile the necessary information for the data base. The actual data base software developed by ITI is "a full-line item data base system as called for by Bellcore," Dayoff said. The data base is queried by the signaling system for routing, billing and custom-feature information each time an 800 call is made.

Although Tandem and ITI plan to have the system ready by 1986, it is not clear whether the customers will be ready as they strive to implement signaling system 7 and compile the necessary data bases. Representatives from Pacific Bell stated that they did not expect to be able to offer 800 service until at least 1987, and similar dates for full-service offerings were given by MCI as well.

MCI, Sprint and others now offer in-WATS services similar to 800 service to their customers, but these services are not as comprehensive and do not use the same access codes as the AT&T service. The companies assert that the installed base of 800 service customers is so big and the 800 system so well entrenched that little competition can be derived from offering non-800 services.

Establishing the same kind of services for 700 numbers, for instance, "just isn't as valuable," remarked Gary Tobin of MCI in Washington, D.C. "Present 800 customers have already spent the money publishing their 800 numbers and won't want to switch anyway."

Some interim agreements have been negotiated to offer 800-service based on a six-digit code, but this solution has been met with limited enthusiasm by local telcos and long-haul carriers (see July 24 MIS Week, page 31).

Although the 800 service is the most immediately significant of-

SEE TANDEM, PAGE 34

n of a new 12-line elec-
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its electronic key systems, which the company attributed to competition from less expensive foreign imports, San/Bar said it expected sales of its 1A2 equipment to remain at a "satisfactory level." It said there were millions of "satisifed 1A2 customers" in the United States that did not want the "bells and whistles" of fancier systems.

US West Wraps Up Marketing Revamp

DENVER—US West announced the completion of its marketing reorganization with the appointment of Dr. Charles M. Lillis as vice president of marketing and head of a new strategic marketing division.

Lillis, former dean of the College of Business and Administration at the University of Colorado, will work with Win Wade, newly hired president of US West Advanced Technologies with responsibility for identifying and applying new technologies for all US West operations, and US West Information Systems president John Jester (see Aug. 7 MIS Week, page 1).

Lillis will be responsible for identifying new market opportunities for the RBOC and its subsidiaries. Wade will be responsible for providing the necessary technologies. Jester's Information Systems Group will provide sales and service support for the company.

SRX Hybrid/PBX Gains 2 Dealers

DALLAS—SRX Inc. said it has signed distribution agreements for its SRX hybrid/PBX with SLT Communications Sales Co. of Sugar Land, Tex., and Business Telecommunications Services Inc. (BTS) of Lenexa, Kan.

Terms of the agreements were not disclosed.

According to SRX, SLT will market its switch in the greater Houston area. BTS will sell it throughout the Southwest. SLT said it serves some 800 businesses in the Houston area. It also sells PBXs from Mitel, Northern Telecom, Toshiba and Northcom.

BTS said it handles switches from Hitachi, Mitel and Fujitsu. The company has an installed base of about 8,000 customers throughout the Southwest.

The SRX switch, which supports from six to 255 telephone stations, is distributed nationally by Continental Telecom's Executone unit (see Mar. 27 MIS Week, page 20).

SW Bell Publications and Amdocs entered into a joint venture called Automated Directory Services in September 1984. The venture markets a computerized directory publication system called ADS/Sales II, which the venture was formed to develop. The system automates publishing management, contracts, billing data and market information and also drives a graphics system, according to a SW Bell Publications spokesman.

"We worked so well with Amdocs in developing and marketing ADS/Sales II," he said, that SW Bell Publications found the partnership attractive. "We now have the chance to benefit from our partner's international activities," he said, and added that SW Bell will provide some financial support for Amdocs' activities.

The spokesman would not reveal the value of either purchase. He said both NYYP and Amdocs are privately held companies and could not disclose either firm's annual revenues.

NYYP publishes eight "Blue Book" directories, each for a separate neighborhood in Manhattan or Brooklyn, and eight trade-specific Yellow Pages directories for businesses in New York, northern New Jersey and southern Connecticut.

The spokesman said NYYP would keep its own name and continue to publish the directories it has produced. The only change SW Bell is considering for NYYP at present, he said, is possibly publishing its directories annually instead of every other year.

SW Bell will use NYYP's existing sales force to promote other SW Bell publications, such as its Silver Pages discount directories for senior citizens, SW Bell said.

"The New York City area is a very viable market for directories marketing," the spokes-

Low Price Touted For New Voice Mail

BEAVERTON, Ore.—A low-cost voice mail system targeted at small applications was introduced last week by AT&E Systems Inc., a subsidiary of American Telephone and Electronics Corp.

The new "RSVP" voice mail system is compatible with any existing Touch-Tone telephone system, including single telephones, key systems and PBXs, according to the company. The RSVP line is aimed at organizations with 10 to 100 telephones.

The company said that the complete RSVP series 100 retails for less than $3,500.

publishing its primary area of diversification.

—Melinda McAdams

Tandem Plans BOC Data Base

CONTINUED FROM PAGE 32

fering from Tandem/ITI, the system has the capability to offer a variety of other telephony services, including specialized call-waiting and call-forwarding capabilities, nearest-facility call routing, and other end-user services. The signaling system 7 is a crucial aspect of ISDN, particularly for the later phases, which will include capabilities such as dynamic bandwidth allocation.

For Tandem, the new move into the telecommunications service market will break fresh ground for the company. "Our customer base has been traditionally in manufacturing areas. We'll be looking primarily to the BOCs and common carriers who are interested in an alternative to AT&T's 800 service and other special services," noted Ash Asman, telecommunications project manager at Tandem.

"It's not unreasonable for Tandem and other computer vendors to look to the telecom industry as the market possibilities opened up by deregulation are realized," asserted Randy Sherman, telecommunications industry analyst at California-based Creative Strategies International. "We can expect companies like Tandem to look to leverage their existing equipment with customized software in order to capitalize on these new market opportunities."

Although terms of the Tandem/ITI agreement were not disclosed, it has been learned that the two companies will make joint sales calls to market the new products and services, and continue their already close product development.

For ITI, a startup company founded last year with private capital, the agreement could be just the beginning. The market for signaling system 7 equipment and data bases is expected to be worth several hundred million dollars annually by the end of this decade. Dayhoff said he anticipated that a number of data communications companies as well as telecom switch manufacturers would be in the market, although he maintained that ITI had a jump on them.

He said ITI currently employed about 30 people, several of whom, like himself, came to the company after stints with Rockwell International and Ericsson.

Enhanced IBM 3270 Emulation Software Tandem also announced enhancements to the company's EM3270 emulator. Enhanced EM3270 software now permits Tandem users, from a single terminal, to access IBM 3270 applications on up to six IBM host computers that communicate using either SNA or binary synchronous (bisync) protocols. Users of Tandem 653X terminals, DYNAMITE 654X workstations, or IBM PCs, can also run IBM 3270 and Tandem applications at the same time; and they can now alternate between IBM SNA and bisync hosts through the use of menus activated by a ''HOST'' key. EM3270 software gives users of Tandem devices or IBM PCs connected to a Tandem host on-line access to 3270 applications on an IBM or IBM-compatible host computer, by enabling Tandem devices (or IBM PCs) to act like an IBM 3270 device. Availability and Pricing Information All products are available now. Prices below are quoted in U.S. dollars for single quantity orders. The DYNAMITE 6548 workstation is $3,790 and the 6549 is $4,790. A field upgrade to color for existing DYNAMITE users is $995. The graphics board required for color products is priced at $575. The 6600 controller is $3,450, for a four-port configuration. An 8-port version is available for $4,250. Enhanced EM3270 has a per processor license fee of $500 for new licensees, and is available at no charge for existing Tandem users who wish to upgrade from the previous version of EM3270 to the enhanced version, providing they have Tandem's GUARDIAN 90 operating system software. Tandem Computers Inc. manufactures and markets computer systems and networks for the on-line transaction processing market. The company is headquartered at 19333 Vallco Parkway, Cupertino, Calif. 95014. The telephone number is 408/725-6000.

CONTACT: Tandem Computers Inc., Cupertino
Corinne DeBra, 408 725-7574

MISWeek 8/14/85 p17

On-Line To Share Information

t To News Media

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ossible for us to ac- volume of telephone ell said. "It would e system." James em, a modified bull- uses the Multi-Link g package from the k, Atlanta.

rrific piece of soft- e you can partition nine separate com- g time-slicing to PU among different, applications," he TVA's nuclear power plants, and to the salaries, telephone numbers and backgrounds of top TVA officials.

In fact, the first background file placed on the system was a complete history of NRC fines, an item placed on-line the day TVA was fined because of an incident in which several workers were sprayed with radioactive water because of a faulty valve.

In addition, said James, the system links analog measuring devices in the many TVA lakes—via a Hewlett-Packard system operated by the agency's Reservoir Operation Branch—to a set

vell, seated, TVA director of information, with Henry R. (Jay) eloper of on-line system, shown at PC/XT news terminal.

information system incoming telephone al of them toll-free linked to the IBM layes 1200-baud mod- wo four-port serial of the partitions are the serial ports and hich is generally the ot in the foreground, or's console.

computer hobbyist much of the bulletin cation himself, based supplied by Multi- documents on the n can be transferred pendent IBM PC/XT , using the main- telecommunications or by saving the ment to disk on the of tables on the bulletin board that are updated daily.

The information has long been popular with fishermen and the recreation and maritime industry on those lakes and rivers, James said, and is made available to those people through the news media. Users on the system need no special software, so long as they can communicate using generally accepted communications parameters, he said.

Multi-Link allows the operator to establish different terminal types for each partition, James said, "but we wanted to keep it as simple as possible, so every one of our partitions is TTY."

Each partition is given 64 kilobytes of the XT's RAM, he added,

Tandem Adds 2 Models To 'Dynamite' VDT Line

CUPERTINO, Calif.—Tandem Computers Inc. has added two color models, the 6548 and 6549, to its family of Dynamite workstations.

At the same time, the manufacturer of on-line transaction processing systems introduced a new cluster controller, the 6600, and said it has enhanced its IBM 3270 emulation software.

Tandem introduced its MS/DOS-based Dynamite workstations last October. The follow-on models unveiled last week allow text and graphic information to be displayed in up to 16 colors. When the new models are used as system terminals, information can be displayed in white-on-black or black-on-white on the display screen.

Tandem spokeswoman Corinne DeBra said the three advantages of the new workstations are that they can be used as stand-alone systems or as terminals, and that there is "lots of MS/DOS-based color graphics software that the new color workstations can take advantage of."

The model 6548 workstation features dual 360-kilobyte floppy disk drives. It is priced at $3,790.

Tandem's 6549 system comes with a 360-Kbyte floppy disk drive and one 10-Mbyte Winchester hard disk drive. It sells for $4,790.

A graphics option board is required for third-party color graphics. The board is priced at $575. A field upgrade of Tandem's monochrome Dynamite workstations to color is available for $995.

Both color workstation models come with 14-inch color screens and 256 Kbytes of memory.

The 6600 cluster controller is compatible with IBM's 3274 communications controller. It permits the clustering of terminals in order to reduce communications line costs. The sharing of communications resources, such as modems and phone lines, is also made possible with the 6600. The 6600 controls communications between a Tandem host system and up to eight terminals or workstations, plus a printer.

The 6600 can support Tandem's 653X terminals, the Dynamite workstations, IBM personal computers and IBM PC clones.

The 6600 controller is priced at $3,450 for a four-port configuration thst supports up to four users

Tandem's enhanced EM3270 emulator lets Tandem users access IBM 3270 applications on up to six IBM host computers from a single Tandem terminal.

The enhanced version of 3270 software is available for an initial license fee of $500 per processor.

—Juli Cortino

Tech Combo Shapes Alert

CONTINUED FROM PAGE 13

Tie-up of phone lines was a major problem in the nation's best-known nuclear power accident at Three Mile Island in Pennsylvania. Asher, whose FEMA region covers that state, said that because nuclear power plants are built in rural areas,

Tandem Computers - Company Report
PAINE WEBBER INC. - Smith, S.K.
07-25-85 (RN=508100)

Tandem Computers
($16 1/2 (OTC - TNDM) 52-week range: $13-29

Rating: Attractive

FY 9/30	1984	1985E	1986E
Q1	$0.24	$0.34A	$0.19
Q2	0.05	0.16A	0.27
Q3	0.23	0.06A	0.30
Q4	0.29	0.11	0.35
Year	0.81	0.66	1.10
P/E	16.0-35.8	25.0	15.0
Div	-	-	-
Yield	-	-	-

Secular Growth Rate 30%

OPINION: ATTRACTIVE

Third quarter EPS of $0.06 per share were even worse than our recent $0.13 estimate. Nevertheless, we are maintaining our attractive rating on Tandem. (*) Not all the news in the quarter was bad. Revenues were flat with a year ago, no worse than seen in the industry overall. New customer activity was strong, suggesting that Tandem is continuing to hold its own against Stratus (*) (STRA - OTC - $17 1/2). However, SG&A expenses jumped sharply and are likely to continue to put further pressure on earnings over the next few quarters, especially in the current economic environment. We are consequently lowering our FY 85 estimate from $0.88 to $0.66 and our FY 86 estimate from $1.35 to $1.10 per share.

WHY CAN'T TANDEM CONTROL EXPENSES?

Tandem reported third quarter EPS to $0.06 per share, vs. $0.23 in the same period a year ago. Product revenues declined by 2% and service revenues increased 19% over Q3 84. Although gross margin improved by almost a half a percentage point over Q2 (due to product mix), a huge increase in SG&A expenses led operating margin to fall from 6.6% in Q2 to 0.4%. SG&A expenses grew from 37.6% of revenues in Q1 85 to 48.2% in the quarter just ended.

The revenue shortfall alone does not appear sufficient to justify the jump in SG&A expenses. Expenses continue to outgrow revenues, despite repeated "freezes". We believe that this is not only due to

poor forecasting. Tandem's move away from fault-tolerance into selling sophisticated on-line transaction processing systems (a lucrative market in which Tandem has already made considerable progress) is placing heavy up-front demands upon its sales and support staff. Furthermore, the sales cycle on these larger bids is longer. However, the market opportunity for Tandem is considerable. As a result we believe that it would be a mistake for Tandem to cut back in this critical area at this time. However, this means that we do not anticipate a rapid rebound in EPS in Q4.

NEW CUSTOMER ACTIVITY BODES WELL FOR THE FUTURE

Nearly 40 new customers signed up in the quarter, most for Tandem's new low-end NonStop EXT processor, suggesting that Tandem's more aggressive move in the low-end of the market is beginning to pay off. The strength at the low-end suggests that, although clearly having some impact, Stratus was not the primary reason for Tandem's revenue shortfall. The weak areas in the quarter were those most likely to be affected by the current capital spending squeeze -- big ticket TXP sales and quantity orders for the EXT by large customers.

Tandem Computers- Quarterly Income Statement Model
(Dollars in millions, except percentages and per share data)

[Part 1 of 4]

Revised 7/11/85		1983A				
	1982A	Q1	Q2	Q3	Q4	Year
Product	$272.59	$81.76	$82.31	$94.55	$101.51	$360.13
Service	$39.55	$12.38	$13.70	$15.74	$16.34	$58.15
Total Revenues	$312.14	$94.14	$96.01	$110.29	$117.85	$418.28
Costs and Expenses:						
Cost of Revenues	$109.31	$37.96	$37.86	$45.12	$47.78	$168.71
Product Development	$33.64	$9.00	$9.81	$9.96	$10.41	$39.17
Marketing, G&A	$128.49	$35.55	$37.95	$41.56	$45.58	$160.64
Total Expenses	$271.44	$82.50	$85.61	$96.64	$103.77	$368.52
Operating Income	$40.71	$11.64	$10.40	$13.65	$14.08	$49.77
Interest, Net	$6.03	$0.05	($0.18)	$0.25	$0.62	$0.73
Pretax Income	$46.74	$11.68	$10.22	$13.90	$14.70	$50.50
Tax rate	0.36	0.39	0.37	0.39	0.40	0.39
Taxes	$16.88	$4.56	$3.77	$5.46	$5.91	$19.69
Net Income	$29.86	$7.13	$6.45	$8.44	$8.79	$30.81
Shares outstanding	39	40	41	41	41	41
EPS	$0.76	$0.18	$0.16	$0.21	$0.21	$0.76
DISC						
EPS incl. DISC						
Growth rates (% year-year)						
product revenue	46	NA	NA	NA	NA	32
service revenue	84	NA	NA	NA	NA	47
Total revenue	50	33	30	38	35	34
EPS	6	-11	0	7	1	-1
Growth rates (% Qtr-Qtr)						
Revenue	-	8	2	15	7	-
EPS	-	-17	-10	30	4	-
Ratios (%):-						
Gross Margin	64.98	59.68	60.57	59.09	59.46	59.67
Product dev: sales	10.78	9.56	10.21	9.03	8.83	9.37
Mktg, G&A: sales	41.16	37.76	39.52	37.68	38.68	38.40
Operating Margin	13.04	12.36	10.83	12.38	11.95	11.90

[Part 2 of 4]
Revised 7/11/85

	1984A				
	Q1	Q2	Q3	Q4	Year
Product	$108.47	$91.22	$119.06	$129.85	$448.61
Service	$17.90	$20.01	$22.86	$23.24	$84.01
Total Revenues	$126.37	$111.24	$141.93	$153.09	$532.62
Costs and Expenses:					
Cost of Revenues	$50.44	$47.25	$57.79	$63.34	$218.81
Product Development	$10.85	$12.85	$13.51	$15.30	$52.51
Marketing, G&A	$48.21	$49.13	$56.28	$56.58	$210.20
Total Expenses	$109.49	$109.23	$127.58	$135.22	$481.52
Operating Income	$16.88	$2.01	$14.34	$17.88	$51.10
Interest, Net	$1.08	$1.14	$1.24	$1.72	$5.18
Pretax Income	$17.95	$3.15	$15.59	$19.60	$56.28
Tax rate	0.44	0.37	0.41	0.39	0.41
Taxes	$7.90	$1.17	$6.34	$7.67	$23.08
Net Income	$10.05	$1.97	$9.25	$11.93	$33.20
Shares outstanding	42	42	41	41	41
EPS	$0.24	$0.05	$0.23	$0.29	$0.81
DISC				$0.24	$0.24
EPS incl. DISC				$0.53	$1.05
Growth rates (% year-year)					
product revenue	33	11	26	28	25
service revenue	45	46	45	42	44
Total revenue	34	16	29	30	27
EPS	36	-70	10	36	7
Growth rates (% Qtr-Qtr)					
Revenue	7	-12	28	8	-
EPS	12	-80	377	29	-
Ratios (%):-					
Gross Margin	60.09	57.53	59.28	58.62	58.92
Product dev: sales	8.59	11.55	9.52	9.99	9.86
Mktg, G&A: sales	38.15	44.17	39.66	36.96	39.46
Operating Margin	13.36	1.80	10.11	11.68	9.59

Revised 7/11/85	Q1	Q2	1985E Q3	current quarter Q4	Year
Product	$134.14	$120.09	$116.87	$123.00	$494.09
Service	$25.52	$26.40	$27.29	$29.00	$108.21
Total Revenues	$159.65	$146.49	$144.16	$152.00	$602.30
Costs and Expenses:					
Cost of Revenues	$62.02	$57.71	$56.12	$59.28	$235.13
Product Development	$15.13	$17.08	$18.03	$17.50	$67.73
Marketing, G&A	$60.00	$62.00	$69.48	$69.50	$260.98
Total Expenses	$137.14	$136.79	$143.63	$146.28	$563.84
Operating Income	$22.51	$9.70	$0.54	$5.72	$38.47
Interest, Net	$1.89	$1.57	$1.30	$1.60	$6.36
Pretax Income	$24.40	$11.28	$1.84	$7.32	$44.83
Tax rate	0.43	0.39	NM	0.38	0.38
Taxes	$10.37	$4.44	($0.55)	$2.78	$17.04
Net Income	$14.03	$6.84	$2.39	$4.54	$27.79
Shares outstanding	41	42	42	42	42
EPS	$0.34	$0.16	$0.06	$0.11	$0.66
DISC					
EPS incl. DISC					
Growth rates (% year-year)					
product revenue	24	32	-2	-5	10
service revenue	43	32	19	25	29
Total revenue	26	32	2	-1	13
EPS	41	244	-75	-63	-18
Growth rates (% Qtr-Qtr)					
Revenue	4	-8	-2	5	
EPS	16	-52	-65	89	
Ratios (%):-					
Gross Margin	61.15	60.60	61.07	61.00	60.96
Product dev: sales	9.47	11.66	12.50	11.51	11.25
Mktg, G&A: sales	37.58	42.32	48.20	45.72	43.33
Operating Margin	14.10	6.62	0.37	3.76	6.39

[Part 4 of 4]

Revised 7/11/85

	1986E					
	Q1	Q2	Q3	Q4	Year	1987E
Product	$134.14	$144.11	$148.42	$153.75	$580.41	$725.52
Service	$30.62	$32.21	$33.57	$35.67	$132.07	$165.09
Total Revenues	$164.76	$176.31	$181.99	$189.42	$712.48	$890.60
Costs and Expenses:						
Cost of Revenues	$65.08	$69.29	$71.34	$73.31	$279.02	$347.34
Product Development	$18.00	$18.50	$19.00	$19.50	$75.00	$89.06
Marketing, G&A	$70.00	$71.00	$72.00	$73.50	$286.50	$338.43
Total Expenses	$153.08	$158.79	$162.34	$166.31	$640.52	$774.83
Operating Income	$11.68	$17.52	$19.65	$23.11	$71.97	$115.78
Interest, Net	$1.50	$1.50	$1.50	$1.50	$6.00	$5.00
Pretax Income	$13.18	$19.02	$21.15	$24.61	$77.97	$120.78
Tax rate	0.40	0.40	0.40	0.40	0.40	0.42
Taxes	$5.27	$7.61	$8.46	$9.85	$31.19	$51.21
Net Income	$7.91	$11.41	$12.69	$14.77	$46.78	$69.57
Shares outstanding	43	43	43	43	43	45
EPS	$0.19	$0.27	$0.30	$0.35	$1.10	$1.55
DISC						
EPS incl. DISC						
Growth rates (% year-year)						
product revenue	0	20	27	25	17	25
service revenue	20	22	23	23	22	25
Total revenue	3	20	26	25	18	25
EPS	-45	65	424	223	66	41
Growth rates (% Qtr-Qtr)						
Revenue	8	7	3	4		
EPS	73	44	11	16		
Ratios (%):-						
Gross Margin	60.50	60.70	60.80	61.30	60.84	91.00
Product dev: sales	10.93	10.49	10.44	10.29	10.53	10.00
Mktg, G&A: sales	42.49	40.27	39.56	38.80	40.21	38.00
Operating Margin	7.09	9.94	10.80	12.20	10.10	13.00

(*) PaineWebber Incorporated and/or Rotan Mosle Inc., an affiliated corporation of PaineWebber Incorporated, makes a market in this security.

LEVEL 1 - 4 OF 6 STORIES

August, 1985

SECTION: PRODUCTS; Pg. 43

LENGTH: 426 words

HEADLINE: Tandem Introduces Five Products

BODY:

Tandem, Computers, Inc. announced five products as well as support for a series of standards.

PS Mail is a distributed electronic mail system designed to provide electronic communications among users of a variety of desktop devices. PS Mail allows users of IBM 327X, conversational or TTY terminals, IBM Personal Computers or Personal Computer-compatibles and Tandem 653X terminals and Dynamite workstations to send and receive electronic mail and to store, forward and file documents electronically.

PS Mail is free to licensees of Tandem's Transfer software for use on Tandem terminals and workstations and for IBM Personal Computer and Personal Computer-compatibles using PC Link.

PS Mail for IBM 3270 and TTY terminals has an initial license fee of $2,000 per system for Tandem's Nonstop or TXP and $1,000 for its EXT system, plus a per-system monthly license fee of $200 for Nonstop II and TXP and $100 for EXT.

Available with PS Mail are PS Text Edit for full document creation and text editing and PS Text Format for formatting and designing documents.

PC Text Edit's initial license fee is $500 per system (Nonstop II and TXP) and $375 (EXT) plus a $50 monthly license fee.

Faxlink is an image storage, forwarding and retrieval capability for moving printed documents or pictures through a Tandem network using any CCITT Group III facsimile machine.

Faxlink, which includes a hardware controller and software, carries a license fee of $12,500 plus a per-system monthly license fee of $200 (Nonstop II and TXP) and $100 (EXT).

PC Link is a diskette-based software product that eliminates the need for an add-in card to allow IBM Personal Computers and Personal Computer-compatibles, when connected to a Tandem system, to emulate a Tandem 653X or IBM 327X terminal.

PC Link's initial license fee is $495 per IBM Personal Computer or Personal Computer-compatible and is free for users of Tandem's Dynamite workstations.

The company announced that development projects are underway to support IBM's Document Interchange Architecture/Document Content Architecture, IBM's Logical Unit 6.2, IEEE 802.3 local-area network standards and host-based MS-DOS file

and print servers.

Tandem also intends to provide gateways to X.400 and IBM's Disoss. The company signed an agreement with AT&T Information Systems to be a licensee of the Digital Multiplexed Interface standard for integrating private branch exchange equipment into the Tandem net environment.

Tandem Computers, Inc., 19191 Vallco Pkwy., Cupertino, Calif. 95014.

LEVEL 1 - 1 OF 6 STORIES

PR Newswire

August 27, 1985, Tuesday

DISTRIBUTION: TO BUSINESS DESK AND ELECTRONICS EDITOR

LENGTH: 324 words

DATELINE: MIAMI, Aug. 27

KEYWORD: BUSINESS COMPUTER SOLUTIONS, TANDEM AGREEMENT

BODY:

MIAMI, Aug. 27 /PRN/ -- Business Computer Solutions Inc. (OTC: BCSI) announced today that it has reached an agreement with Tandem Computers Inc. (NASDAQ: TNDM), Cupertino, Calif., to jointly market Business Computers' Solutions fourth generation relational database management system, the EMIS, and the company's integrated hotel control system, RESORTEL.

Under the terms of the agreement, Business Computer Solutions will produce the EMIS fourth generation database management systems and RESORTEL, an integrated hotel system, and market them directly to Tandem NonStop(tm) users under the sponsorship the Tandem Alliance.

The Tandem Alliance is a program designed to encourage application designers to develop software solutions for Tandem users.

Business Computer Solutions Inc. primary products are advanced fourth and fifth generation computer software programs and packages for business, professional and industrial end users of mini-, supermini- and mainframe computers and computer systems in industries such as accounting and financial, hospitality, health care, medical, computer security, aerospace, chemical, petrochemical, and petroleum.

The software products researched, developed, designed and marketed by Business Computer Solutions range in cost from approximately $1,500 to more than $150,000, depending on adaptations and enhancements.

Business Computer Solutions Inc. recently announced the signing of a 15-year joint venture with the Acadamy of Sciences of the People's Republic of China for the development, introduction, distribution and implementation of software and software/hardware products throughout the Chinese mainland.

Tandem Computers Inc., founded in 1974, manufactures and markets computer systems and networks for the on-line transaction processing (OLTP) market.

CONTACT -- J. B. Brooks at 305-591-2274, or P. T. Haller at 305-421-8243

LEVEL 1 - 2 OF 6 STORIES

August 26, 1985, Monday

DISTRIBUTION: Business Editors

LENGTH: 402 words

HEADLINE: STRATUS-COMPUTER; Selected for Catcus Switch, major Arizona financial network

DATELINE: MARLBORO, Mass.

BODY:

The Arizona Clearing House Association of Phoenix, Ariz. has selected Stratus Computer Inc. to provide the fault tolerant computer system for its new state-wide point of sale (POS) and automated clearing house (ACH) network known as the ''Cactus Switch.'' The Arizona Clearing House Association provides ACH and POS services to 106 member financial institutions, including banks, savings and loans, and credit unions. The Cactus Switch represents the nation's first network to extend ACH and POS services through an intermediary clearing house to each and every one of its member financial institutions. The Cactus Switch will also include applications software from Applied Communications Inc. (ACI) of Omaha, Neb. which will provide its Base24-POS switching software. Paul W. Finch, president of the Arizona Clearing House Association and vice president and manager of research and development of Valley National Bank in Phoenix, said that the ACH service will be operational for all 106 association members during the fourth quarter of 1985. He stated that the association has an existing POS pilot program that will be converted to the Cactus Switch the POS service will be operational during the first quarter of 1986. It is expected that some of the larger member institutions will in turn offer POS services to their department store, convenience store and service station customers. ''This is a major win for stratus in what was a highly competitive selling situation,'' remarked John P. Morgridge, Stratus vice president of marketing. ''We passed some very tough benchmarking and throughput tests to emerge as the top contender for an innovative point of sale network requiring the best in powerful fault tolerant computing.'' The initial sale of Stratus equipment included an XA600 Continuous Processing system. Headquartered in Marlboro, Stratus Computer Inc. designs, manufactures, markets and services the family of Stratus/32 Continuous Processing systems for fault tolerant on-line transaction processing and communications control.

CONTACT: Stratus Computer Inc., Marlboro
Anne M. Phaneuf, 617/460-2371

Tandem announces C, Pascal versions for Nonstop systems

CUPERTINO, Calif. — Tandem Computers, Inc. has unveiled versions of the C and Pascal programming languages for applications development on its Nonstop systems. The vendor also announced a version of Cobol 85, a proposed Ansi standard programming language that provides productivity extensions, and the Tandem Advanced Command Language, a command interpreter for Nonstop systems.

Tandem C, based on the Lattice, Inc. C compiler, has extensions that provide access to Tandem facilities and is compatible with the C compiler used for programming the Tandem Dynamite workstation and the IBM Personal Computer.

Tandem Pascal is based on the Ansi/IEEE 770 X3.97-1983 standard and Level 0 of the ISO 7185 standard. Tandem Cobol 85 supports all required modules specified in the Draft Proposed Revised Ansi Programming Language Cobol (X3.23-198X).

Both C and Pascal cost an initial $1,000, plus a monthly license fee of $225 for Nonstop II and Nonstop TXP systems, and $500 plus $115 per month for Nonstop EXT systems. Prices include runtime libraries. C will be available in the fourth quarter of 1985 and Pascal in the first quarter of 1986.

Cobol 85 costs $1,000 per Nonstop II or TXP system, with a monthly license fee of $300. The EXT costs $500 with a $150 monthly fee. The runtime library costs $500 per system for the Nonstop II and TXP and $250 for the EXT, with a monthly fee of $100 per system. First shipments of Cobol 85 will take place in the first quarter of 1986.

More information is available from Tandem at 19333 Vallco Pkwy., Cupertino, Calif. 95014.

SINGLE from page 45

together is a feature that must be considered in addressing a single-vendor solution. Will the security system from a particular vendor, for example, work better and offer more ease of use if it is combined with the vendor's Dasd management system, as opposed to a similar package from another vendor?

That question can only be answered through a detailed requirements definition and analysis by the user. One would certainly expect that if a vendor's products have been designed to work together — and, it must be remembered, not all have — then there would be increased efficiency and functionality from using them together. But that is not always the case.

Service, support sensitive issue

The issue of improved service and support is a somewhat sensitive one for most software vendors. Will buying five or six products automatically entitle a user to additional consideration when a problem is discovered? Most reputable vendors claim their support is outstanding even if a user has only one product.

The capable data center manager will keep in mind that it becomes much easier to assign responsibility for a problem between two products if both are from the same vendor.

If your shop is a major customer of the vendor, it seems reasonable to assume that a higher degree of attention will be brought to bear on a significant problem. A problem is also easier to locate and fix if the same service personnel can look at both products involved.

But, it must also be remembered that software maintenance people at vendor support locations are often willing and equipped to locate problems that turn out to be with another vendor's product. The question of additional service leverage is a subjective one and is open to change as the individuals involved change.

Additional disadvantages

In addition to the cautions noted above, there are some other potential disadvantages involved in the one-vendor approach. The most serious may be that such an approach often limits a user's choices to some less-than-optimal software packages.

If you have decided on a one-vendor solution, you may be forced to settle for an inferior product for any one particular function. The overall benefits of a single vendor may outweigh this disadvantage, but it is one that must be considered carefully.

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as served as
marketing vice-president for CAD/CAM at Prime Computers, Inc., and in a variety of posts at Control Data, Honeywell and L.M. Ericsson.

Mr. Razmilovic's duties as international operations president have been assumed on an acting basis by Encore national accounts vice-president Thomas Perry.

No decision has been made on when to appoint a permanent successor to Mr. Razmilovic's post, which was formed last spring as Encore started building its sales and service organization (EN, June 3).

Mr. Perry had been based at Sperry prior to the recent termination of Encore's contract to supply systems to the Blue Bell, Pa. operation (EN, Aug. 19).

Mr. Perry continues to report to sales and service senior vice-president Robert G. Calussen, the spokesman said.

Comp. Consoles Sees Little Financial Improvement for 15 M

NEW YORK — John F. Cunningham, who a month ago joined Computer Consoles, Inc., as chairman and chief executive, last week said it will be 15 to 24 months before there is any significant improvement in the company's financial performance.

In a briefing of securities analysts, the former Wang president said he will take several steps to lower the company's break-even point. Mr. Cunningham said he has already canceled some development activities "not central to computers or communications."

CCI, which recently laid off 70 workers, has brought employment levels to 1,500 from 1,650 at the start of the year. Mr. Cunningham said the firm will take other actions to lower manufacturing costs and will make some organizational changes such as consolidating marketing organizations for its telephony, office systems and computer operations.

CCI, which has separat
ations marketing telephon
tory assistance systems,
systems and processors,
first 6 months of this year
$10.1 million loss on reve
$61 million.

"We won't see improvem
financial performance for
months," Mr. Cunningha
He expects the company t
some black quarters son
next year. "The plan fo
year can certainly show b
he said. "It shouldn't sh
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doesn't show red."

The company's backlog is
15 per cent from the end o
tember. Mr. Cunningha
scribed current order lev
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firm's 32-bit Unix processo
good and those companie
"interested in growing their
ing business with us." He
that while CCI's office sy
and telephony operations a
profitable, the 32-bit proc
business has been profitable

Mr. Cunningham told an
that the company is targetin
enue and earnings growth ra
20 per cent yearly.

Mr. Cunningham, who was
Wang for 18 years, joined CC
month (EN, July 29). At that
he said he would remain a d
tor of Wang. Last week, how
he said he will not stand
re-election to the Wang boar

Tandem Introduces Color Workstations

CUPERTINO, Calif. — Tandem Computers, Inc., has added color versions of its workstations, a new cluster controller, and enhanced its IBM 3270 terminal emulation software.

The two new Dynamite color workstations, which can be used as stand-alone MS-DOS workstations or system terminals, are said to enable users to display text and graphics in up to 16 colors when used with an optional graphics card. The optional bit-mapped graphics card supports three screen resolutions: 320 by 200 pixels; 640 by 200; or 800 by 300.

The Dynamite 6548 comes with dual 360 K-byte floppy disk drives, while the Dynamite 6549 comes with one 360 K-byte floppy drive and a 10 M-byte Winchester hard disk drive. Both Models include 14-inch color screens, 256 K-byte of memory expandable to 640 K-byte, and the MS-DOS operating system.

The 6548 is priced at $3,790, while the 6549 is priced at $4,790. The graphics card is priced at $575. All three products are available now.

Tandem's new Model 6600 cluster controller is designed to be capable of controlling communications between a Tandem host and up to 8 terminals, workstations, or IBM PC's, and one printer. The controller, which is available now, is priced at $3,450 for a 4-port configuration, and $4,250 for an 8-port configuration.

The enhanced version of the company's IBM 3270 terminal emulation software is said to provide access to IBM 3270 applications on up to 6 IBM hosts using either SNA or binary synchronous protocols. The enhanced EM3270 software has a per-processor license fee of $500 for new licensees, and is available at no charge for existing Tandem users who want to upgrade.

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retain their positions and titles, but now report to Mr. McNulty.

Computer Consoles said it has named Alfred W. Fera to replace Mr. McNulty as vice-president and general manager of its Office Systems Group.

Mr. Fera, who had been an independent consultant to CCI, will take over all Mr. McNulty's duties for the office systems operation. He reports to Gary Haynes, senior vice-president of marketing for CCI's Systems operations. Mr. Fera is a 30-year Sperry veteran, who in his last position at Sperry was vice-president and general manager of Sperry Canada. He retired from Sperry in 1982.

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"This system gives our help-desk professionals the expertise to solve a significant percentage of problems in minutes without having to rely on the experts themselves," said Luther Weeks, assistant director in the data processing department.

"It will result in quicker and ... cause it embodies a significant portion of the expertise of several of Travelers' data processing professionals who are diagnostic experts on the 8100 system."

The new system, originally designed as a prototype, places the knowledge of the network experts in the hands of help-desk personnel. A help-desk staff member ... of people to build them and an incredible amount of work," Weeks said. "But if you have the right tools, you can expend a modest amount of effort and still make an impact."

Weeks said Travelers plans to continue refining Diag8100 to expand its problem-resolution capacity and is considering developing more expert systems.

AI Workstation, Expert Generator Pkg., Two 3rd-Party Pacts Announced By DEC

HUDSON, Mass.—Digital Equipment Corp. introduced a new version of its expert generator software and an artificial intelligence (AI) workstation based on its MicroVAX II computer that interfaces with DECnet and Ethernet.

The company also announced two third—party software agreements that will allow DEC to market the Prolog AI language and a natural language for the VAX architecture.

The new AI VAXstation is a turn-key workstation for developing AI applications on a desktop system. The system offers a Lisp language environment that consists of an interpreter, a compiler, a debugger, a tracer and other development tools.

Included in an AI VAXstation configuration is a MicroVAX II processor, 5 megabytes of random-access memory (expandable up to 9 Mbytes), an RD53 71-Mbyte hard disk drive (expandable to 213 Mbytes of storage), a 95-Mbyte tape subsystem, a mouse, a 19-inch display and the network interface. Priced at $48,690, the system is scheduled for delivery in December.

DEC also announced an enhanced version of its OPS5 expert building software. The new version is expected to be available in October on a permanent license basis and prices will range from $7,500 for the VAX 8600 to $3,000 for the MicroVAX II.

DEC signed a five-year non-exclusive agreement with Artificial Intelligence Corp. (AIC) of Waltham, Mass., which will allow DEC to market Intellect, AIC's natural language.

DEC expects to offer a VAX "C" version of Intellect that will operate under the VMS operating system and will be supported by DEC's RDB relational database software.

No pricing or availability was given, a DEC spokesman said, because Intellect in the C version is currently under development and will undergo an indeterminate period of testing before it is brought to market.

DEC also signed a three-year marketing and distribution agreement with Quintis Computer Systems Inc., Palo Alto, Calif. Quintis's version of Prolog, an AI development language, will be marketed by DEC for the VAX architecture.

Prolog prices range from $6,000 for the MicroVAX II to as much as $17,000 for a VAX 8600. It operates under either VMS or Ultrix-32 operating systems.

A spokesman for DEC said that tests of Quintis Prolog, done on the VAX 8600, showed that it ran at "approximately 80,000 logical inferences per second (lips), at 23,000 lips on the VAX 11/780 and between 15,000 and 16,000 lips on the MicroVAX II."

The spokesman said DEC has been using artificial intelligence to configure its own systems for the past five years and has been the largest user of practical AI applications in the world.

—Bill Dooley

Tandem Expands With 3 Languages

CUPERTINO, Calif.—Tandem Computers Inc. has introduced Cobol/85, C and Pascal programming languages for its NonStop family of processors. The company also brought out a new memory board for its NonStop TXP on-line transaction processor.

The new memory board features 256 kilobytes of random-access memory (RAM) chips configured to provide as much as 8 megabytes of storage on a single board. Tandem expects the board to reduce the cost-per-Mbyte of storage by 35 percent.

The $39,200, 8-Mbyte board also doubles the maximum main memory capacity of the company's TXP system. The capacity is now increased from 128 Mbytes to 256 Mbytes in a 16-processor system.

Cobol/85 for the NonStop II and TXP systems is $1,000 per system with a monthly license fee of $300 per system. Cost for the NonStop EXT system, recently introduced by the fault-tolerant computer maker, is $500 per system with a monthly fee of $150 per system. First shipments are expected in the first quarter of 1986.

Prices for C and Pascal, for the NonStop II and NonStop TXP systems, are $1,000 per system, with a monthly license fee of $225 per system. Price for the NonStop EXT system is $500 per processor, with a monthly fee of $115 per unit. Pascal is expected to be available in the first quarter next year and the C language in the fourth quarter.

The new programming languages were introduced, said a Tandem spokeswoman, because potential customers often express an interest in them when considering Tandem systems.

Cobol/85, in particular, is desired because it offers more programmer productivity aids than its veteran predecessor, Cobol/74, said the spokeswoman. Introduction of the C language offers customers a bridge from Tandem's systems to the Unix environment, she said.

Dennis McEvoy, Tandem vice president of software development, said, "Languages are the key to application portability across operating environments."

—Juli Cortino

Aug 21, 1985

Computer Weekly Aug 22, 1985 p11

Tandem plans to expand Alliance

by Charles Arthur

US fault-tolerant minicomputer maker Tandem plans to expand its Alliance programme, which encourages software houses to write applications for it, to new markets, and more European countries.

Roger Bellass, European manager of Tandem's third-party marketing, says: "We're targeting markets other than just the financial ones. There's transport and manufacturing as well."

Tandem's Non-Stop machines are often used in banking applications, but last year it signed a contract with Scandinavian Airlines for its cargo transport software, and last May it joined the companies supporting General Motors' manufacturing application protocol (Map).

Bellass is also renewing efforts to work with local software houses in Switzerland, Belgium and Denmark. But they can be hard to find.

He remarks: "In those places there are enough US, UK and French software houses that users there can just go to them."

The Alliance programme has been a runaway success, he believes, having fulfilled the target of 20 European firms to write applications in eight months, seven months ahead of schedule. The new target is 3D.

BELLASS . . . Targeting new markets at Tandem.

Informatics i swallowed up

The long saga of the Informatics takeover seems to have reached its conclusion with the news that Walter Bauer will yield the chairmanship to Sam Wyly next month.

This marks the completion of the campaign by Sterling Software of Dallas to gain control of the Californian firm, which is the largest software and computer services organisation in the world. It has been swallowed by a company only a fraction of its size.

Wyly is moving the headquarters from California to Dallas and laying off 65 headquarters staff. But the UK will not be affected, according to one of its managers, Rayo Shroff. The redundancies follow a rationalisation of the administrative situation in the US and will not lead to any more over here, he says.

The arrival of Wyly at the top of the group will cause a wave of speculation among employees, as well as the group's competitors. Wyly's record as chief of Wyly Corporation, which propelled UCC (now Uccel) into prominence, was controversial.

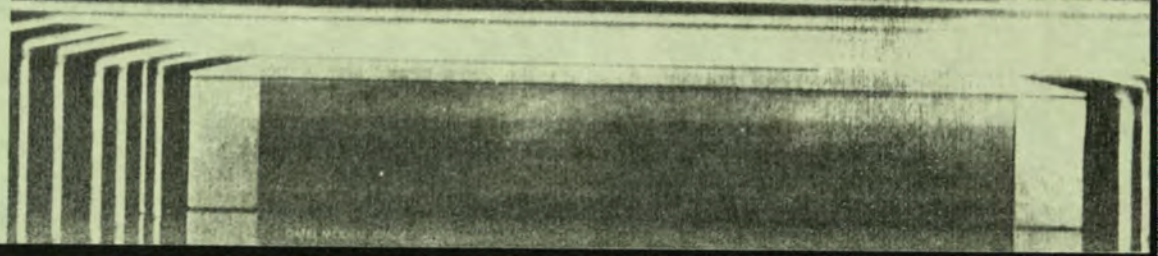
As the University Computing Company, peared in the when Wyly c announcing bi years of rap lowed, makin gest services Europe and leaders.

But UCC trouble with i national data network, end with AT&T w years. It made the 1970s, b bankruptcy. U the last cou shown signs o

Nuclear managers insist on proof

by Charles Arthur

Management at British draughtsmen found it was overloaded," remarks Co-



LEVEL 1 - 1 OF 1 STORY

Business Wire

August 19, 1985, Monday

DISTRIBUTION: Business Editors

LENGTH: 424 words

HEADLINE: TANDEM-COMPUTERS; Signs telecommunications cooperative agreement with Integrated Technology Inc.

DATELINE: CUPERTINO, Calif.

BODY:

Tandem Computers Inc. (OTC/TNDM) Monday announced it has signed a cooperative agreement with Integrated Technology Inc. to develop and market advanced 800 telephone service software for the telecommunications industry. Terms of the agreement were not disclosed. Enhanced 800 service is the first in a series of products that allow local and long distance telephone companies to compete in special services formerly provided exclusively by AT&T. Designed for Tandem's NonStop systems, the software will be tested at customer sites beginning in the third quarter of 1985. Enhanced 800 will initially offer toll-free number services including advanced features such as over-the-phone dialing instructions by computer-generated voice messages, access to different departments within a company using a single telephone number, and call accounting by a company's departments or extensions. According to Robert C. Marshall, Tandem senior vice president and chief operating officer, ''Divestiture has created signficant new opportunities for Tandem and the Bell operating companies and other common carriers. Our cooperative venture with ITI will provide the telephone industry with its first viable alternative to AT&T's 800 service. ''We believe it will form the basis for many other future services and play a key role in helping the industry to move quickly into the deregulated era.'' Tom Martinson, ITI's chairman and chief executive officer, stated, ''We are pleased to join Tandem's aggressive and well-focused commitment to the telecommunications industry. ITI brings to the joint venture a seasoned team of engineers with combined experience of over 75 years in voice/data software and hardware development.'' Tandem Computers Inc. manufactures and markets computers systems and networks for the on-line transaction processing market, which includes the telecommunications, manufacturing, banking and financial industries. The company is headquartered at 19333 Vallco Parkway, Cupertino, 95014. Telephone is 408/725-6000. Integrated Technology Inc. was founded in 1984 to serve the hardware and software development requirements of the telecommunications industry. ITI is headquartered at 850 East Central Parkway, Suite 240, Plano, Texas, 75074. Telephone is 214/423-5383.

CONTACT: Tandem Computers, Cupertino
Gina Burr, 408/725-7455
or
Integrated Technology Inc., Plano, Texas
Peter Walsh, 214/423-5383

INVESTEXT/COMPUTERS AND OFFICE EQUIPMENT
August 19, 1985

Tandem Computers - Company Report
DREXEL BURNHAM LAMBERT INCORPORATED - Labe, P.
07-30-85 (RN=508317)

TANDEM COMPUTERS (*)
(TNDM - $15 5/8)

The Concept Has Changed

Rating:		BUY	Shares outstanding:		41.9 million
52-Week Range:		29-13	Dividend:	None	Yield None
	From	To			
EPS 1984A:	$0.80	-	P/E 1984E:	19.5x	
1985E:	$0.95	$0.70	1985E:	22.3x	
1986E:	$1.45	$1.20	1986E:	13.0x	
Projected 5-year growth rate:		39.6%	Operating return on tangible assets:		16.5%
Market proxy ROR1:		12.3%	Total debt/equity:		5.2%
Company ROR1:		22.1%	Return on equity:		11.4%
Market cycle beta:		2.22	Reinvestment rate:		11.4%

Note: Fiscal year ends September 30.
(*) DBL makes a market in this security.

POINT OF VIEW

The stock's price action during July suggested that the unreported quarter would be worse than the $0.18 EPS we have been predicting. While we didn't know this for a fact, we were not that surprised by the weak quarter reported July 27.

The character of investing in Tandem has changed from when we recommended it six months ago. At that time we suggested a growth stock thesis based on the secular growth and proprietary position in transaction processing.

Subsequent developments have tended to disprove this thesis. No one is immune from an economic recession, including Tandem. But if the secular growth story was valid, the company should be doing better than it is. There would be diminished growth, not declines.

At this point, and at this price, Tandem is an investment in two developments: 1) A cyclical recovery in the computer business, like all the others; and, 2) financial strength.

Tandem has $109 million in cash and practically no debt. At least $80 million is not needed as far as we can see. We think Tandem should be buying its own stock at these prices. Whether such a sensible idea has occurred to them or not we can't say, but sooner or later this thinking could develop. In the alternative, the company could do something constructive with the cash.

The Quarter

Revenues were slightly up year-over-year but sequentially down - not a typical computer company pattern for the June quarter. With SG&A up $7.5 million and revenues down $2 million sequentially, it is not surprising that a minuscule operating profit was reported. Only with a tax credit could reported EPS reach $0.06, versus our expectations of $0.18.

Domestic vs. International

We have no exact figures but the U.S. has been weak and Europe strong. Tandem appears to have had special weakness toward the end of the quarter and some "firm" orders deferred. There was no particular change in the pattern of customers by industry type.

The best part of the quarter was that the new customer count was high. While Tandem no longer releases these figures, we believe it was in the mid-thirties.

Products

A lot of the revenue shortfall was new high-end TXP systems. Presumably this is a big ticket item most affected by budget-restrictions of customers. However, the new low-end EXT is off to a slower than expected start. Its early yet, and it may be Tandem hasn't learned enough yet about a new segment of the market.

Estimates

The fourth fiscal quarter ending September 30 should show some revenue gain and better expense ratios. Our preliminary estimate is that under these conditions the company could earn $0.14 per share (plus or minus). There is no way that we can see last year's $0.29 surmounted. On this basis, our new estimate is $0.70 per share for fiscal 1985, versus our earlier estimate of $0.95.

For the next fiscal year, there are no real yardsticks. On a revenue growth expectation of 16.5% and assuming tight expense controls, we come up with $1.20 per share, which includes a down first fiscal quarter and easy compares thereafter. Pending better evidence, this is what we will open with -- more conservative than our previous $1.45.

The Balance Sheet

On June 30, Tandem had $109 million cash and the likelihood some part of the $150 million receivables would turn into cash soon (revenues in the quarter were only $144 million). Total long and short debt is under $10 million, and cash exceeds all current liabilities. There are no major capital spending plans with excess capacity.

Our hope is that this impressive war chest can be utilized to the benefit of shareholders.

Data

The comparative income statement is shown below.

Third Fiscal Quarter
to June 30

(Data in $mill.)	1985	1984	% Change
Product Revenues	$116.9	$119.1	(1.8)
Service & Other	27.3	22.9	19.2
Total Revenues	114.2	141.9	1.6
Ratios:			
Cost of Rev.	38.9%	48.5%	
R&D	12.5%	9.5%	
SG&A	48.2%	39.7%	
Operating Profit	0.4%	10.1%	
Pretax Income	1.8	15.6	(88.5)
Pretax Margin	1.3%	11.0%	
Income Taxes	(0.6)	6.3	
Effective Tax Rate	credit	40.6%	
Net Income	2.4	9.3	(74.2)
Avg. Shares (mill.)	41.9	41.0	2.2
E.P.S.	$0.06	$0.23	(73.9)

Source: Company reports.

Last Research Abstract on Tandem Computers: May 28, 1985.

(*) DBL makes a market in this security.

Tandem Computers, Inc. - Company Report
DONALDSON, LUFKIN & JENRETTE, INC. - Rooney, T.T.
07-26-85 (RN=508343)

TANDEM COMPUTERS, INC. (TNDM - 16 1/4)(*)

Sharply Lower Third Quarter Causes Reduction in FY 85 Estimates, Strong Hold Recommendation Maintained

	Earnings Per Share			P/E Ratio		
52-Week Range	1984	1985E	1986E	1985E	1986E	Dividend
29-13	$0.81	$0.75	$1.10	21.7	14.8	Nil

Shares outstanding: 41.9 million Market capitalization: $680 million

July 26, 1985
DJIA: 1353.61
SPII: 213.97

Summary
The sharp variability that has characterized Tandem's quarterly results in the past was again evident in June as final numbers came in well below Street estimates. For the quarter, revenues rose to $144.2 million, or only 1.6% over the revenues for the corresponding period a year ago ($141.9 million) and declined 1.6% sequentially. The shortfall and budgeted-for increases in marketing substantially reduced operating profit, which totaled only $540,000. Interest income of $1.3 million and a $550,000 tax credit made reported net income $2.4 million, or $0.06 per share. This per-share figure compares with $0.23 a year ago and $0.16 in the preceding period. Because this quarter was $0.15-0.20 below our estimate and prospects for the fourth quarter are more restrained, we are lowering our FY 1985 estimate to $0.75-0.80 per share from $1.10. On the basis of our outlook for a cyclical pickup in the economy and Tandem's relative valuation, however, we are maintaining our strong hold recommendation on the shares.

Comments:

1. Revenues of $160.2 million were about $12.0 million of our estimate with most of the shortfall attributable to lower-than-projected sales of high-end TXPs and low-end EXTs. Product revenues totaled $116.9 million, down 1.9% from levels of a year ago, and about $15 million short of estimate. Service and support of $27.3 million were up 19.7% from a year ago generally in line.

2. Gross margins were 61.1% compared with 59.3% a year earlier and 60.6% in the previous quarter.

3. R&D at $18.0 million was up 33.4% from the corresponding period in FY 1984 and because of the revenue shortfall totaled 12.5% of revenues. The sequential increase here was only about $0.4 million and again was generally in line.

4. SG&A posted the biggest surge, rising 23.5% year over year and 12.1% sequentially. For the period, SG&A represented an inflated 48.2% of revenues. Contributing to this surge in SG&A were new-product programs and the addition of new marketing personnel. Total employment has increased about 6.3% since the first of the year, with the most of that marketing related.

5. Liquidity further improved in the quarter, with cash rising by $1.3 million to $109.0 million. The driving factor here was a $12.4-million decrease in accounts receivable, which went from 100 days in March to 94 days in June. Inventories rose by $3.3 million principally because of the shipment shortfall; however, at 59 days, it remains well under control. Also noteworthy is that prepaid expenses rose by $20.8 million from March, while payables held even; book value as of June 30 was $9.73 per share.

Clearly, the June quarter has caused the variability issue to re-emerge at Tandem, but we believe that the shares at current levels reflect much of this concern. Furthermore, like most of the minicomputer manufacturers, Tandem's current ills will be quickly remedied by a cyclical pickup in the economy. Longer term, the company must become more competitive in the under-$50,000 price segment, something that may not be an easy task given Tandem's architecture. Despite those issues, we nonetheless recommend that investors hold the shares at current levels. Our FY 1985 estimate is now $0.75-0.80, while FY 1986 is now $1.10.

Table 1
Tandem Computers, Inc.
Consolidated Statement of Income
(Dollars in thousands)

	Third Quarter 6/30			Nine Months 6/30		
	1985	1984	% Change	1985	1984	% Change
Revenues	$144,165	$141,925	+1.6%	$450,307	$379,530	+18.7%
CGS	56,116	57,787	-2.9	175,850	155,469	+13.1
Gross profit	$88,049	$84,138	+4.6%	$274,457	$224,061	+22.5%
R&D	18,027	13,514	+33.4	50,229	37,216	+35.0
SG&A	69,482	56,282	+23.5	191,476	153,619	+24.6
Total	87,509	69,796	+25.4	241,705	190,835	+26.7
Operating profit	$540	$14,342	-96.2%	$32,752	$33,226	+1.4%
Interest, net	1,298	1,243	+4.4	4,759	3,461	+37.5
Pretax profit	$1,838	$15,585	-88.2%	$37,511	$36,687	+2.2%
Taxes	(550)	6,335	NM	14,254	15,409	-7.5
Net profit	$2,388	$9,250	-74.2%	$23,257	$21,278	+9.3%
EPS	$0.06	$0.23	-73.9%	$0.56	$0.52	+7.7%
Shares out. (000)	41,896	41,039	+2.1%	41,530	40,919	+1.5%
% Sales						
Gross profit	61.1%	59.3%		60.9%	59.0%	
R&D expense	12.5	9.5		11.2	9.8	
SG&A expense	48.2	39.7		42.5	40.5	
Operating profit	0.4	10.1		7.3	8.8	
Pretax profit	1.3	11.0		8.3	9.7	
Tax rate	NM	40.7		38.0	42.0	
Net profit	1.7	6.5		5.2	5.6	

(*) DONALDSON, LUFKIN & JENRETTE SECURITIES CORPORATION MAKES A MARKET IN THIS SECURITY AND HAS PERIODIC POSITIONS IN THIS SECURITY IN CONNECTION WITH THIS ACTIVITY.

COMPUTERWORLD AUG. 12, 1985 p. 77

FILE

Tandem workstations, controller, emulator out

CUPERTINO, Calif. — Tandem Computers, Inc. announced two color workstations, a cluster controller and an enhanced version of its IBM 3270 emulator for the company's line of fault-tolerant transaction processing systems.

The Dynamite workstations can operate either as system terminals or as standalone microcomputers using Microsoft, Corp.'s MS-DOS operating system. Both models support a dual-mode monitor that can display both text and graphics data simultaneously. An optional bit-mapped graphics card can support three screen resolutions; a 300- by 320-pixel format, a medium resolution of 640 by 200 pixels and an 800- by 300-pixel resolution for graphics applications. The terminals feature all the standard features of other Dynamite series terminals, the company said.

The Dynamite 6548 workstation comes with dual-360K-byte floppy disk drives, and the Dynamite 6549 comes with one 360K-floppy disk drive and a 10M-byte hard disk drive. Both models come with 14-in. screens, 256K bytes of random-access memory expandable to 640K bytes and the ability to run Tandem 6530 series terminal software. The Dynamite 6548 workstation costs $3,790 and the 6549 costs $4,790. Existing users of Dynamite workstations can upgrade their units to support color monitors for $995. The optional graphics board costs $575, according to the company.

Tandem also announced the 6600 cluster controller. The unit allows clustering of terminals, which is said to reduce communications costs. The 6600 controls communications between a Tandem host processor and up to eight terminals, workstations or IBM Personal Computers and one printer. The unit can support any combination of Tandem 6530 series terminals or Dynamite series workstations, IBM Personal Computers or compatible microcomputers. The 6600 costs $3,450 for a four-port configuration. An eight-port version costs $4,250, the company said. The company also enhanced its EM3270 emula-

See **UNITS** page 85

UNITS from page 77

tion package. The enhancement allows Tandem users to access, from a single terminal, 3270 applications from up to six IBM host processors via IBM's Systems Network Architecture (SNA) or binary synchronous protocols. Users of Tandem 6530 series terminals, Dynamite 6540 series workstations or IBM Personal Computers can run IBM 3270 and Tandem applications at the same time. Those users can also alternate between IBM SNA and binary synchronous host processors through the use of menus. The enhanced emulator has a license fee of $500 for new licenses; however it is a no-charge upgrade for current users of Tandem's 3270 emulation package.

All four products are available immediately.

Tandem is located at 19333 Vallco Pkwy., Cupertino, Calif. 95014.

AUG/SEPT. 2/1985

Data Communications

When the shoe's on the vendor's foot: A look at Tandem's corporate network

How multiprocessor nodes can become more sociable

Kent Madsen and David Foley, Tandem Computers Inc., Sunnyvale, Calif.

When the shoe's on the vendor's foot: A look at Tandem's corporate network

When a computer vendor sets up an internal network using its own products, outsiders may see what the machines can really do.

As part of an ambitious internal communications and information management strategy, Tandem Computers Inc. has used its own hardware and software products to build a vast corporate network. The data communications web contains 200 nodes and spans 18 countries. Users in such countries as Japan and Australia are tied to sites in the United States, Canada, and Mexico, as are offices in the major commercial centers of Europe.

Over a hundred different applications run over the in-house network. Perhaps the most important of these is electronic mail. Roughly 70,000 messages are originated, and 250,000 are delivered each week to and from users throughout the world.

The widely used electronic mail is joined by a number of more specialized applications. For instance, the company's various manufacturing groups maintain their records in a distributed database. A battery of financial packages is available to network users, including tools for order entry, invoicing, credit and collections, and budgeting. A network-based program is also available to process requests for product enhancements and to track the actions taken in response.

In addition to the applications, many databases and information resources are accessed via the network by domestic and international Tandem workers. A "public" database, accessible by anyone in the company, contains information on employee office locations, office telephone numbers, department affiliations, facsimile and mail drops, and so on. Customer lists, notes about software, and other marketing information are listed in a customer-reference database.

An innovative archive of technical information has been compiled primarily from electronic mail exchanges. Another database, set up as an electronic bulletin board, provides a central source of support information. Field salespeople, responding to requests for proposals, make use of a constantly expanding collection of proposal text files.

Resources like these have become indispensable to nearly all Tandem employees. Since data communications is so important to the way the company does business, developing and maintaining the corporate network has become a leading concern.

Topology

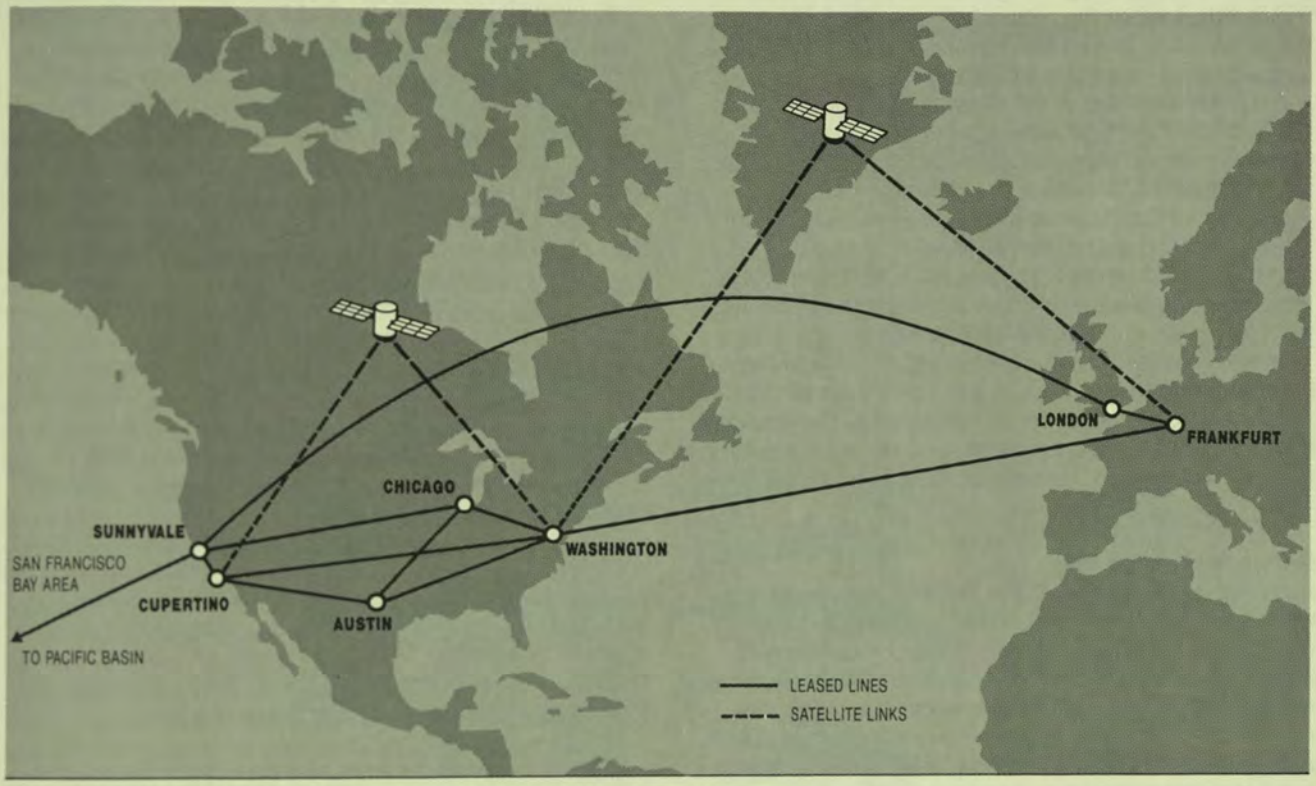
Management has insisted that the corporate network be built using standard Tandem products. Thus, each node consists of a multiple-processor computer in the NonStop line. Standard Tandem communications software and hardware are used, and databases are managed by standard Tandem products as well.

Of the 200 computers in the corporate network, 193 support applications and databases. These application nodes exist primarily to meet local word- and data-processing needs. However, they do handle communications for local users and applications, and they accept passenger traffic from other nodes.

The application nodes are built around seven "backbone" nodes that are dedicated to communications (Fig. 1). These nodes are linked by leased high-speed lines and, in several instances, by high-bandwidth satellite or microwave links. The backbone nodes have only one job: to be constantly available to move information between application processors. Roughly 1,500 Mbytes of data flow through them each day. There is, in addition, a substantial amount of regional traffic that never reaches the backbone nodes.

Connected directly to the backbone nodes are "Class I" nodes—machines that run accounting, manufacturing, and customer-support applications. These programs must be available if the company is to do

1. Over a billion and a half served. *Tandem branches from Osaka, Singapore, and Sydney to Neufahrn in West Germany can reach each other, as well as programs and data in the United States, via an extensive, internal computer network. The seven backbone nodes handle 1.5 billion bytes of traffic a day.*



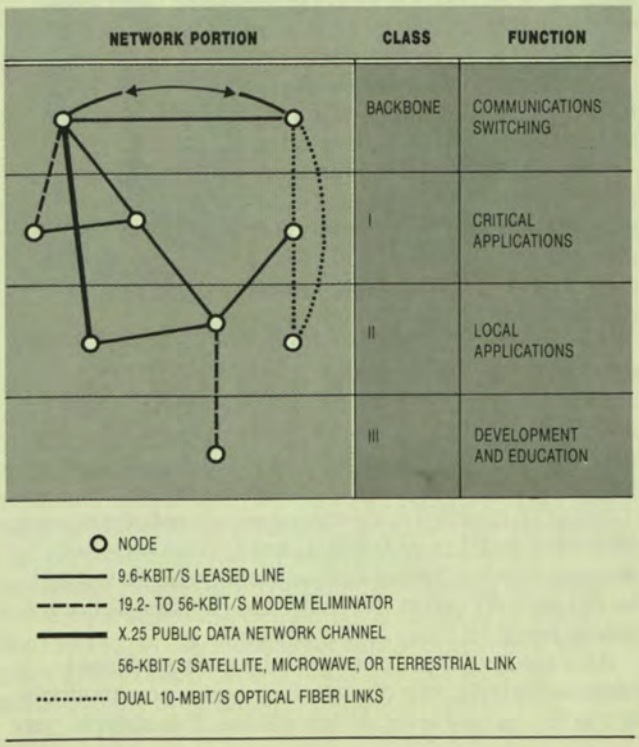
business, and thus the nodes in which they run must always be accessible from a backbone node.

The network's 26 Class I nodes are always linked directly to at least one backbone node and either directly or indirectly (through another Class I or Class II machine) to a second backbone node (Fig. 2). Each machine is thus part of a ring. This dual-path policy has been established to provide uninterrupted network service. It ensures that even if a backbone machine, a communications line, or a modem fails, the Class I node will not be cut off from the network.

Over a hundred network nodes are Class II. They typically serve field sales and service offices, running local applications and less time-critical network applications such as electronic mail. Thus, they need access to the network, but response-time and availability requirements are not as stringent as in the case of Class I nodes. Class II nodes are connected no more than two nodes away from a backbone machine (or a high-speed lightwave cluster, as in Figure 2) whenever possible. They also each have an alternate path to a backbone node—and thus to the rest of the network.

Class III nodes are used primarily for development work or customer education, not for running network applications. They are often intentionally overloaded, brought down, or crashed to debug and test the capabilities of software products and, therefore, are not always connected to the network. They are also used to give customers and internal support people experience in loading machines and handling recovery.

2. Architectural outline. *In this sample layout, all applications nodes except for the development machines have at least two paths to the backbone network.*



When any of the 63 Class III nodes is connected to the network, the connection is either through a ring or a spur composed only of Class III nodes. (A spur is a group of nodes strung along a communications path that is attached to the network at one end.) Thus, no higher-class node ever has to rely on a path through a Class III node for access to the network.

Application nodes of the three classes are usually connected to the backbone nodes (and to one another) via leased lines or satellite links. A microwave scheme from M/A-Com with Coastcom multiplexers joins the two California backbone nodes. Some application nodes, most notably in Mexico, Canada, and Europe, are linked via X.25 circuits. In addition to the node-to-node lines, there are numerous connections from terminals and terminal clusters to nearby nodes.

Tandem believes that, considering the size of the company and the network, it pays very little for communications. Expenses for domestic and international circuits, satellite links, modems, and other communications services are in the neighborhood of $180,000 per month.

Network management

Between 1979 and 1981, the Tandem corporate network grew from zero to about 40 nodes without any centralized management. Individual computers and applications were locally managed, and when local operations people wanted to interconnect their machines, they did so by whatever means seemed appropriate or convenient. Admittedly, this was haphazard, but it met the company's needs at the time.

During this three-year period, the average availability of Class I nodes over the network was low, not because of a problem with the computers themselves, but because no thought had been given to network architecture. At first, the 40 computers had been linked in star fashion to several central machines at corporate headquarters, to facilitate order-processing activities, communications between software developers, and so forth. However, disruptions in the star network could isolate users from resources in the network.

No provision had been made for alternate communications paths. Thus, line and modem failures inevitably isolated at least one node (and sometimes several) from the rest of the network. This also occurred when a node in the middle of a spur was brought down for maintenance or configuration changes.

In response to difficulties of this kind, a small network support group was formed in 1981 to evaluate the situation and address the problems involved in running a large multifunction network. Within four months, the backbone structure was put into place and rings were formed to provide less-interruptible service.

Network-oriented node-management practices were also instituted. For example, Class I nodes were not allowed to leave the network without being scheduled by the support group. Test software required approval before being let loose on the network.

As a result of these changes, the average Class I node availability rose dramatically and is now routinely at the 99 percent level. At first glance, this statistic may be misunderstood. Vendor hype usually includes claims of high availability. The respectability of these claims depends on how the term "availability" is defined. One must examine what underlies this kind of statistic.

To achieve complete availability with a standalone computer during five consecutive 8- or 12-hour business days requires only that the machine run during these days without a hardware failure. Maintenance and reconfiguration can be handled at night or on weekends without affecting the average. But achieving an average network availability of 99 percent running 26 Class I nodes for seven 24-hour days per week (as the network support group has done for almost three years) is far more complicated.

The Class I nodes must be available whenever the applications on them are likely to be accessed. In a domestic operation, this means 12 hours a day, since people work eight-hour business days in each of four time zones. Adding European users, and now users in the Pacific basin (Japan, Hong Kong, New Zealand, Australia, Singapore, and Hawaii), has put an unprecedented demand on the network.

Global demand for network access to Class I nodes imposes several stringent conditions. Maintenance and configuration changes requiring any of the Class I computers to be out of service count against the availability average. Whenever these computers are reconfigured, brought down for software changes, moved, or upgraded, the downtime is noted.

Not only must each Class I application node be available, but also, at least one communications path from each of these nodes to a backbone node is required continuously. This path may include several modems and lines and, on occasion, a Class II node, all of which must be available if the path is to be used. Finally, the backbone network itself must be available virtually all the time, to ensure that the primary and alternate communications paths are usable.

Given the above details, it is easy to appreciate what underlies the 99 percent availability statistic for Class I nodes. Global operations make incredible demands on network components and personnel. Even preventive maintenance is carefully scheduled and carried out.

The division of labor

Application nodes within the Tandem corporate network are locally managed. The applications that make use of the network are likewise developed, maintained, and managed by the groups that use them (manufacturing, capital management, marketing, etc.) or by specially designated organizations within the company.

The network support group is responsible for the backbone machines and related communications equipment. The backbone concept was implemented to separate the basic communications from the applications. This separation has made the nodes that handle the two functions more efficient and manageable. Backbone and application machines are configured differently to optimize the performance of each.

The primary role of network support is to manage the corporate network as a multifunction communications medium. Members of the support group collect data on

network operations, manage the backbone machines, and troubleshoot line problems. They also train operations people at each node to consider the impact of their actions on the network at large.

Group members investigate and make recommendations on new hardware, software, and line services that might enhance the usefulness and responsiveness of the network. They must also plan for and maintain a sensible network architecture. This means treading a fine line between cost-effective implementation and satisfactory availability and response time.

The means to keep growing

Since 1981, the network support group has overseen the growth of the network from 40 to 200 nodes. Yet the group has never consisted of more than six people. The work of this group is simplified by the architecture and operating system of the computers used in the network. Each node consists of a computer designed for "failure tolerance" and expandability.

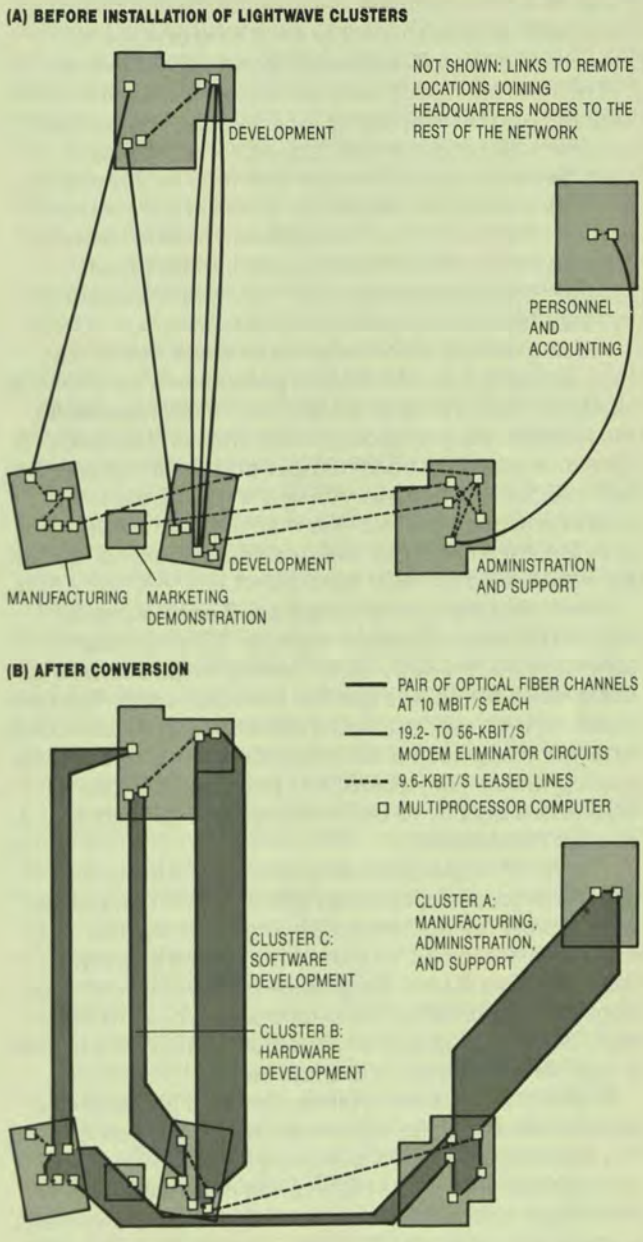
Failure tolerance refers to the ability of these computers to continue to function in the face of any single component failure, including a processor failure, and to the fact that it is possible to repair and reintegrate a failed component without shutting the computer down. This feature is important to the functioning of Class I nodes in Tandem's global network.

Expandability refers to the fact that a single machine can consist of anywhere from two to 16 cooperating processors. Guardian, the distributed operating system that manages resources for each multiprocessor node, allows the machine to grow through that range without requiring any reprogramming of applications. This means, for example, that operators of a NonStop TXP machine can increase the processing power of the computer from roughly four million instructions per second (MIPS) to 32 MIPS without having to change a single line of code.

Where even more local processing power is required, up to 14 of these computers (for up to 224 processors) can be linked locally in a ring via a Tandem software/hardware product known as the Fiber Optic Extension (FOX). This link is almost as fast as the internal bus that links processors within a single machine. The data transfer that takes place over the link is managed by the same operating system mechanism that handles traffic within a single multiprocessor node (independently of the input/output channels of the processors). As a result, the entire local subnetwork thus created can be used as if it were one large machine with a processing capability of 448 MIPS (14 nodes each with 16 two-MIPS processors).

The reliability and local expansion capability of the computers used in the Tandem corporate network make the network far easier to manage than it would otherwise be. As explained above, the operating system running in the local machine has the ability to make multiple processors appear to users and programmers as a single unified resource. In a network setting, this operating system also has the ability to blur node boundaries. The operating system and associated networking software permit operations people and users to log on to their local machine and do work on remote nodes.

3. Rings of light. *Computers in buildings at company headquarters are being linked into lightwave rings. The portions of the rings within buildings are now complete.*



For example, they can type in successive two- or three-word commands that will start a program on a machine in New York, instruct that program to access a file in a disk volume in Atlanta, and print out the results for another employee on a device attached to a computer in Chicago. The command syntax by which these operations are carried out is identical to those that would be used locally for similar operations, except that, in each case, a node specifier must be added to the program, file, or device name.

Five of the seven backbone nodes in the corporate

network are managed remotely from control points in Cupertino, Calif., and Frankfurt, West Germany. If, in the course of routine monitoring (or as a result of a telephone call from users), network support people detect a noisy line that is causing delays and timeouts, they can run tests to identify what kind of noise is present and then, if necessary, bring down the line.

The networking software will immediately detect this change, update the routing tables in each node, and automatically channel messages over an alternate path. Network support people can then simply call the telephone company personnel to report the problem and let them fix it. When the problem is fixed, network support brings the line back up and, at that point, network software updates the routing tables again to indicate that the old path is available.

Adding a node to the network involves little more than plugging it in. The local organization finds physical space for the new machine and sets it up. Meanwhile, the network support group orders the communications lines and assigns a node number and node name to the new machine. When everything is in place, the local operations people attach the machine to the line, activate the line handler with a single command, and let the networking software do the rest.

When the new node is attached, it announces its existence to its immediate neighbor. The neighbor sends the node a copy of its routing tables containing information about all the other network nodes. The new machine then sends greeting messages to those nodes. After receiving such a message, each node updates its routing tables. Only operations people at the nodes connected directly to the new one need to know that a change has occurred.

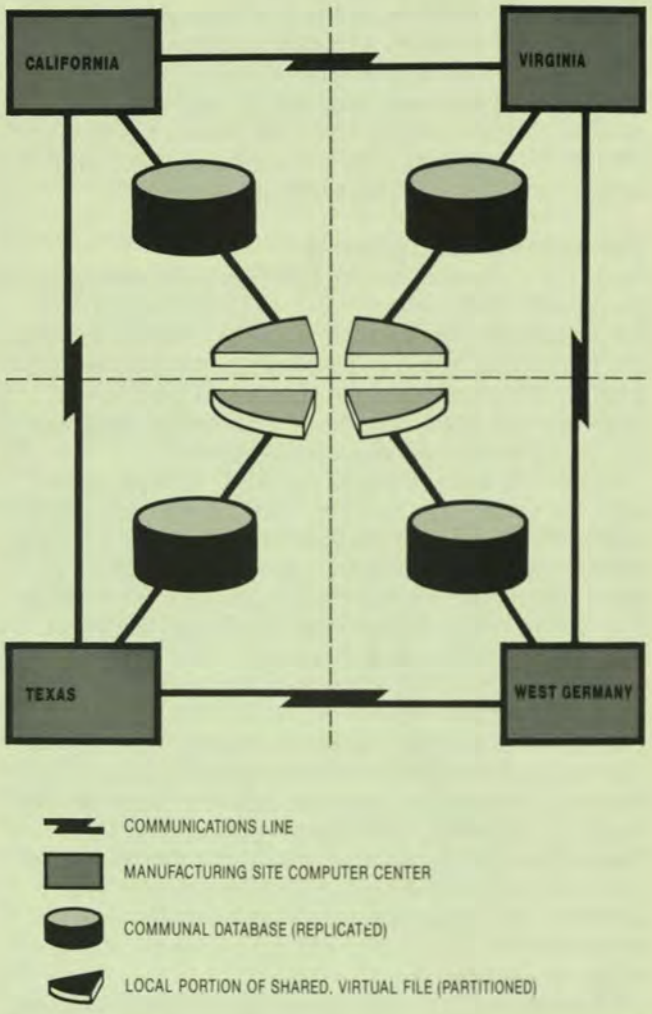
The network support group is currently using the lightwave product described above to link computers at company headquarters into rings (Fig. 3). The machines are joined by 9.6-kbit/s leased lines, with modems from Codex Corp. and Halcyon Communications Inc. Intrabuilding connections are 19.2- to 56-kbit/s RS-449 modem eliminators from Compre Comm Inc. or ARK Electronic Products Inc.

With lightwave links in place, up to 14 nodes will be able to communicate with each other almost as fast as the multiple processors within a given node. The link joining machines into a high-speed cluster consists of four fibers, two each for transmit and receive channels, configured in a ring at 10 Mbit/s per fiber.

Implementing the headquarters' architecture shown in Figure 3 will reduce the processing overhead associated with networking, since a controller, rather than the machines participating in the ring, will process pass-through traffic. In addition, functional groups of computers and users will be consolidated and certain replicated databases will no longer be needed, since it will be possible to access a database on another node in the ring almost as fast as if the database were locally attached.

Another reason for moving to lightwave technology is its improved reliability. The current architecture provides only two paths from most machines to the network at large, while the lightwave rings yield four paths to each and every node in the cluster. Also, pass-through traffic can continue over a link even if the intermediate nodes are down.

4. Breaking up is hard to do. *In this distributed database, communal data is replicated at each site, and local data is partitioned among the sites.*



A distributed database

Nearly all phases of Tandem's business depend in one way or another on services that the corporate network provides. As mentioned earlier, over a hundred different applications run over the network. Numerous databases and information resources are also available remotely. One sophisticated application developed by and for the manufacturing organization uses the network to maintain a distributed database.

Tandem has manufacturing plants in four locations: California, Texas, Virginia, and West Germany. Each one has a fair degree of local autonomy but similar information needs. Managers and employees at each plant need access to communal data, such as the company's comprehensive parts catalog and bills-of-materials (lists of parts that go into specific assemblies and finished products). For their own shops, they must

keep a close eye on local information. This includes production schedules, materials requirements, purchasing of parts, receiving, inventory, interplant materials transfers, and work-in-process.

Originally, manufacturing information of this kind was maintained in separate databases at each site. This was good for autonomy because local information was under local control and communal information was always available, even when communications lines or distant computers were down. However, it also meant that communal data (such as the parts catalog and bills-of-materials) was often inconsistent from site to site. Monthly, there were typically 4,500 updates to the bills-of-materials files and 1,000 to the parts catalog. Thus, the copies of these files used at the various sites had to be updated and reconciled once a week.

Anticipated growth in the number of manufacturing sites was bound to increase the need for local autonomy. As each site's functions became increasingly specialized, so did its data requirements. At the same time, growth would aggravate the problem of consistency. Sites would need better ways to keep each other current and to share resources. Anticipating this, manufacturing information planners decided to use the network to provide an integrated, distributed resource.

The application they created distributes data across the network in two ways, as shown in Figure 4. Communal data, which is used heavily at each site, is replicated so that all manufacturing sites have ready access to it. Local data, which consists of records of interest only to users on particular nodes is stored at those nodes. The files containing those records are partitioned across the network.

Reads and updates of local data are easy because the information is on the local node and because there is no need to inform any other node of changes. Reads are also easy with replicated data, because the files are available on the local node. Updates of replicated data are more complex, however, because the local update cannot be considered complete until copies at all other remote manufacturing sites have been updated as well.

The designers of the application had a choice of how to handle these remote updates. One strategy would be to include the updates as part of the local transaction and not consider that transaction complete until the relevant records on all remote manufacturing nodes had been successfully updated. This would have a substantial negative impact on response time for the user requesting the local update, whose terminal or process would be suspended until update requests traveled to, and were completed by, all other nodes. It would also mean that if, for some reason, one of the remote nodes were inaccessible, the transaction could not be successfully completed, even on the local node.

Another approach would be to let the local software incorporate some kind of independent delivery mechanism. This mechanism would take responsibility for updating communal data on remote nodes as soon as possible after the local update transaction had been completed. The "asynchronous delivery" approach would mean that replicated files would be inconsistent for brief periods of time, until the independent delivery mechanism completed its work. It would also introduce the possibility of concurrent (and inconsistent) updates of the same replicated record by different nodes.

The developers decided to sacrifice absolute consistency of the replicated files at every moment in exchange for site autonomy and short terminal response times. To prevent conflicting updates to replicated data, they granted "ownership" of specific records to specific nodes and wrote the application in such a way that only the owner node could update a particular record. To prevent conflicting additions to replicated files, they pre-assigned various key ranges to certain sites and limited the additions to those ranges.

A customized delivery mechanism for delivery independent of the user was also developed. In it, each request to change a global record is put on a queue. This queue is emptied over a period of time by a software module that scrolls through the requests trying to update the remote databases. The module is programmed to perform the updates in the order in which they are received, preventing conflict.

The distributed manufacturing application was one of the first such programs to make extensive use of the network. It was implemented via standard Tandem products including a relational database manager and a terminal control program. If it were being developed today, there would be no need for the request queue or the customized delivery module, because a standard product now provides a reliable asynchronous delivery mechanism. This mechanism, known as Transfer, was developed to meet the future needs of distributed applications and interconnections between them.

The delivery mechanism consists of high-level (transport layer) software that gets information to people, devices, and processes in a specified time frame. Earlier approaches to network messaging (built into the operating system) were designed for interactive exchanges and could not be used unless the two communicating entities were available at the same time. If a particular node was not available, the user (or program) took responsibility for trying again at a later time.

The new software was designed to overcome this limitation. It attempts to deliver messages as soon as possible or within a specified time frame. If unsuccessful on the first try, it takes responsibility for periodic retry attempts thereafter. Delivery of the message or information package once and exactly once is guaranteed. If line failures, node failures, or disk controller failures make delivery impossible within the time period specified, the delivery mechanism notifies the requester of that fact.

Supporting support

Sales and service offices exchange information with hardware and software support centers by means of a product-reporting application. This network-based program provides a way for a field analyst (or, indirectly, a customer) to report a perceived engineering defect or bug, to request an enhancement to a product, or to ask a question concerning a product.

Field personnel enter product reports on software screens generated by the reporting application. Once a

product report has been entered, the application forwards the report over the network to the appropriate support person. (If no support destination is specified on the report, an administrator decides where the report should go and forwards it.)

Although a report can be sent from any node to any other node (where both nodes have the application), it is normally sent from a field sales and service office to one of several regional technical support groups. In some cases, the regional group will be able to supply an answer and will simply return the report to the originating node. In other cases, the regional group will send the report to the corporate technical group, which will then either answer it or forward it again to the appropriate software or hardware development group.

Whenever a report gets forwarded, the application uses its electronic-mail interface to send a message to the report's originator. This keeps the person with the problem abreast of who is working on it. In such cases, the application also generates a mail message to the analyst to whom the report has been referred, as a reminder that someone is waiting for an answer.

Regardless of the exact path of a particular report, when a response is complete, the report is "returned to the field." All information pertaining to the problem is automatically collected and sent to the originating node by the application. To inform everyone concerned how the problem was resolved, and to make it easier to handle like problems in the future, an updated copy of the report (with the response) is automatically sent to all nodes that the report traveled to during its lifetime.

In addition, the application maintains a database on each individual node that contains all reports originated from that node as well as those that have been sent to it from other nodes. Thus, there is a fair amount of replication of the application's data throughout the network, even though each node has only a subset of the entire problem-reporting database. The database is frequently accessed by support personnel to identify outstanding problems that have already been reported, thus eliminating duplication of effort and ensuring faster resolution of problems for all customers.

Help for the business side

The network offers resources aimed at groups besides manufacturing and support. Business functions, from closing sales to processing orders to reporting financial data, have been computerized. Most of these are traditional, centralized applications, but some make extensive use of the network.

Products are built because someone wants to buy them. To help sales representatives sell them, the marketing department maintains a customer-reference database. Field salespeople who learn how customers or software houses use their products can submit that information to the database. Their colleagues can then view the data over the network and generate reports by industry, by application, or by product.

In this way, sales representatives can identify existing customers who might be able to help future ones. The customer-reference database is also a source of ideas on what to propose to prospective purchasers. And finally, a complementary-products listing provides a catalog of software packages available in the marketplace that can strengthen a representative's offerings.

Salespeople worldwide must often respond to "requests for proposals" because these requests usually present substantial opportunities. To eliminate the need to reinvent the wheel each time a proposal must be written, a headquarters proposal-assistance team maintains text files, accessible over the network. While they do not eliminate the need for writing and analysis by field sales, the text files substantially reduce the time it takes to prepare a customized proposal.

Once a sale has been made, it must be accounted for and the order administered. Contracts are sent to a sales administrator who verifies them and enters them into a marketing support application. The application sends an "electronic packing slip" to a manufacturing group. The message tells manufacturing to build and ship the order.

When the ordered equipment is shipped, a manufacturing person logs on to the marketing application and marks the order complete. (Order status is reflected in daily reports that are sent by the application to regional sales and service offices over the network.) The application then sends a message to an accounting and invoicing routine, telling it to bill the customer.

The accounting and invoicing application is tied to a database of ledgers, which it updates when bills are sent or payment received. It supplies sales reports to management people and answers their queries. It uses the network to broadcast reports to field offices and to tell accountants at the manufacturing site when a piece of equipment has been booked as a revenue item.

The budget model is another financial application that runs on the network. This tool is used by every organizational unit within Tandem in preparing capital asset and operating budgets for the coming year. Managers enter basic salary, hiring, and expense data on specially formatted screens, and the model calculates monthly, quarterly, and annual totals and generates reports that are used in evaluating spending plans

The budget model provides software that rolls, or merges, the budgets of various groups together automatically and generates an overall budget for larger organizational units. The results of local calculations can be forwarded over the network to headquarters where they are used in forecasting cash requirements and ensuring that a reasonable level of profitability is achieved by the company. ■

This is the first in a two-part series on Tandem's internal network operations. The second part will focus on electronic mail, the company's most widely used application, and take a closer look at network hardware and software.

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How multiprocessor nodes can become more sociable

This month's continuing look at Tandem's corporate network and its nodes shows a company increasingly dependent on distributed network applications like electronic mail.

At Tandem Computers Inc., electronic mail began as an ad hoc program allowing employees to send messages through existing machines used primarily for development, marketing, manufacturing, and order processing. However, today it is the most heavily used application in a worldwide internal network, and its importance is growing. During a recent 18-month period, network traffic doubled, but mail volume tripled.

Through electronic mail, Tandem salespeople from Singapore to Stockholm now collaborate and share information on a daily basis. Analysts from Montreal to Melbourne help each other respond to customer problems and to queries from prospects. Hardware repair personnel at distant sites communicate with manufacturing workers to resolve customer equipment problems. Managers at all levels use the network to keep in touch with employees and colleagues throughout the world. Moreover, electronic mail helps employees establish and maintain personal relationships across geographic or organizational boundaries. Thus, it contributes to a sense of community and teamwork.

One way of understanding the impact of electronic mail on the organization as a whole is to follow a fictitious employee through a typical day, noting how extensively this corporate resource is used. John is the manager of a technical support group of 40 or 50 people affiliated with the headquarters' marketing organization. The first thing he does when he arrives at the office in the morning is to log on to the local computer to scan his electronic mail, that is, to view a list of all messages in his electronic in-box.

Each item in the list of incoming mail gives the sender's name, the message type (original, forward, reply, and so on), and a subject line. Having scanned his mail, John can then select the most important messages to read first. Currently, there are four messages waiting. The first invites him to a strategy meeting that morning with the software development group. Another message contains minutes of a meeting he attended last week. John responds immediately to the invitation and files the minutes of last week's meeting (on disk) in electronic folders bearing names that he has specified.

John's third memo is a request from the vice president of marketing asking him to provide people to help with a design review for a large customer's application. John uses the electronic-mail editor to compose a short addendum and to add an enclosure to the vice president's request, providing more specific instructions. John then forwards the whole package to a subordinate, who will follow through for him.

He notices among his messages a request from a technical analyst in Australia for performance information on a new hardware product. John doesn't have the performance information needed, but he knows of someone at the performance research center in Germany who might. He forwards the message there and replies to the analyst in Australia, indicating what he has done, then heads out the door for his meeting.

All of this has been accomplished in less than five minutes. The messages John has sent are delivered almost immediately (or within the time frame he has specified). Thus, problems can be resolved and answers obtained very quickly, and John can be responsive without carrying details around in his head all day (or all week).

After returning from his strategy meeting, John again reviews his in-box. This keeps him in touch with people and problems from hour to hour, without being interrupted and without interrupting others. He typically checks his mail each time he finishes one of the day's

major projects (a meeting, an interview, a lunch engagement, or a trip to the corporate library).

By using the in-house electronic mail, John avoids the frustration and inefficiency of "telephone tag" and cuts down on his long-distance telephone costs. He can leave lengthy messages on complex technical topics for someone who may not be available at the moment, and be assured that the message will not be garbled by an intermediary. In addition, John uses electronic mail to communicate easily with people on the other side of the world, whose business day may not overlap his own at all.

Letting digits do the walking . . .

John (and every other employee) is identified by a correspondent name. Electronic mail includes a way to look up the correspondent names of people on local and remote nodes. These names are listed in a directory application of the "public database," which contains such information as employee office locations, telephone numbers, correspondent names, and department affiliations.

It is easier to look up the correspondent name via computer than it is to find a number in a conventional telephone directory, because the computer does the searching. The correspondent database is updated weekly to incorporate all new hires, internal transfers, changes of address, and changes of status. With a query program, John searches the database for correspondent names by office location, node location, surname, or partial spelling of the surname.

John uses electronic mail to broadcast messages to large numbers of people via distribution lists. For example, when he wants to call a group meeting, he invokes a mailing list containing the correspondent names of everyone in his group. When he wants to announce some change in support policies, he invokes a much larger distribution list to send a message to everyone in the company. Thus, it is no more difficult to address many than it is to communicate with a few—or with one.

. . . and putting heads together

An interesting and well-used offshoot of electronic mail is an archive of technical information. Much of the mail that comes across the network is in the form of technical queries, broadcast to all employees. Workers send such queries when they need information on competitors, product performance, how to link particular devices, and so on. Answers are not hard to come by. Chances are that, out of the 5,200 Tandem employees who receive these messages, at least one will have the required experience or information.

At first, broadcast technical queries typically provoked dozens of secondary queries from people wanting to know what the original questioner had learned. To avoid having to answer these secondary queries individually, authors of technical query messages began to adopt the practice of identifying a file (accessible over the network) in which any replies would be stored. This allowed other interested parties to benefit from the exchange simply by accessing the reply file a day or two after the initial query was sent out.

The whole process has now been taken one step further. An administrative employee systematically reads and files (on disk) all technical queries related to a particular topic. After a week or so, the employee copies all the reply fields to a central node, stores them on disk (with the relevant query), and adds appropriate entries to a subject index.

This centralized repository, referred to as the "archive," is equipped with search software to facilitate information retrieval. Many employees may not be interested in particular informal exchanges of information at the time they occur. However, they can locate and access a stored record of these discussions whenever the need arises. The archive virtually eliminates the need for duplicate queries and provides an extremely valuable information resource, reachable from any network node.

There is a vast reservoir of information and insight within the organization itself, many times larger and more valuable than most formal, structured databases. The combined on-the-job experience of the 5,200 Tandem employees probably exceeds 30,000 years, and their combined college and university experience may amount to 20,000 years or more. Electronic mail and the archive allow people to share insights easily and store them for the use of others. These tools are instrumental in tapping a wealth of information and human experience.

Electronic mail helps to preserve small-company interpersonal communications in the face of rapid growth. It also gives employees easy access to information resources within the company, regardless of where those resources may be. The archive and the electronic-mail network eliminate much duplication of effort and energy.

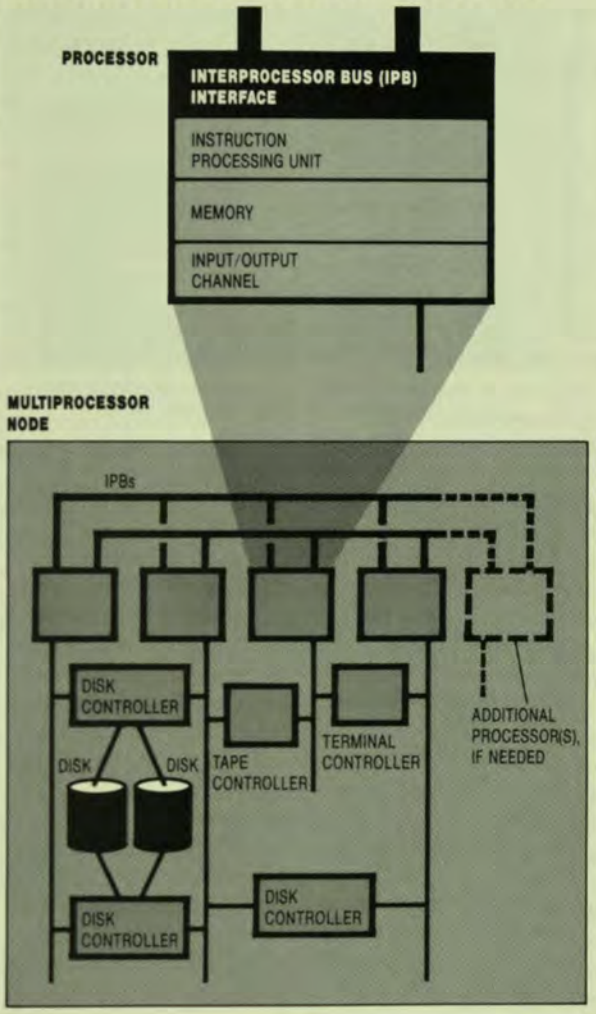
Overcoming hardware failures

While other applications are growing in use, electronic mail has become the lifeblood of the company's operations. It succeeds basically because users have come to trust the network to deliver their messages. This trust can be credited to one fundamental design principle, which underlies the network architecture and the hardware and software architecture at each node. The principle is that of "fault tolerance."

A fault-tolerant computer is one that can ensure continuous operation and data integrity in the face of any single component's failure. In addition, it must allow hardware service personnel to replace components and activate them without shutting the machine down. Such performance is crucial to computers in a network as large as Tandem's because the more computers there are, the more likely it is that a disabling failure will occur somewhere in the network.

A hypothetical computer running 24 hours a day and capable of offering 99 percent availability might have a mean time between failures of about two weeks. A two-node network composed of such machines would therefore average one failed node a week. With 200 nodes, a network would experience a node failure about every two hours. If we assume that communica-

1. Hardware. *Each node contains several processors (at least two) that communicate with a high-speed bus and dual-ported device controllers.*



tions lines go down as frequently as nodes and that the mean time to repair a line or a node is three or four hours, it is likely that a network that large would never be completely operational. Clearly, much higher standards of machine availability are required for large networks.

The overall availability of Tandem's corporate network rests on the continued functioning of its constituent hardware, as shown in Figure 1. Each node (including the backbone nodes) contains multiple processors linked by dual high-speed buses. Any one of these interprocessor buses (IPBs) can carry traffic at up to 13 Mbyte/s.

Each processor has its own IPB interface, instruction processing unit, memory, and input/output (I/O) channel (as well as its own power supply). However, the Guardian operating system distributed over these processors makes them appear to local or remote users as a single computer. It also allows them to cooperate with one another in processing individual transactions, to share the work load equitably, and to back one another up in the event of a failure.

The IPB uses a multiplexed, packet-interleaved protocol for high-speed interprocessor communications at the local node with a minimum of CPU interruption. However, it would be a mistake to view it as an ordinary communications link. From a logical standpoint, it is more like an internal bus in a conventional computer, since it ties cooperating elements of the local machine together and makes them appear as one.

As Figure 1 shows, designing for fault tolerance meant using multiple hardware components within a single computer. It also implied that techniques would have to be found for detecting failures, disabling problem components, and allowing for their repair and replacement without bringing down the rest of the computer.

Accordingly, hardware and software designers devised rigorous internal consistency checks for each processor. They believed that it was important to detect problems rapidly and halt a failed processor before it had a chance to contaminate data or disrupt the operations of the other processors. In keeping with this philosophy, if a processor finds that it cannot pass its own internal consistency checks, it will simply halt itself, allowing another processor to take over control of its peripheral devices.

If, by some fluke, a processor with a problem manages to pass its own internal checks anyway, there is yet another mechanism provided by which the processor can be restrained. Designers of the operating system decided that, once every second, each processor within a given node would send status messages over the IPB to all others indicating that it is alive and well. Also, every two seconds, each processor would check to make sure that it had received such a message from all the others.

When operational processors detect that one of the others is not following this established protocol, they can effectively quarantine the offender by declaring it "down." Control of its peripheral devices is then transferred automatically to the backup processor. In addition, backup applications program modules running in the other processors are activated to take over the work formerly assigned to the failed processor. When a processor is declared down in this manner, one of the other processors will also take corrective action to clean up any outstanding messages.

To allow the transfer of control of peripheral devices, hardware designers built dual-ported device controllers that can be connected to the I/O channels of two different processors. The controller is owned by only one processor at a time. However, if there is a problem either with the owning processor or with its I/O channel, operating system procedures switch ownership of the device and controller to the other processor (and its I/O channel). In this way, any device can be accessed even if the controlling processor or I/O channel fails. To ensure continuous operation even in the face of disk-controller failures, the disks themselves are dual-ported as well and can be connected to two different controllers, as shown in Figure 1.

The hardware designers also made provisions for the

attachment of "mirrored disks" so that failure of a disk drive or its storage medium does not require that the computer be shut down. Mirrored disks are pairs of physically independent disk drives. Writes are performed on the disks in both drives; reads are taken from whichever disk has the shortest seek time. If one becomes inoperable, processing can continue with reads and updates directed to the healthy disk. When the failed disk is repaired, it can be restored to operation and its contents brought to a recent, consistent state. Then all updates performed on the other disk in the interim are transferred to it automatically.

Clearly, fault tolerance could not be achieved without the duplication of hardware components within a single computer. However, software runs on the hardware, and, therefore, if one processor is to take over for another, software components must be duplicated as well. This is accomplished through the use of "process pairs." (A process is a program module running in a particular processor.)

The operating system allows a "primary" process running in one processor to send periodic checkpoint messages to a "backup" process running in another processor. Checkpoint messages, usually sent before the primary process performs a critical task, such as I/O or updating a database, contain all the information that the backup process would need to take over for the primary one in the event of a processor crash.

If a processor goes down, backup processes running in other processors are activated so that they can continue the activities of the primary processes that were running in the now-failed processor. Because the backup process does not duplicate the activities of the primary one while the primary is still functional, it places only minimal demands on the processor in which it resides. Thus, processors can host backup processes as well as primary ones and do almost as much useful work as they would if the backup processes were not present.

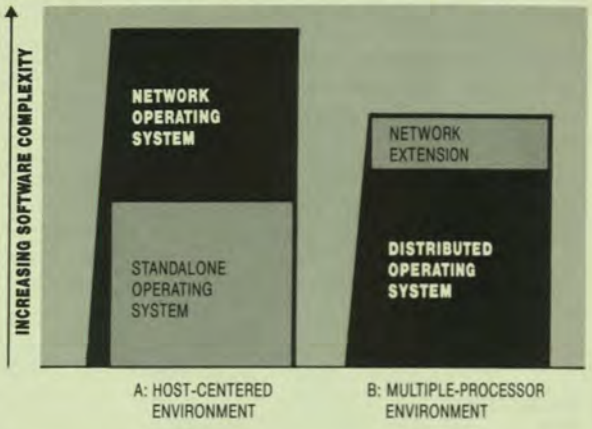
The operating system itself is protected by the implementation of process pairs. Early users of Tandem machines had to program their own primary and backup application processes (and devise effective checkpointing strategies) to get full protection. Now, however, a standard Tandem application development environment obviates the need for user programming of process pairs.

Sociable vs. self-centered computers

Hardware and software reliability are critical in a large network. However, there is an equally important need for machines that communicate and cooperate with their peers. Over the years, Tandem has come to believe that successful networking begins with the design of such "sociable" computers. A number of complex problems, which many people associate with networking itself, actually stem from the architectures of the machines being used as nodes. In most cases, such machines were originally designed with no thought for networking.

The economic need to preserve these architectures has forced many computer vendors to adopt an "add-on" approach to networking (Fig. 2). According to this approach, at each end of the communications line is a computer with an operating system designed for standalone processing. This operating system conditions the computer to think of itself as the main (if not the only) intelligent entity and to view anything attached to it as a peripheral.

2. Overhead of the loner. *To get a typical computer to interact takes a lot more code than if the machine already considers itself a network.*



Layered on top of each node's operating system is a very substantial body of code, which must correct that myopic view. By clever and complex ruses, this "network operating system" overcomes the ingrained reclusiveness and egocentricity of the standalone computer, making it possible for that machine to converse with other computers in a network. Such communications is limited, though, and subject to rigid and somewhat arbitrary constraints, because each computer must be made to believe that it is still only talking to peripherals.

Inherent in this approach is a heavy communications processing burden that falls on the computers themselves (Fig. 2A), stemming from the fact that, in essence, the network operating system has to work against the local operating system. In addition, this approach entails a formidable burden of mounting software complexity. This burden is like an irrevocable tax on every network user, manager, and application, and it has a substantial negative impact on productivity for as long as the network exists.

This complexity increases exponentially as more (and different) computers are added to the network. And even if the linked computers are identical, networking is almost always a strange new world, with remote access procedures and syntax rules vastly different from those used at the local level.

Intranode communications

By contrast, the software that supports Tandem's corporate network does not present a new world to users and programs, but rather functions as an extension of the local environment. In a very real sense, networking is not layered on top of the nodal operating

system, but built into it. No separate network operating system is needed.

Nodes in the corporate network routinely engage in "internal dialogues." Since each computer is, in and of itself, a local network composed of multiple independent processors, a machine's processing consists of conversations between its constituent parts. (Artificial intelligence theorists suggest that people may also think this way.) The same communications mechanisms that the operating system uses to blur processor boundaries on the local level are effective in blurring node boundaries within a network as well. When coupled with basic internode communications protocols, these local mechanisms (built into the operating system) contribute greatly to network operations.

The most important of these mechanisms is a "message manager," upon which the entire local operating system is based. Messages are important in the Tandem computing environment because the operating system itself is not a single monolithic program but a collection of "interrupt handlers" and processes. Each process has particular areas of responsibility and must communicate and cooperate with others (through messages) to get work done. These messages must flow, not only within a single processor, but also among the various processors (none of which shares memory).

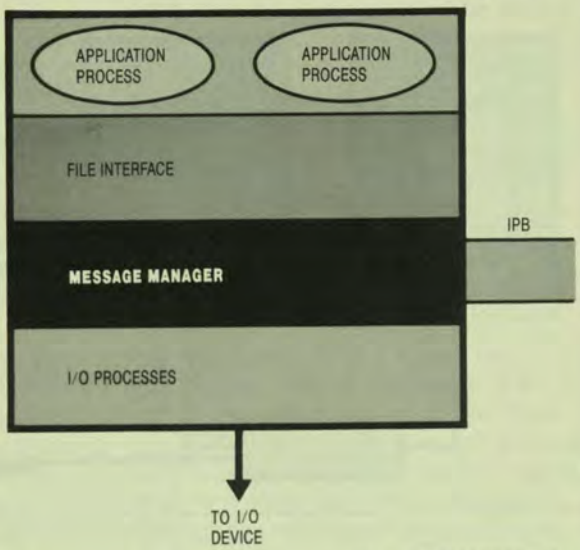
Copies of the most basic operating system processes (such as the "monitor" and the "memory manager") run in every processor. However, some functions, most notably input and output, must be handled by the particular processors to which the I/O devices are physically attached. This posed a problem for the early designers because all the hardware and software entities in a multiprocessor computer needed access to these I/O resources.

To resolve the problem, the designers developed the message manager, which allows a process to communicate with another process anywhere in the local machine simply by providing the destination entity's symbolic name. The message manager takes full responsibility for locating the named process and getting the message to it regardless of where that process may be running. Disks, tape drives, and terminals are all associated with processes. Thus, the message manager provides a way of addressing and accessing such devices from any location at all in the multiprocessor machine.

A message, as defined in the operating system, is bidirectional. It consists of a "request" for service and a "reply." Several such messages may be required to carry out a given operating system function. For example, a monitor process may be asked to create a new process. To do so, it must do some work and then make requests of several other operating system processes to gather the resources needed.

One of the requests would be to a "disk process," asking that space be allocated on disk as virtual memory for the new process. When the disk process has allocated the space, it replies, indicating that the work has been done. (This reply completes the message.) Other requests are made as well, and when the monitor process has seen to it that all of the necessary resources are in place, it replies to the entity that made the request, indicating that the process has been created.

3. Software. *Segmented code allows the operating system to span processors over an IPB and hide details of the hardware from user programs.*



It is easy to underestimate the value and uniqueness of the message manager. There is certainly nothing special about the concept of program modules passing information to one another. That happens all the time in conventional computing environments that lack a formal messaging scheme. Usually, one program module places information at a specified location in memory, and another picks it up. By contrast, the message manager is a general-purpose mechanism for getting a message between any two processes in a multiprocessor machine. It does not assume that communicating program modules will inevitably be running in the same processor or that memory is shared between the processors involved.

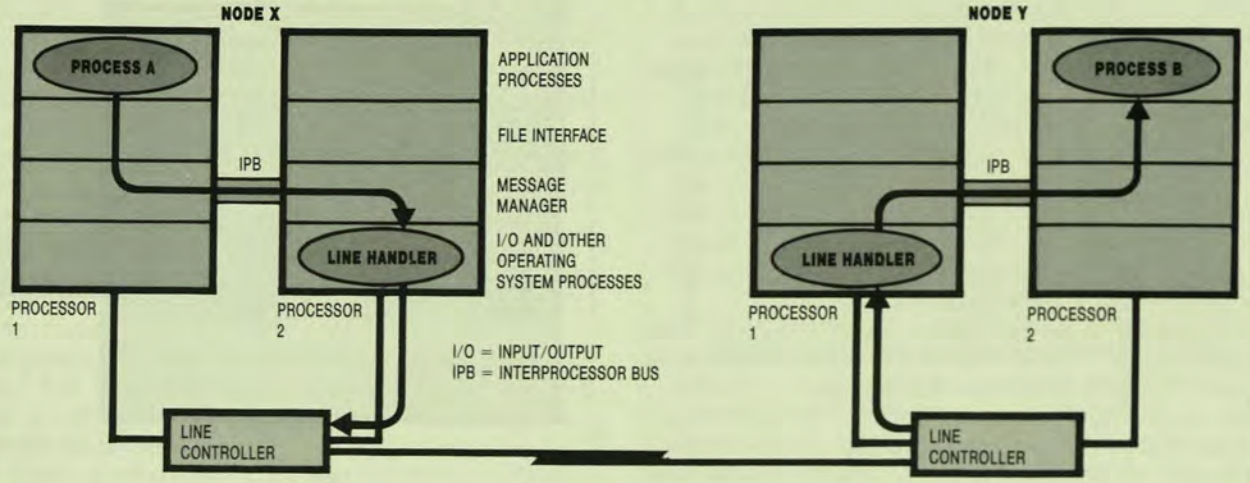
Accessing resources within nodes . . .

Applications processes are not allowed to communicate directly with the message manager or with basic operating system processes. However, the processes can make use of the operating system through a "file interface," which ensures that such interactions do not accidentally create problems for the user or for the machine (Fig. 3).

The file interface works with the message manager to allow application processes to communicate with entities such as other processes, files, and I/O devices, by a single set of calls. That is, such resources can all be referenced by means of pre-assigned symbolic file names. Application processes do not need to know physical locations since the file interface can access operating system tables that keep track of the entities.

To distribute the load over multiple processors (as

4. Network travel. *Application process A need only know the unique network name of process B, and the operating system handles the trip for any request from A. Thus, process A can access remote files, programs, and devices (through processes like B) almost as easily as it can reach local ones.*



well as for other reasons), application programs typically have a structure similar to the operating system in terms of requester and server processes. They also use the message manager's basic request/reply protocol.

For example, an application-type requester process running in one processor might be programmed to control a group of terminals and validate input from them, while an application server, running in another processor, might be programmed to formulate database queries. As a particular transaction is received, the requester validates the initial input and then sends a request to the server (via the file interface) that indicates what work needs to be done. The server process accesses the database (again via the file interface), retrieves the desired information (or updates the appropriate records), and then replies with the requested information or a confirmation that the work has been completed.

. . . and throughout the network

Since the computers that compose the network already consisted of multiple, communicating entities, it was far easier to interconnect them than it would otherwise have been. A group of four or five people spent only about a year developing the required networking software. This software, known as Expand, allows the local file interface and message manager to address and communicate with processes, files, and devices anywhere in a Tandem network.

The networking software consists of line handlers, a proprietary protocol for guaranteed data integrity, and a network control program (NCP). The NCP, which runs at every node, monitors and logs changes in network status.

Routing responsibility is distributed. The NCP maintains a copy of the network routing table (NRT) in each processor. The NRT lists the location of all of the other network nodes. NRTs are used to determine the best path to other nodes and to establish the communications link. (Thus there is no centralized routing that can fail and paralyze the entire network.)

The file interface bridges the network by allowing local processes to access files, processes, and devices anywhere in the network through a single set of calls. The addition of a node specifier to the symbolic name uniquely identifies these resources throughout the network.

Listening in on network dialogue

The networking software is basically an extension of the services provided by the local message manager. Just as the message manager software allows one process to send messages to others within the local machine, its networking extension allows a local process to send messages to other processes running at remote nodes in the network.

As mentioned last month, operations people and other users of the corporate network can, with proper security authorization, log on to a network node in California (or anywhere else) and do work on remote nodes. For example, with successive two- or three-word commands, they can start a program running on a machine in New York, instruct that program to access a file on a disk volume in Atlanta, and print out the results for another employee on a device attached to a computer in Chicago. Also noted was the fact that the command structures by which these operations are carried out are identical to those that would be used locally for similar operations except that, in each case, the program, file, or device name must be further qualified by a node name.

This sequence of events can be used to illustrate how the operating system entities work together. In fact, the different operations were achieved through one mechanism: messages. Process-to-process messages pass first through the local file interface and message manager, next through local and remote line handlers, and finally through the remote message

manager and file interface software layers.

Consider process A running on node X within the corporate network (Fig. 4). If process A (an application process) needs to communicate with a process running at the local node, it gives the message, along with the name of the destination process, to the file interface. The file interface checks the message, makes sure that it is legitimate, consults operating system tables to find out where the destination process is running, and hands the message to the message manager.

The message manager takes responsibility for delivering the message and for returning the reply from the destination process. If the destination process is an operating system process, it replies directly through the message manager. If, on the other hand, it is a user application process, it must use the file interface to pass the reply to the message manager.

When process A wants to communicate with process B located at remote node Y, it proceeds the same way, giving a message and destination process name to the local file interface. However, this time the name consists of the process name appended to a node name (for instance, "nodeY.processB"). The file interface, discerning that this resource is not available locally, accesses the network routing table.

From the information contained in the table, the file interface determines that the message must go through a specific network line handler to reach its destination. It therefore preserves the name of the destination process but tells the message manager to deliver the message to that line handler. (In the event that there are two or more line handlers leading to the remote node, the routing table will indicate which path is best, based on the speed of the communications lines and the number of intervening nodes.)

When it receives the message, the local line handler compresses and packetizes the data and sends it over a communications line to another line handler at node Y. This line handler reassembles and decompresses the data and strips off the node portion of the destination process name. It then hands the message to node Y's message manager, which uses operating system tables to locate process B and present the message to it. Process B does whatever it was instructed to do and then replies. The message manager takes responsibility for seeing to it that the reply retraces the path of the request back to process A.

Through this basic mechanism, a user in California can log on to a local machine and enter a command that will start a program running on a machine in New York (Fig. 5A). First the user accesses a local "command interpreter" process, which reads input from the terminal through a terminal I/O process. In response to this input, the command interpreter (acting as a requester process, analogous to process A in Figure 4) sends a message to an operating system process, the "monitor" (a server, analogous to process B), running in the New York machine. The monitor process starts up the program and replies.

The new program started in New York then requests input from the user terminal in California (by sending a message to the terminal I/O process). In response, the user instructs the program to access a disk file attached to a machine in Atlanta. As shown in Figure 5B, the New York program (now analogous to process A) sends a message to the disk process in Atlanta (analogous to process B). The disk process does the necessary work and replies with the requested information. The program in New York then responds to the California terminal and requests further input.

In response, the user in California instructs the program in New York to print out the results of the disk access on a machine in Chicago. As shown in Figure 5C, the New York program sends a message to a line-printer process in Chicago. The line-printer process sees to it that the information gets printed, and replies.

In all these cases, the destination process does not have to be aware of the origin of requests. From its point of view, the message might just as well have come from a local process. This is because all the destination process has to do is to hand the reply to the message manager (or file interface), which will see that the reply finds its way back to the source process, following essentially the same path as the request.

Because Tandem chose to use standard software products at all nodes in the network, the syntax in the above operations is the same as would be used to perform similar operations locally. The only change needed is that the file, process, or device name would have to be qualified by a node name.

Managing growth and applications

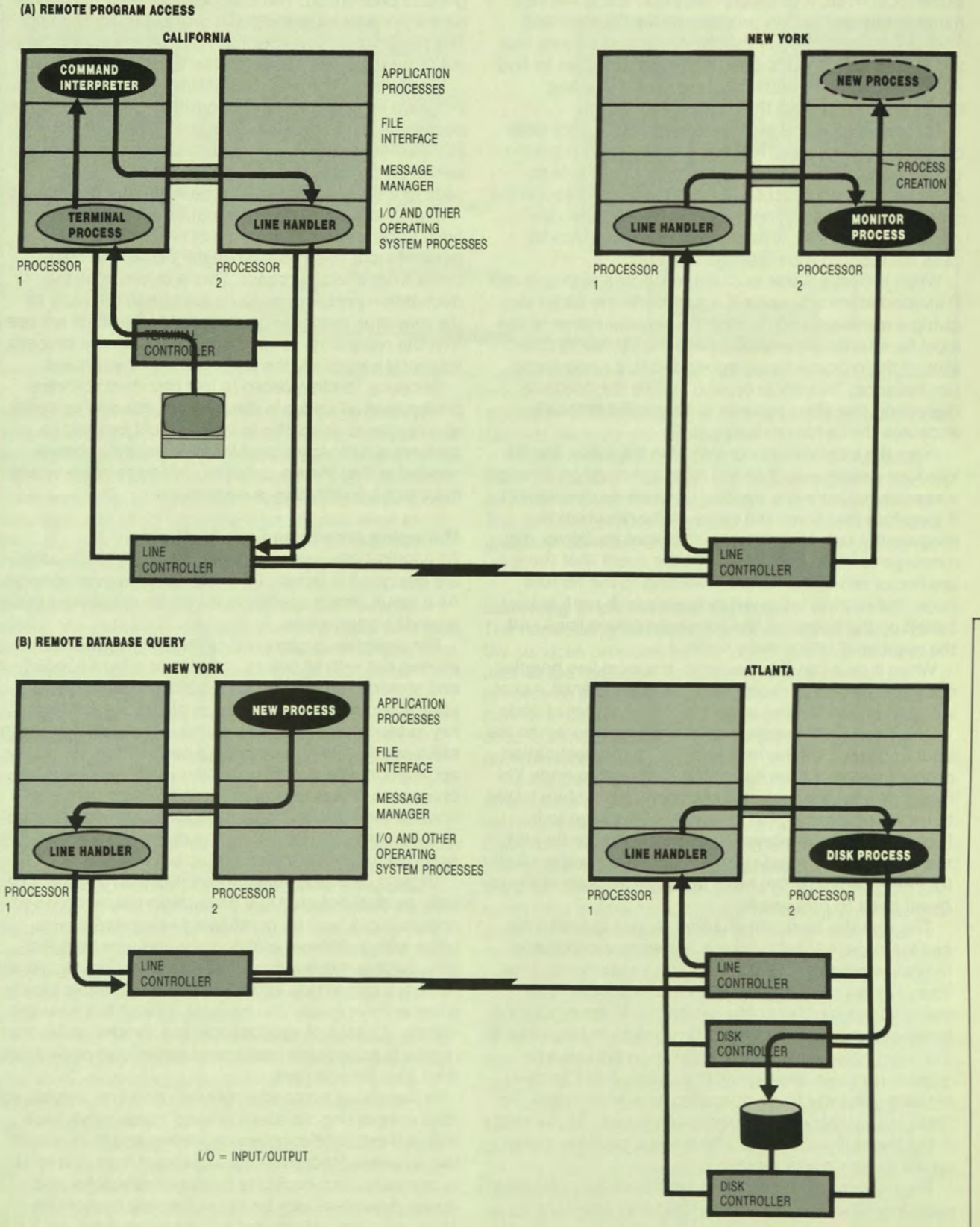
All applications, even those running on a single node, are designed in terms of the requester/server concept. As a result, these applications can be distributed easily when the need arises.

For example, a particular order-entry application started out with all orders called in to a central point and stored on disk. This application became distributed when people in the branch offices were able to key in the information themselves. However, there was still a need to keep a copy on a central disk. Since the application was written using requester and server processes, it was simple to move the requester portions to the regional nodes while the servers remained at the central site to update the database and to return acknowledgments to the requester.

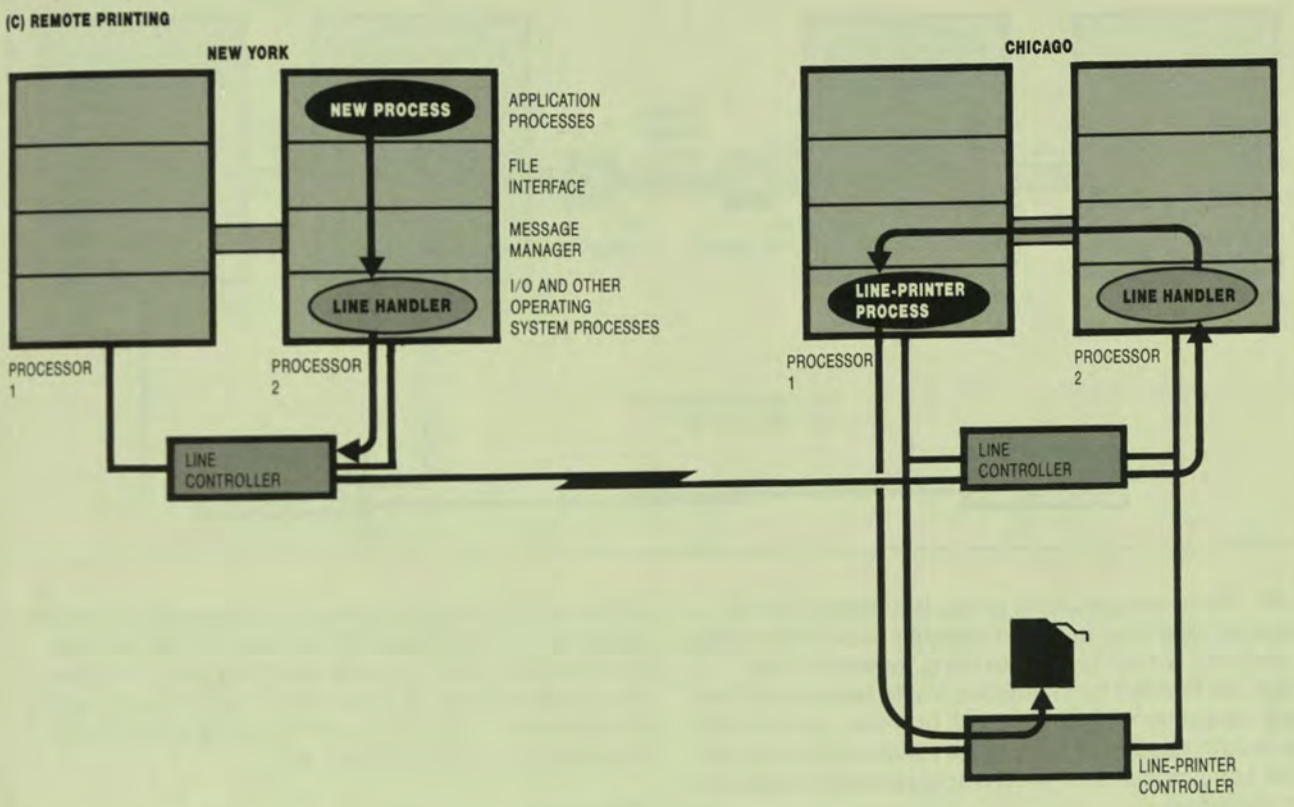
Growth can affect user applications almost as drastically as distribution. Most environments can only add processing power by purchasing a larger machine, often with a different architecture and operating system. Such a move almost inevitably entails a significant software conversion effort. Even if manageable locally, a capacity upgrade can become difficult in a network setting. Dozens of applications and remote nodes that regularly access the newly configured local node must then also be changed.

In Tandem's corporate network, however, increased data processing demands at local nodes have been met without producing waves locally and throughout the network. Nodes can be expanded from two to 16 processors, and duplicate copies of requester and server processes can be run in the new processors. Thus, the applications can handle twice the work load,

5. The network as single virtual machine. *Authorized users can log on to a network node in California (or anywhere else) and, with single commands, start a program on a node in New York (A), instruct that program to read a disk file in Atlanta (B), and have it print the file on a device in Chicago (C). Processes that be-*



gin as or are created by servers (such as the new process in New York) can turn around and make requests of other processes. They can also use the same techniques in communicating with remote nodes. User programs use the file interface, while operating system processes go directly via the message manager.



but programmers do not have to change a single line of code.

The network is remarkably homogeneous. All working nodes have the same architecture and run identical versions of the nodal operating system. Along with the local expandability of each node, this homogeneity greatly facilitates network management from a logical standpoint. It is much easier not having to deal with new operating systems as the network grows. The ability to reuse the same box also means that, physically, remote sites are more readily upgraded. Even at the central computer center, expanding a node is far less disruptive than replacing it.

Expandability also aids in the management of distributed applications. When the use of such applications grows, certain components such as disks, controllers, or CPUs may become bottlenecks. Modules can be added to replicate these components. In the example considered earlier, an order-entry application was replicated to the regional nodes. When a region grows, the requester program can be duplicated and run on a different CPU. The application then doubles its capacity without being rewritten, simply by having another copy of itself spawned.

New processors are often added to overworked nodes to relieve the burden on the existing processors. If several application processes are then moved from their original processors to the new ones to redistribute the load, the application programs do not have to be changed. They will run just as they did under the old configuration except that, overall, response times will be better.

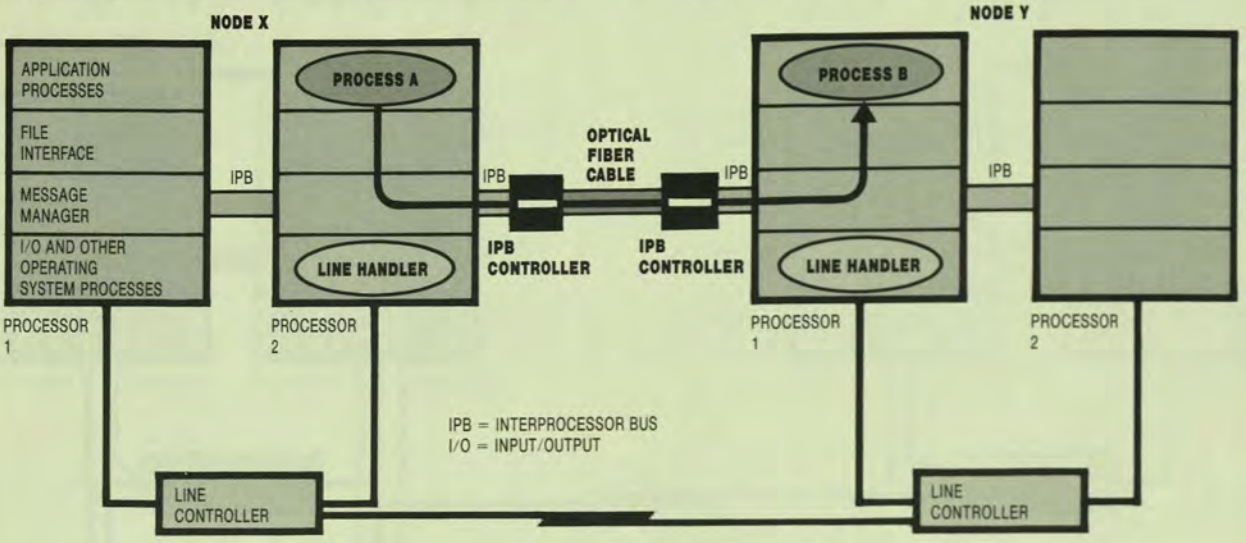
Looking to the future

In any structure as large and multifaceted as the Tandem corporate network, change is a constant. Use of the network's long-haul circuits has grown enormously in the recent past. For example, the bandwidth required on the backbone link between the two U. S. coasts began at 10 kbit/s in the middle of 1982. It doubled the following year. By 1984 it was up to 56 kbit/s, and by the end of this year it will have doubled again. Projections for the fourth quarter of next year show a need for another 56 kbit/s, a full T1 (1.544 Mbit/s) by the end of the decade.

These projections are for the network's data traffic only. The introduction of facsimile transmission capability to the network, which is currently taking place, will undoubtedly increase the rate of growth. Facsimile applications expected soon are a tie-in to electronic mail, store-and-forward facsimile switching, and dialing in or out to distribute and archive facsimile images on disk. The manufacturing division is starting with 40 to 80 pages a day, and the number is expected to increase.

To meet future needs for data transmission band-

6. Lightwave 'telepathy.' *Two nodes joined in a lightwave cluster exchange messages CPU-to-CPU, bypassing the traditional computer "talk-paths" (communications line, line handlers, and controllers). Transfers such as reads, writes, and protocol matters take place at the level of the message manager.*



width, the network support group is making plans to install satellite links between selected backbone nodes. These links will not replace existing terrestrial lines, which are needed for interactive traffic because of their low propagation delay. They will, however, provide the bandwidth needed to carry large volumes of mail and other transmissions for which rapid response times are not important.

Local traffic (particularly at the company's headquarters) is increasing roughly 50 percent faster than long-haul traffic. Clusters of machines linked by the company's lightwave product will therefore play an increasingly important role in the corporate network. Up to 14 computers can be linked in a ring via double-circuit optical fiber. The entire subnetwork thus created may contain up to 224 processors, each capable of processing 4 million instructions per second. The main headquarters subnetwork will initially contain over 100 processors.

A lightwave subnetwork is very much like a single, large, powerful node for two reasons. First of all, the transmission medium offers the speed and bandwidth needed to ensure that response times are essentially the same whether processing tasks involve communications within or between individual computers. Each of the four fibers (two full-duplex circuits) carries data at 10 Mbit/s, for an aggregate data transfer rate of 40 Mbit/s (the theoretical optimum; actual user throughput depends upon the application).

Secondly, the message manager allows users and executing programs to communicate with or access any other executing program, peripheral, or file in the corporate network simply by supplying its name and the relevant node name. As Figure 6 shows, the lightwave ring is designed to transport messages between processes. It sends them directly over the interprocessor bus, without using I/O channels or controllers. Clustering nodes on a lightwave ring takes advantage of higher-speed hardware. This method consumes up to 80 percent less CPU time than does the conventional way of handling data traffic, in which data leaves a node via a line handler. It also provides much faster response times. ■

(This is the second part of a two-part article.)

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The authors gratefully acknowledge substantial contributions to this article by Denis Winn, operating system specialist with Tandem's software education department.

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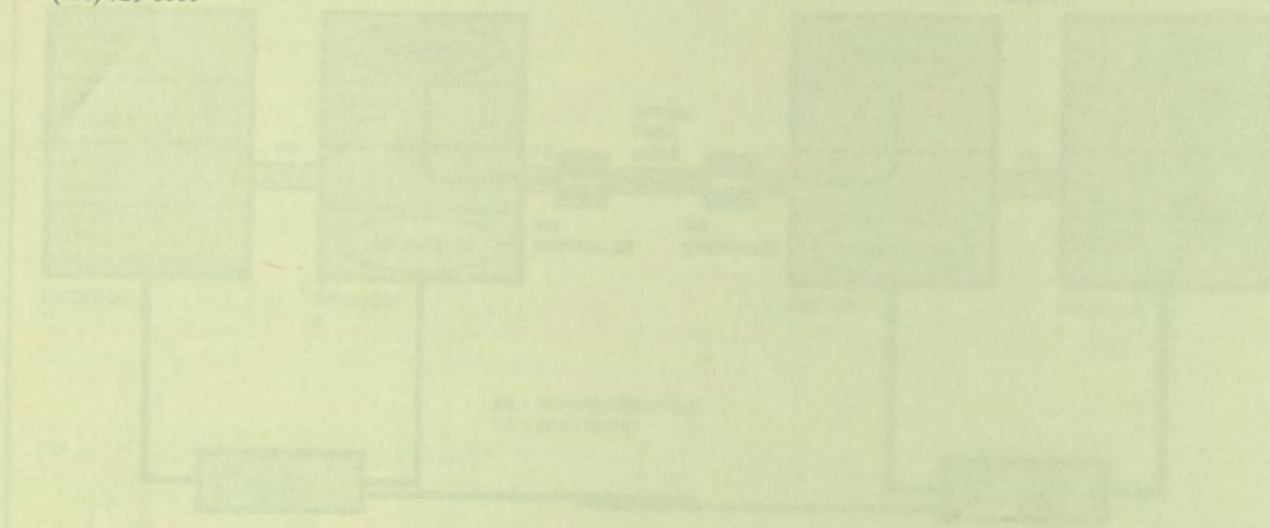

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TANDEM, OLTP

A look at the expanding universe of on-line transaction processing applications.

EXPLORING THE OLTP REALM

by Omri Serlin

Sophisticated market research is not required to convince anyone that computers are deeply ingrained within the structure of today's business enterprises. It has become nearly impossible to complete a business transaction without the involvement of some computer somewhere. One has only to think of one's latest interaction with a travel agent, bank teller, automatic teller machine, telephone directory assistance operator, or retail store clerk to realize how far this process has progressed.

Since the mid-1960s, on-line applications have been consuming a progressively larger share of the processing power represented by all new shipments of mainframe and medium-scale computers. The proportion of such systems intended exclusively or partially for on-line work is already well over 50% by some estimates, and is projected to reach 75% before the end of the decade.

On-line transaction processing (OLTP) is the name commonly used to describe applications in which a common database is available to interactive terminal users for both inquiries and updates. The database in such applications is a representation of some aspect of the business; a transaction is a representation of an activity (e.g., receipt of an order) that may transform the database from one state to another, or which may result in merely displaying some information about the state of the business.

OLTP is fundamentally different from the so-called interactive computing or the timesharing systems of the 1960s and 1970s—although, with users hunched over terminals, it does resemble them superficially. Timesharing systems attempt, through architectural artifices and specialized operating systems, to create the illusion that each user has access to a completely independent, private computer. OLTP systems, on the other hand, are created explicitly to allow concurrent, on-line sharing of common databases by multiple users.

Unlike early users of timesharing systems, who would probably be regarded today as hackers or computer technology enthusiasts, most users of OLTP systems regard the computer as a business tool and care little about the underlying technology. This is key to the expansion of the OLTP market—just as the dramatic expansion of the desktop microcomputer market occurred when business software supplanted kits for tinkerers.

The earliest large-scale OLTP systems were the airline reservations systems of the mid-1960s, which were expanded later to include such functions as crew and equipment scheduling. In the mid-1970s came other reservation systems for hotel/motel and car-rental agencies; large-scale banking applications, such as demand/deposit teller support, automatic teller machines (ATMs), and electronic funds transfer (EFT); credit authorization systems; and trading and brokerage systems.

Today, the acceptance of OLTP systems is rapidly spreading to the manufacturing segment, where JIT (just-in-time) disciplines and paperless factories are dependent on the computer for their minute-by-minute operations. Even such classical back-room functions as billing and inventory control are rapidly being converted to on-line operations with strong OLTP characteristics. Many editorial support systems in large newspapers and magazines have an OLTP flavor, as do some hospital management systems that combine clinical and administrative support.

IBM IS USED BY MOST

By far the majority of OLTP applications today are being implemented with IBM large-scale 308X mainframes (see Fig. 1). The two key software elements usually involved are CICS and IMS. The venerable CICS (customer information control system), despite its age, is still used in nearly 70% of all large IBM installations, according to an August 1984 survey. CICS provides centralized terminal management and applications scheduling for OLTP applications.

IMS, of course, is IBM's main database offering; its data communications (DC) facility is sometimes used to implement OLTP applications. IMS/Fastpath is a specialized, OLTP-oriented database subsystem that offers higher transaction throughput, but at the cost of reduced functionality. Among minicomputer makers, DEC, Hewlett-Packard, and Prime are probably the leading suppliers of transaction processing equipment.

A budding application with substantial (though so far unfulfilled) potential is generically known as videotex. Originating in the U.K., videotex was meant to provide consumers and small businesses access to useful databases (e.g., airline and railway schedules) by relying on an augmented tv set as a terminal, using the public telephone network as the communications medium. Despite a number of promising experiments, the idea never caught on in the U.S., where the popularity of desktop microcomputers preempted the need for the tv set.

Rather than provide for inquiries only, videotex efforts in the U.S. are now focused more on transaction services like home banking. Notable in this respect is the recently formed partnership between Bank of America, Chemical Bank, AT&T, and Time Inc., which plans to offer homes equipped with a personal computer access to banking services, a discount stock brokerage, and teleshopping.

In the telephone system, the computers that now control many central office switches (and indeed those within modern PBXs too) may be regarded as rudimentary on-line transaction processing systems. More complex on-line transaction functions are rendered by the directory assistance systems the operators use and the

ILLUSTRATION BY ANDREA BARUFFI

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The airline reservations systems remain the archetype of OLTP applications.

systems that support toll-free calling.

Promising future applications with varying OLTP content include value-added communications networks; support of automatic point-of-sale (POS) retail systems like automated gasoline pumps; and the emerging work group computer or file-server application, where a small multi-user system supports electronic mail functions and possibly other common databases in the office environment (see "Departmental Computing: A Choice of Strategies," May 1, p. 86).

Airline reservations. In many ways, the airline reservations system remains the archetype of OLTP applications: it has to support a large number of users, must allow concurrent updates to a large database, must be up and available around the clock and year-round, and is at the heart of the business its serves.

In an airline reservations system, the common database, representing the inventory of available seats on various flights, is made accessible to travel agents using interactive terminals. The agents can make various inquiries against the database (such as which flights operate between two cities on a given date on or about a given hour, and what class seats are still available). Then the agent can make an actual booking, which involves on-line database updates—reducing the number of available seats on a given flight by the number booked, and creating a related passenger name record (PNR) containing such information as the passenger's name and phone number. A booking cancellation also results in a database update.

Although Sperry Univac was initially a contender in the airline reservations business, virtually all major systems currently in use (American Airlines' SABRE, United Airlines' Apollo, TWA's PARS) use IBM large-scale mainframes. In cooperation with the airlines, IBM developed ACP (Airline Control Program), an operating system specialized to achieve the high transaction throughput required by the reservation application.

ACP, now renamed TPF (for Transaction Processing Facility), is being offered to other industries as well. At the Bank of America, for example, the latest TPF version (TPF2) is the basis of a new on-line teller support system now under development.

FIG. 1

ESTIMATED OLTP MARKET SIZE

WORLDWIDE SHIPMENTS BY U.S. MFGS.—HW/SW/PERIPH (NO SERVICE) • ADJUSTED FOR CALENDAR YEAR • $ BIL.

	CY 1982	CY 1983	CY 1984	CY 1989
IBM	10.8	14.2	17.6	28.3
BUNCH & PCMs	5.5	6.5	7.9	12.7
Minis	2.2	3.1	4.7	9.4
FT Suppliers	0.3	0.4	0.5	1.8
Total	18.8	24.2	30.7	52.0

FT SUPPLIERS ($ MIL.)

	CY 1982	CY 1983	CY 1984	CY 1989
Tandem	310	387	474	1,390
Stratus	5.5	20	40	320
Others	—	—	5	50
Total	315	407	519	1,760

Source: ITOM International Co.

MASSIVE VOLUMES TYPICAL

The airline reservation application is characterized by massive amounts of disk data, a large number of terminals, and high transaction volumes. The TWA system, for example, which is the smallest of the big three noted above, runs on a 9083 system (a specially modified version of the 3083 mainframe), uses 144 300MB disk drives, supports some 12,000 terminals, and handles peak loads of over 200 messages per second. (A message, the basic transaction in this system, involves execution of about 20,000 to 25,000 instructions and more than nine DASD accesses.)

Telephony-related applications. At about the same time the airline reservations systems were being installed, AT&T in the U.S. and the PTT in France began installing computerized central office switches in their respective telephone systems. The computer in such systems is involved principally in call setup: it determines the routing for the call and creates a connection by setting parameters into the switching apparatus. It must be able to handle a large volume of such transactions, and must be highly available. In these respects, it is rather like an OLTP system.

This application is not typical OLTP, however, because it does not involve a database and it does not require the computer to remember contexts; an interrupted call is simply lost, and the parties must redial to establish a connection. Logging is used merely as the basis for billing. In contrast, an OLTP system must keep careful logs in order to be able to back out of transactions or roll forward the database. (Roll forward is explained later in this article.)

In the U.S., AT&T developed a series of fault tolerant (FT) processors for service in central office switching applications. The 3B20D is the latest in the series: it was first offered to the public in March 1984. One notable application with some OLTP flavor is the 800 calling system, which is serviced by a network of 3B20D computers. Here, toll-free numbers dialed by subscribers must first be translated to the correct area code and number of the destination.

The telephony-related application with the strongest OLTP character is the directory assistance support (DAS) system, supplied chiefly by Computer Consoles, Rochester, N.Y. This system allows multiple operators to retrieve telephone numbers by subscriber names or other keys. It offers high availability and fast response time by replicating the database up to eight times.

Banking and financial applications. Since the mid-1970s, banks have been installing OLTP systems at an increasing pace. The most visible of these systems support teller activities, which are principally concerned with demand/deposit (checking) and small savings accounts. Banks have been automating depositors' account handling and other aspects of their operations for at least 25 years now, but the complete on-line handling of account transactions is only now becoming the accepted norm.

For example, in 1977 the Bank of America installed a multiple minicomputer system to help 10,000 tellers in 1,200 branches administer 10 million customer accounts. In each of the bank's two processing centers (Los Angeles and San Francisco), a network of 32 minicomputers acts as a front end to large IBM mainframes, where account information is held. Every morning the account status is loaded into

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the mini system; during the day, most teller transactions involving debits or credits to the accounts are merely captured on-line. At night, the transactions are processed in batch fashion by the main computers to update the account information. At this point the bank is engaged in a project that will replace this system with a more integrated one based on IBM's TPF2 software. Other, smaller banks have already implemented such integrated on-line teller support systems, some using Tandem equipment.

DEMANDS MORE SEVERE

In many ways, the demands of the financial OLTP environment are far more severe than other OLTP applications. There is a need to maintain absolute accuracy (in account balances, for example), despite concurrent update activities and, possibly, hardware failures.

The explosion in new customer services, including local, regional, and national ATM networks, is increasing the demand for OLTP systems in the banking industry. Such services are being spurred by increasing competition due to deregulation, as well as by the need to reduce costs (e.g., replacing manned branches with ATMs).

Manufacturing. Despite increasing use of computers in planning (manufacturing resource planning, or MRP) functions, much of the actual running of a discrete-process production plant is still paper-controlled and often characterized by batch-style operations, where blocks of raw materials are converted to end-products as a group.

Increasing attention is now being focused on shop floor control and other systems involved in the minute-by-minute operation of such plants. The concept of a paperless factory is rapidly gaining acceptance. In such factories, the paperwork accompanying each product or batch is replaced by a combination of bar-code stickers and information entered through terminals located in the various work areas. The systems supporting paperless factories are prime examples of the application of OLTP technique in the manufacturing environment.

Because of increasing concerns regarding industrial productivity, such systems have been funded more aggressively in the past few years, and are likely to continue to be the focus of substantial interest. These systems save time once lost to form filling; provide up-to-the-minute reports on the status of plant, inventories, and finished goods; and can be used to pinpoint sources of production problems earlier than before. The adoption of JIT inventory disciplines virtually mandates the use of on-line control systems.

Tandem Computers, the leading supplier of fault tolerant systems for OLTP service, is mounting a major campaign to place its systems in manufacturing applications. Tandem practices what it preaches: its plant in Austin, Texas, which manufactures the NonStop EXT computer and a variety of terminals, is one of the early examples of a paperless factory. Similar and related systems are being installed in other Tandem manufacturing plants.

In Austin, bar-code stickers attached to pc boards are used at the test stations to automatically download the appropriate test program. All of the tracking of materials flow, from receiving and stocking through processing and shipping, is based on bar-code identification at each work stage. (In the terminal products, the plant also employs innovative work disciplines, under which each worker is responsible for assembling a complete product, as well as for testing and reworking if necessary; there are no inspectors as such.) Naturally, the plant's control systems run on Tandem gear.

At Apple's famed Macintosh plant in Fremont, Calif., which tried to enforce the JIT discipline and originally utilized highly automated material movement systems (some of which have since been removed), a Tandem system now supports the key management information system. Although this system is not yet on-line, there is a plan to move in that direction. The plant employs a paperless rework facility based on an HP 1000 minicomputer.

Fault tolerance and availability. The spread of OLTP systems, beginning with the airline reservations systems, brought to the fore some concerns about the reliability of computer systems. Previously, computer downtime affected just a small number of back-room workers who were typically engaged in after-the-fact record-keeping.

OLTP AT HEART OF BUSINESS

By contrast, OLTP systems are frequently at the heart of the business; a disruption in system operation can forcibly idle many employees and possibly halt important services that customers rely on. An airline with an inoperative reservations system can't book new business; a bank with inoperative ATMs is antagonizing its customers.

The impetus for the development of commercial FT systems came chiefly from such concerns. (It should be added that in the mid-1960s, fault tolerance was also important in the space program, various military aerospace projects, and in the computerization of the telephone network in the U.S. and in France. These efforts were principally focused on cpu and memory redundancy techniques, however; they did not deal with database robustness or concurrency and consistency issues, and hence contributed only marginally to today's commercial FT systems for OLTP service.)

Some of the key ingredients of today's FT systems were first developed and tested in the airline reservations systems. Among these are disk mirroring, or shadowing, a scheme by which the system undertakes to maintain a mirror image of critical disk data by automatically replicating every write to a second, physically separate drive. This assures that the critical portions of the database are physically accessible even after a disk drive failure. This capability was implemented in early versions of IBM's ACP.

TRAVEL AGENTS' DILEMMA

The early OLTP systems for the first time allowed many users to concurrently access and update the same data. This focused attention on a new problem: how to assure data consistency in the face of concurrent updates. For example, if two travel agents wish, at about the same time, to book two different passengers on a given flight, they may both first read the current status (N seats available) and modify it by computing the new balance, N-1. Both write back this new balance, resulting in an inconsistent inventory: N-1 instead of N-2.

The most common solution for this type of problem is to serialize the concurrent accesses by means of file and record locks, also an early feature of ACP. Thus if the agent's transaction intends to modify the seat inventory, a lock is placed on the relevant flight record to prevent anyone else with similar update intent from reading the seat status until the first agent is through.

As it turns out, the airline reservations environment is not overly sensitive to this particular consistency issue, if for no other reason than the fact that airlines practice flight overbooking to counter no-shows. Data consistency became a key concern in the mid-1970s, when the banking and financial communities began implementing large-scale OLTP systems.

While in other OLTP systems slight variances between the computer's database and the real inventory situation, for example, are acceptable, in the banking environment such variances are intolerable. A bank can't tell a customer his current balance is approximately so many dollars; ex-

The explosion of new customer services is increasing the demand for OLTP systems in the banking industry.

actitude is of the essence.

How does one protect this exactness requirement in the face of possible computer failure? For example, suppose the system crashed in the middle of executing a transaction that takes money from one account and puts it into another. The database is now inconsistent, since the money is missing from the source account but isn't yet reflected in the recipient's account.

The concept of atomic transactions originated as a response to this and similar problems. Atomicity is a property of the system under which the user may define a sequence of related database actions (by, for example, bracketing the sequence with "BEGIN TRANSACTION" and "COMMIT" commands); the system undertakes to guarantee either that all such actions will be effected or that none will.

There are various ways to achieve this guarantee. Perhaps the most popular is the write-ahead log technique, in which the before and after images of the affected records are first written to a mirrored disk log file. If the system is successful in then implementing these changes in the actual database, a success record is added to the log file.

If the processor or the system crashes in the middle of such actions, the system can examine the log file upon being restarted; those transactions not successfully implemented (detected by the absence of the success record in log file) can be undone by using the before and after images. As long as one copy of the log file and the database remain intact, any number of system failures can be compensated for by repeating this transaction-backout process, which removes the effects of incomplete transactions.

Such facilities are now becoming common in most transaction-oriented systems. IBM's IMS and CICS have had them for a while, as has Tandem's Encompass, and Hewlett-Packard recently incorporated transaction backout in its Turboimage DBMS. But fault tolerant systems, which feature multiple processors, can perform such transaction backout actions essentially on-line, whereas a conventional uniprocessor system typically has to be manually restarted before attempting transaction backout.

Roll forward is a more drastic database recovery technique that is needed when the current on-line database is lost, because, for example, of a disk drive failure or double disk drive failure in mirrored disk situations. Here the system periodically dumps the database to an off-line tape; after a crash, the system can input the most recent dump, and use the log file to redo all the transactions that were successfully committed since that dump.

Tandem Computers, Cupertino, Calif., has been the premier supplier of FT systems for commerical OLTP applications since it began shipping some 10 years ago. The company quickly grew to become a Fortune 500 member, with revenues of over $600 million projected for the fiscal year ending September 1985. The Tandem multiprocessor system can restart failed processes through a checkpointing scheme and supports the full range of database integrity and consistency measures, including some that apply in distributed environments.

STRATUS ANOTHER SUCCESS

Stratus Computer, Marlboro, Mass., is another successful supplier of commercial FT systems. Launched in 1980 and still much smaller than Tandem in terms of revenues (projected to exceed $70 million in 1985), Stratus's growth rate will have averaged over 100% a year since shipments began in 1982. Furthermore, earlier this year, Stratus concluded an unprecedented agreement with IBM, under which the giant firm obtained the right to resell the Stratus system under its own logo. The program is still highly tentative; general availability from IBM will depend to a large extent on favorable reactions from a number of test sites. Regardless of the actual volume of shipments, though, the prestige of being the first computer supplier to IBM is valuable in itself.

While IBM's involvement with Stratus is interesting and significant, it is not nearly as fraught with strategic consequences as some analysts have suggested. IBM is a large, diverse organization, which in recent years has delegated more and more responsibilities to its various product divisions and adopted increasingly aggressive tactics. The Stratus agreement came about as a result of one such division's perception of what it needed to serve its customer base. There are some indications, however, that the Stratus move has served to focus attention on the issue of fault tolerance within IBM, and that the company is making some attempt to centralize at least the marketing and support functions for its diverse high-availablity efforts.

Some in IBM are not convinced that fault tolerant hardware is required for high availability. They have been claiming, for example, that some 308X installations have never experienced a TCM failure. (TCM, thermal conduction module, is the basic package of chips from which the 308X systems are built.) Field data collected by Reliability Research, Stamford, Conn., and reported in the author's *FT Systems* newsletter supports this claim, and indicates that IBM 308X cpus enjoy mean time between failures (MTBFs) of 1.9 to 3.4 years—substantially better than an Apple desktop micro. Nevertheless, customers evidently want more; in response, IBM plans to unveil in 1986 the extended reliability feature (XRF) for IMS. XRF is an enhancement to IMS that will allow two IMS-running systems to act as an on-line/hot backup pair, and to automatically switch roles on a failure in the on-line system.

A host of would-be FT suppliers, launched at about the same time as Stratus, have encountered substantial product development and financing problems (see "Fault Tolerant Blues," March 15, p. 82). Still, some are likely to survive and reach production status, although possibly not as independent entities.

Performance considerations. Measuring the performance of OLTP systems is important for both capacity planning and for comparing various vendors' offerings prior to procurement. Such comparisons have always been a subject of controversy even with conventional computer systems, and are even more difficult in the OLTP environment.

Whetstones, MFLOPS, and MIPS are not very meaningful in the OLTP environment. They tend to measure the raw cpu performance, completely ignoring the three most important factors that affect the performance of OLTP systems: system software capabilities, I/O efficiency, and the impact of communications protocols. They also do not properly reflect the capabilities of multiprocessor systems, which are especially popular in OLTP and FT applications.

MEASURING HOW OLTP PERFORMS

A much better measure of OLTP performance is the tps (transactions per second) rating. A number of OLTP system suppliers, including Tandem and Stratus, are now routinely reporting results of benchmarks in terms of tps. The difficulty is that just as there is no standard way to define an average instruction for a MIPS calculation, the average transaction is equally elusive. Yet the definition of what a transaction does is crucial if tps figures are to have any merit as comparative performance indexes.

For example, a transaction representing a bank withdrawal or deposit may involve four to six database accesses, some of which may require locking one or more records. With a teller and a customer waiting for a result, response time is obviously critical and must be factored in. In contrast, a transaction in, say, a gaming support system may involve pure logging; in

Data consistency became a key concern in the mid-1970s, when the financial community began implementing large-scale OLTP systems.

such an environment, many transactions could be logged to disk in one access. Clearly, tps figures from such widely differing applications are not comparable.

A notable first attempt to define a standard transaction benchmark has been described in DATAMATION ("A Measure of Transaction Processing Power," April 1, p. 112). That article is also notable in that it proposes a standard way to assign a cost factor to a tps, so that a user could actually make a meaningful tradeoff between performance and cost. The cost per tps for typical multiprocessor systems such as Tandem or Stratus runs about $50,000 to $100,000 per tps. Such systems can deliver about 1tps to 5tps per cpu under this benchmark. Large IBM mainframes can do perhaps 10 times better in terms of tps/cpu, but are not necessarily more cost-effective in terms of cost per tps. Unfortunately, not enough comparative data are yet available.

How many tps are enough? Much as batch systems gobble up MIPS, the OLTP market seems to have an insatiable appetite for higher tps capacities. A number of large customers, especially the airlines, financial institutions, and brokerage firms, already foresee the need for systems offering 1,000 or more tps. A key issue is whether architectures that rely on multiple low-powered processors can effectively serve such applications.

The reason for this concern is the well-known loss of performance due to multiprocessing overhead, which results in a less-than-linear performance increase as the number of processors is increased. Tandem, for one, is convinced that it can handle the task by locally interconnecting multiple systems of its top-of-the-line TXP multiprocessor over a fiber-optic network dubbed FOX. Preliminary benchmark results appear to support Tandem's claims that performance growth can be made nearly linear, both within TXP systems and across the FOX network.

IBM, on the other hand, appears to be placing its bets on TPF2 and large mainframes. While this combination is indeed capable of supporting high transaction rates, its chief weaknesses, as pointed out by competitors, are that it provides only rudimentary database facilities, requires the user to implement system services and applications in assembly language, and generally requires substantial customization and support.

Both approaches are likely to find favor for a while. Applications requiring very high transaction rates will continue to have to sacrifice functionality (i.e., a wide variety of file types and access methods) for performance. As hardware costs continue to plummet, and as basic system performance continues to improve, we will probably see high-functionality systems, such as IBM's IMS or Tandems' Encompass, begin to approach the high transaction rates currently possible only with highly tuned, minimum functionality systems. ◉

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