T A N D E M

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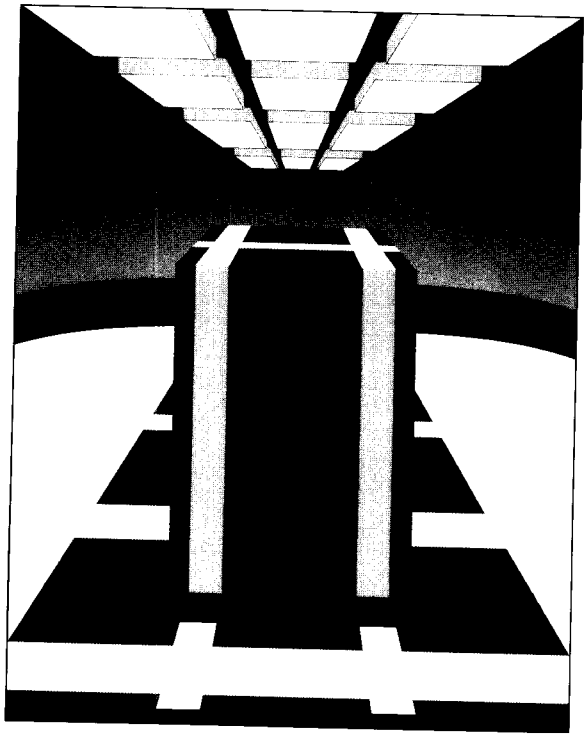

The VLX: A Design for Serviceability

Remote Support Strategy

SNAX/APC: Tandem's New SNA Software for Distributed Processing

Enhancements to PS MAIL

Customer Information Service

Tandem's Software Support Plan

TANDEM SYSTEMS REVIEW

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The VLX: A Design for Serviceability

The NonStop VLX™ system was designed to provide the lowest cost of ownership of computer systems used for large OLTP applications. Cost of ownership encompasses all costs associated with a system, including:

- Initial purchase price.
- Application development.
- Facilities to house the system.
- System operation.
- Service.

Historically, the cost of service has been a significant component of cost of ownership.

In the past decade, computer vendors typically provided service for computer hardware at a charge of as much as 12% or more of the initial purchase price per year. Assuming a $1 million system, this adds up to $600,000 over the first five years of ownership.

The Tandem™ NonStop VLX system was designed to lower the cost of ownership in three ways:

- Increased system reliability.
- Accurate fault analysis and remote support capability.
- Simplified service through improved packaging.

This design has reduced the cost of hardware service contracts on an entry-level NonStop VLX system to as little as 3% of the system purchase price per year. This article describes the features designed into the NonStop VLX system to achieve this reduction.

Design

Maintenance Strategy

The maintenance strategy that guided the design of VLX service and support features is the result of an evolutionary process at Tandem. The strategy can be summarized as follows:

- Provide a highly reliable system through careful component selection and sophisticated design technique.
- Provide continuously available on-line operations and diagnostic tools.
- Constantly monitor all critical system resources and the operating environment, and log all significant events for further analysis and action.
- Provide highly accurate fault isolation of field-replaceable units (FRUs).
- Provide the capability to operate and diagnose the system either locally or remotely.
- Provide a single operator interface for all system maintenance activity.

Features

Newly designed system components for the NonStop VLX system include the processor, interprocessor bus (IPB), fiber-optic extension (FOXII™), system cabinets, system power supplies, and the maintenance and operation facility (CHECK). In this article, these components are referred to as the "processor complex." The following features were designed into the processor complex to implement Tandem's strategy.

The CHECK Facility. The CHECK facility provides continuous monitoring of, and diagnostic access to, the VLX processor complex. Its features include:

- Continuous monitoring of processor complex components and environment.
- Detection and reporting of events.
- Diagnostic access to facilitate analysis of events and execution of tests.
- Operator console.
- Remote support/operations interface.

These features are discussed in greater detail later in this article.

Integrated Diagnostics and Fault Analysis. All diagnostic functions are integrated with the on-line Tandem Maintenance and Diagnostic System, or TMDS (Troisi, 1985), which provides a single human interface for all maintenance activities.

Built-in self-test capabilities in the processor improve the diagnostic test coverage and drastically reduce the test time.

Automatic fault analysis uses information captured and reported at the time an event occurs to isolate faulty components without requiring tests to be executed.

Remote Support Capabilities. Integration of the NonStop VLX system service and support features with the Tandem On-line Support Center (OSC) provides remote support capabilities. An accompanying article, "Remote Support Strategy," describes the OSC and the evolution of remote support at Tandem.

Error-checking Circuitry. Error-checking circuitry in all system components is capable of capturing critical information about errors that occur and reports this information via the CHECK facility for analysis by TMDS fault analyzers. It also protects the integrity of the customer's data.

Reliable Components. Highly reliable components, including VLSI circuits, were used in the design.

Failure Protection. Use of sparing, error correction, and retry and error recovery techniques increase availability of system resources.

Packaging. System packaging was designed to improve the mean-time-to-repair, and to allow error-free identification, removal, and replacement of all assemblies.

The rest of this article describes:

- The CHECK facility.
- Error detecting, reporting, and recovery.
- The built-in self-test features.
- Automatic fault analysis.
- The system features designed for ease of service and basic operations.

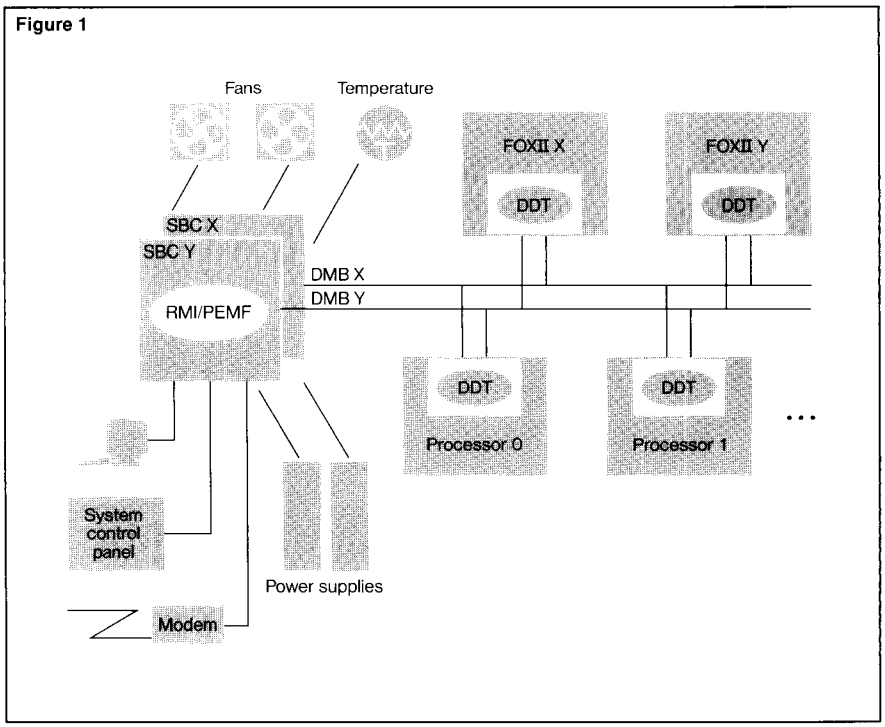


Figure 1.
Simplified view of the NonStop VLX CHECK facility.

CHECK Facility

The NonStop VLX system includes distributed hardware, software, and firmware that provide basic system operation, monitoring, and diagnostic facilities. Collectively, these components are referred to as the CHECK facility. (See Figure 1.)

Overview

Operations. The CHECK facility provides the mechanisms needed to perform basic system operations such as cold-loading, setting system time at cold load or power failure recovery, resetting processors, taking memory dumps, obtaining system status, and notifying the operator of fault conditions.

Access to these facilities is provided through a terminal, a system control panel, a remote communications port (via a modem), and applications programs running on-line (e.g., TMDS).

Monitoring. The CHECK facility monitors the processor complex components and its environment via interfaces to the VLX processors, FOXII components, power supplies, batteries, and fan and temperature sensors.

The CHECK facility performs all voltage, current, temperature, and rotational measurements needed to identify abnormal power and environmental conditions. Each I/O and CPU cabinet is continually monitored. The inlet and outlet air temperature of each cabinet is monitored. (See Figure 2.) Each fan is monitored for its rotational speed, allowing fan failures to be reported immediately. Power supplies are monitored for correct operation, including DC levels, peak levels, periodic and random deviation (such as ripple) values, and ground and voltage return shifts. (See Figure 3.) Loss of AC input power is detected by the power supplies and reported to the respective processors, to allow the processor state to be saved to memory. Memory is protected by battery power until AC input power is restored (in a brownout or blackout). Periodically, the memory backup batteries and charging system are tested for current and voltage under load, to identify faulty batteries and charging systems.

The processors, IPB controllers, and FOXII modules are continually polled for status information. Whenever a resource being monitored changes operational state (e.g., a processor is reset by an operator) or an abnormal condition is detected (e.g., a processor is frozen by a hardware error), the CHECK facility generates an event signature (ES), which is forwarded to TMDS for analysis. When conditions requiring immediate operator attention are detected, an audible alarm is sounded and an alarm message is displayed on the operator console. The customer has the option of permitting the CHECK facility to automatically notify the Tandem OSC of the alarm condition via a phone call placed by the system.

Figure 2

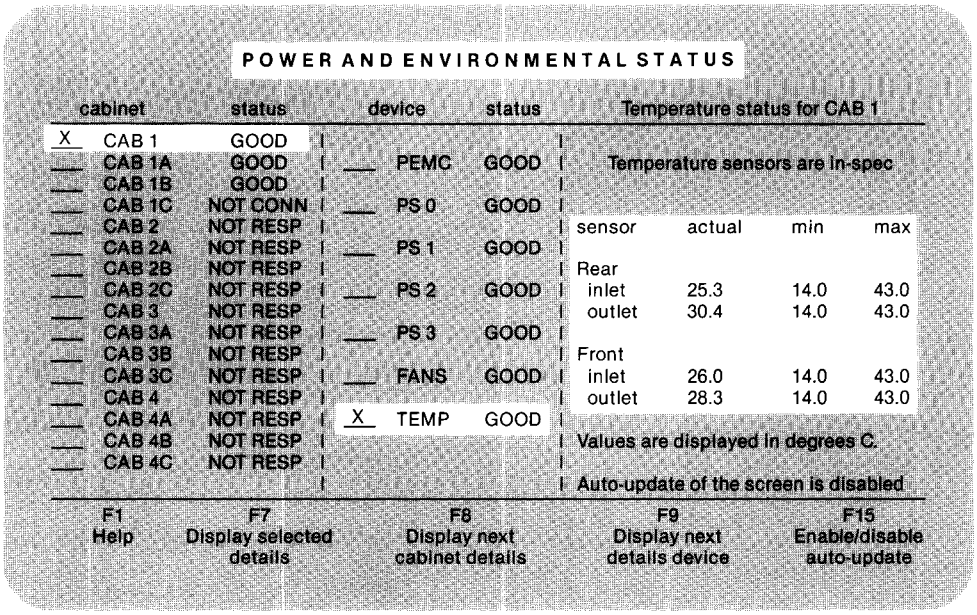


Figure 2.
RMI Operator Console Power and Environment Temperature status screen for a NonStop VLX system with a single-processor cabinet and two I/O-only cabinets. If any values were out of specification they would be displayed in reverse video. The information to be displayed is selected by marking the desired cabinet and device with any nonblank character and pressing the F7 key.

Figure 3

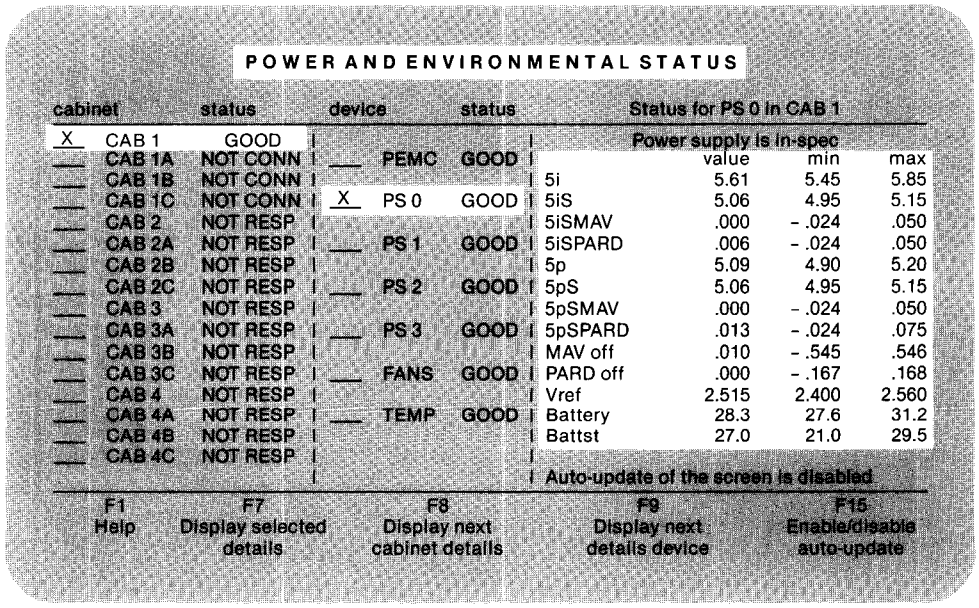
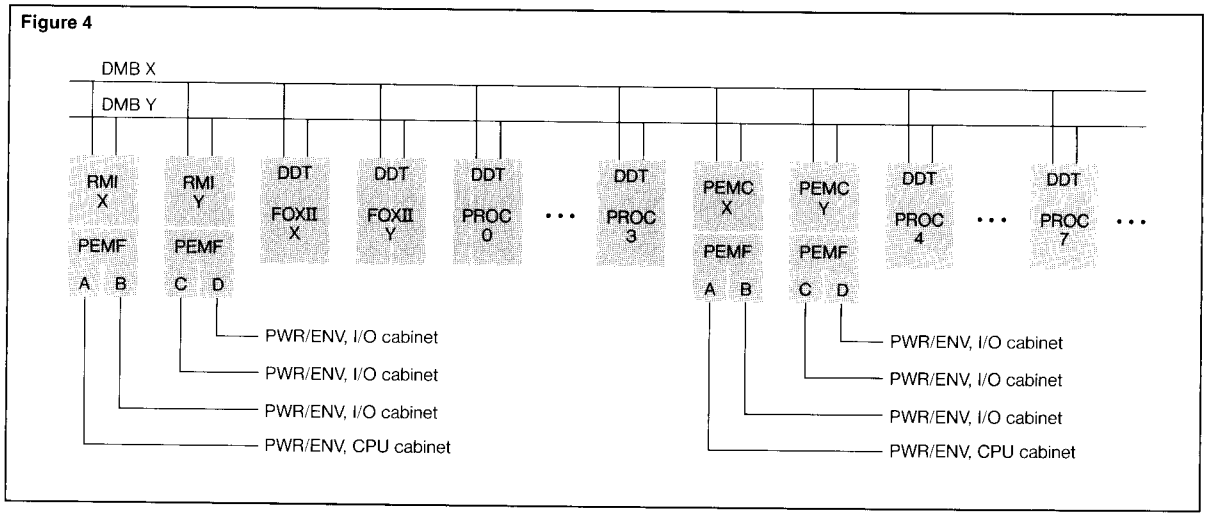


Figure 3.
RMI Operator Console Power and Environment Power Supply status screen for a NonStop VLX system with a single-processor cabinet and no I/O-only cabinets. If any values were out of specification they would be displayed in reverse video.

Figure 4.

A fault-tolerant diagnostic and maintenance bus (DMB) links all the major electronic modules of the VLX processor complex together, providing continuous monitoring and diagnostic access to the processor complex components.



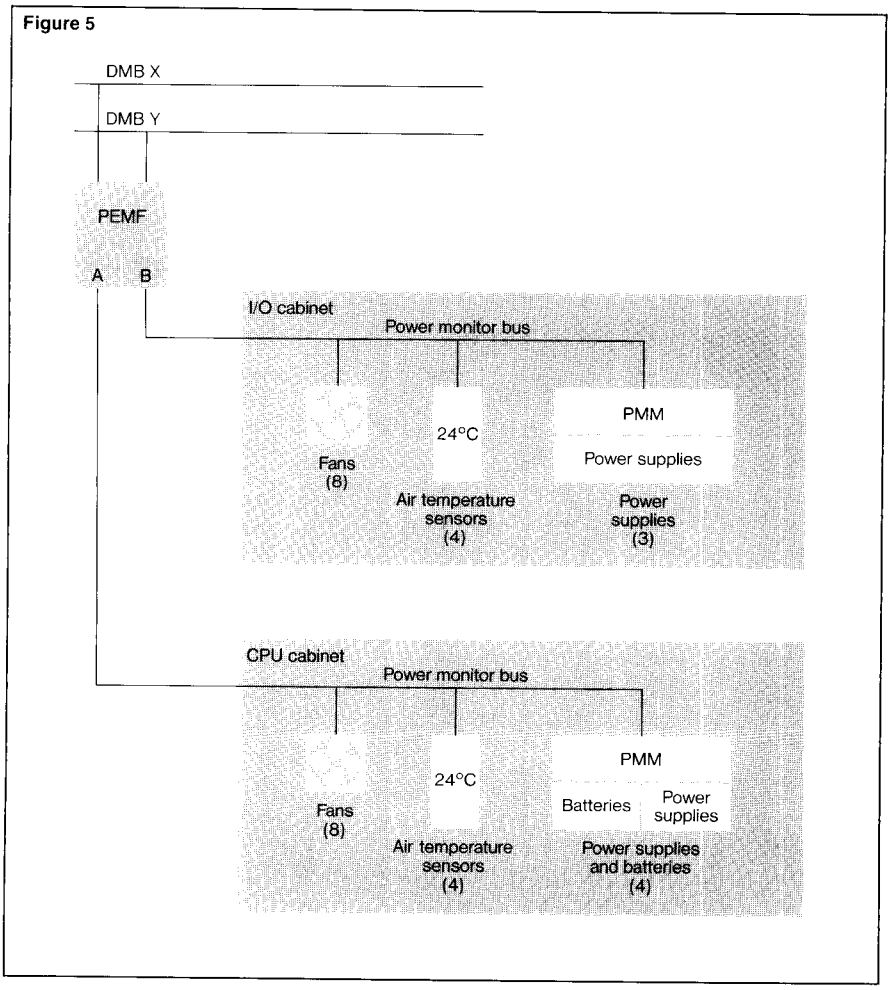


Figure 5.

On each SBC and PEMC, a power and environment monitor facility (PEMF) monitors one or two cabinets for air temperature, fan rotation, and power supply operation, and periodically tests the memory backup batteries.

Diagnostic Access. The CHECK facility provides diagnostic access to the VLX processors, FOXII modules, and power supplies via the same interfaces used for monitoring these devices. These interfaces are used to load and invoke tests and to access state information needed to accurately isolate faults.

The interface to the power supplies can vary the power supplied to the processors, allowing the processors to be tested under marginal power conditions. Processor clocks can also be varied to test the processor logic at higher than normal clock rates. This allows the service personnel to stress test the processors to detect marginal components.

CHECK Components

CHECK facility components are distributed throughout the system. In an entry level, or base, system, two 68000 microprocessors and eight 6809 microprocessors perform the functions of the CHECK facility. A fully configured 16-processor system has eight 68000 microprocessors and seventy 6809 microprocessors. These microprocessors reside on the system bus controller (SBC) boards, the power and environmental monitor and controller (PEMC) boards, the FOXII boards, and in each VLX processor and power supply. (See Figures 4 and 5.) They continually monitor the state of the system, its power, and its environment. The major components are explained in the following sections.

Remote Maintenance Interface (RMI). A pair of RMIs form the fault-tolerant operations and service processor for the VLX system. One RMI resides on each of the two SBC boards, typically located in CPU cabinet 1. The two RMIs function as a fault-tolerant processor pair using checkpointing techniques similar to those used by the GUARDIAN 90™ operating system, providing for a continuously available maintenance and operations facility.

Each RMI is a self-contained, 68000 microprocessor-based module, with interfaces to the processors, FOXII modules, and PEMCs, as well as the SBC power and environment monitoring facility, an operator's terminal, and an autodial/autoanswer, 2400-bps modem.

The RMIs function as the central point of control and communications within the CHECK facility and provide operator console functions, the remote operations and service interface, and the interface to all the other CHECK components via two diagnostic maintenance buses (DMBs). Each DMB is a high-speed serial communication bus over which the major CHECK components communicate.

The power and environment monitoring facility for a CPU cabinet (typically CPU cabinet 1), and up to three associated I/O cabinets, also reside on the SBC boards.

Power and Environment Monitoring Facility (PEMF). The PEMF comprises the hardware and software that monitors and controls power supplies and monitors fans and cabinet temperatures. Each PEMF supports monitoring of two system cabinets (either CPU or I/O cabinets). The facility measures analog signals from power supplies, fan speed sensors, and cabinet temperature transducers, and sends digital data to the RMIs.

The PEMF for the base system is integrated with the RMI on the SBC boards, typically located in CPU cabinet 1.

Power and Environment Monitor and Controller (PEMC). The PEMC board (also 68000 microprocessor-based) provides an additional PEMF as a system grows beyond one CPU cabinet. There are one or two PEMC boards in each additional CPU cabinet, depending on the number of I/O cabinets in the system. Each PEMC supports monitoring of up to two I/O or CPU cabinets.

The Power Monitor Module (PMM). The PMM is a 6809 microprocessor-based board that monitors and controls a power supply and memory backup batteries. The PMM gates analog data onto the power monitor bus (PMB), varies the power supply, and tests the processor-memory backup batteries under load. In addition, it does real-time monitoring of peak voltage values and thresholds. One PMM is attached to each system power supply. The PMMs are controlled by the PEMF located on either an SBC or a PEMC board and communicate via the PMB.

Fan and Temperature Sensors. Fan sensors detect fan rotational speed to determine whether the fan is operational. Each CPU and I/O cabinet has four temperature sensors that are used to measure inlet and outlet air temperature. The analog output of these sensors is measured by the PEMFs on either the SBC or PEMC.

Diagnostic Data Transceiver (DDT). Each VLX processor and FOXII module has a DDT. The 6809 microprocessor-based DDT allows the CHECK facility to monitor and control these devices. The DDT has a parallel interface to the device micro-engine used to communicate with the microcode and a serial interface to the DMB used to communicate with the RMIs. When the device is being diagnosed, the DDTs have full access to the state of the device via scan logic.

Figure 6

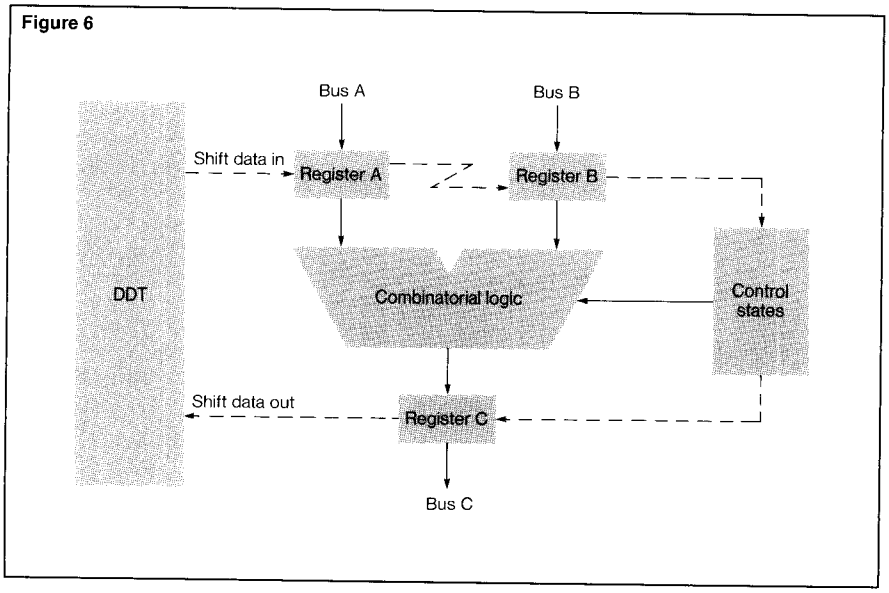


Figure 6.

Scan automatically configures all state logic (e.g., registers A, B, and C and control states) into a shift register string shown by the dashed line. This allows a diagnostic data transceiver (DDT) to read and write state for initialization, problem analysis, and high-speed verification using a built-in self-test unit.

Scan is a technique by which all state elements and memory of a logic assembly can be read and rewritten for test and diagnostic purposes. Each VLSI gate array contains at least one scan string, which allows all the state elements in the gate array to be connected not only as functional combinatorial logic used for normal computation, but also as a serial shift chain that allows data to be shifted in and out of the logic array, to initialize and observe the state values. (See Figure 6.) Thus, the state of a VLX processor can be captured when a fault occurs and stored for later analysis. In addition, scan is used by the built-in self-test unit.

Error Detection, Reporting, and Recovery

The VLX processors and FOXII modules use highly reliable VLSI gate arrays and 256-Kbit dynamic RAM devices to ensure greater reliability and thus reduce the need for service. When a failure does occur, however, it is detected by an extensive set of error checkers and reported to on-line fault analyzers, which locate the cause of error. Information about the error, along with current state information and previous system event history, allow accurate determination of the failing FRU.

Built-in retry mechanisms enable the VLX processor to automatically detect and recover from many types of errors. Using redundant logic and storage elements, a data access failure can be retried from the redundant element while the failing element is refreshed. For example, the VLX processor's control store contains two identical RAM banks. A misread word from one bank can be reread from the other bank and the bad location can be written over with the data from the second bank. The scratch pad registers, entry point table, page table cache, and data cache are protected by similar schemes (Brown, 1986). In addition, single-bit error correction and multiple-bit error detection in memory protect the VLX from transient and hard memory array errors. More than 60% of the processor circuitry is similarly protected, allowing for a high degree of error recovery within the processor.

Self-repairing design techniques further increase availability by allowing the VLX processor to quickly recover from some device failures. The VLX is equipped with on-line sparing modules in the entry point table, scratch pad registers, data cache, and control store. For these, when a failure is detected and a retry fails, the failing device is deallocated, the spare device is allocated, the contents are revived, and the processor continues application processing.

Built-in Self Test (BIST)

Each VLX processor has its own BIST capability, which provides on-site test capabilities previously available only at the Tandem factory. The self-test has the following advantages over traditional diagnostics:

- No download requirement.
- Fast execution.
- High coverage of logic and timing faults.
- Isolation to the FRU level (or better).
- Not affected by microcode revisions.
- No disk space requirement.

The BIST unit in the VLX processor is capable of running over 80 Mbytes of scan-based verification test patterns in less than 0.7 seconds with very high fault coverage. This hardware-based, firmware-controlled test system is invoked every time a CPU is powered on. It can also be invoked by a TMDS command or an automatic fault analyzer.

The BIST is included in each VLX processor's DDT. It consists of a small firmware-controlled test processor, a pattern generator, a parallel scan read/write mechanism, and signature analyzers.

The BIST automatically generates and applies 2.56 million test patterns to all scan strings. Each pattern is loaded and then stepped one or more cycles to test timing sensitivity (at full speed or under a higher speed margin clock), and the result is then sampled by the test signature generator. At any point in the testing the signature values can be compared to known values to determine the quality of machine operation.

The BIST first isolates detected failures to an individual scan string. Then, under the direction of TMDS, a binary search technique and a special signature mode can be used to further isolate the fault to the failing bit or bits. Applying a fault analyzer to the failing bits allows fault isolation to the most likely area of failure.

Although the 80 Mbytes of automatically generated test vectors provide a full verification test, additional test vector sequences can be run. Through statistical data collection using computer-aided design tools developed by Tandem, the design team identified logic that is difficult to test and isolate. These same tools can create additional test vectors that may be applied to the logic and give greater coverage for specific classes of faults. The high-speed parallel pattern loader is able to shift these patterns through the processor, and the results are compared against expected results or against expected signatures. In addition, a complete set of microdiagnostics is available to functionally verify all processor sections and interfaces.

Design for Ease of Service and Operation

No special service tools are required to service most assemblies in the VLX processor complex. Simple fasteners and connectors allow easy error-free removal and replacement of FRUs. LED indicators allow customer engineers to quickly identify and replace failed modules.

Figure 7

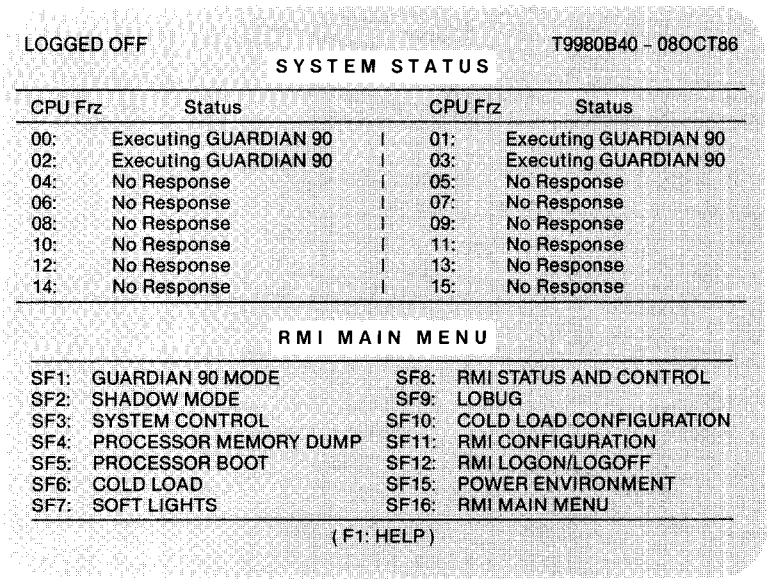


Figure 7.

RMI Operator Console Main Menu Screen. The operator may select any of the available screens from any other. The operator may switch to a GUARDIAN 90 command interpreter by using the SF1 key and return to the RMI main menu using the SF16 key. Status information is always available, but to perform control operations the operator must log on to the RMI using the RMI LOGON/LOGOFF screen. Extensive help is available for each screen.

Each CPU cabinet is identified with a cabinet ID number (1, 2, 3, or 4). The VLX processor boards, FOXII modules, power supplies, and CHECK assemblies are capable of reporting their cabinet and location within the cabinet. Each assembly contains nonvolatile storage elements in which part number, revision level, and tracking ID, as well as a brief event history, are stored. Processor, SBC, PEMC, and FOXII boards have three lights, indicating:

- Exception/abnormal event (red).
- Normal (green).
- Power on (yellow).

Processor, FOXII, and CHECK modules are easily replaced. Special circuits within each module sense removal, and the assembly is automatically powered off. Special color coding and connector keying prevent installation of a board into the wrong slot. There are no interconnect cables between boards, so removal and insertion of boards is a simple one-step operation.

All power cables are keyed to prevent errors during installation. Power modules slide on a tray and are secured with a single thumbscrew, as are the battery modules. Modular fan assemblies are used to allow quick removal and replacement.

Compared to earlier systems, operating a VLX system has been simplified. Individual CPUs no longer have their own lights and switches. Instead, operations are controlled from a local operator/service terminal or from a remote system. A menu-driven operator interface, with password security, allows the operator to manage the VLX system from a single terminal. From the same terminal, all power and environmental measurements are displayed in real time. (Refer to Figures 2, 3, and 7.)

In addition, a single system control panel secured by an operator's key provides basic system operation functions. These functions include cold load, remote access enable or disable, and local RMI password checking enable or disable. Audible and visual alarms alert the operator to system-level errors.

A fault-tolerant battery-operated clock automatically resets system time at cold load or after a power outage. The clock is fully integrated into the GUARDIAN 90 timekeeping facility so as to minimize the need to reset it.

Automatic Fault Analysis

The implementation of TMDS for the NonStop VLX system includes automatic fault analysis. (See Figure 8.) TMDS continuously collects information from the CHECK facility and other sources. This information is maintained in an event signature log (ESLOG), that is continuously monitored by a process to determine whether failure has occurred. When an abnormal condition exists (i.e., one that may require operator intervention), TMDS executes a specific fault analyzer (SPECFA).

The SPECFA examines the ESLOG entries and collects data from other sources to determine whether a fault actually exists. If the SPECFA determines a fault exists, it attempts to identify the faulty FRU using the data in the ESLOG. The system control panel alarm notifies the operator. Optionally, if enabled by the customer, a telephone call is automatically placed to a Tandem OSC.

Currently, most NonStop VLX processor faults are identified by TMDS SPECFAs. Some disk and magnetic tape and FOXII faults are also analyzed by SPECFAs. In the future, all components of the NonStop VLX system will be fully covered by fault analyzers. Remote event recording at the Tandem OSC will be used to collect and further study these analyses to provide continued improvement in FRU problem determination and isolation.

Conclusion

The NonStop VLX system has made significant advances in reducing the cost of ownership of large OLTP computer systems. The features that reduce its cost of ownership have already been proven in the field. These features will continue to be improved based on experience gained with the VLX, benefiting future Tandem systems even further.

Figure 8

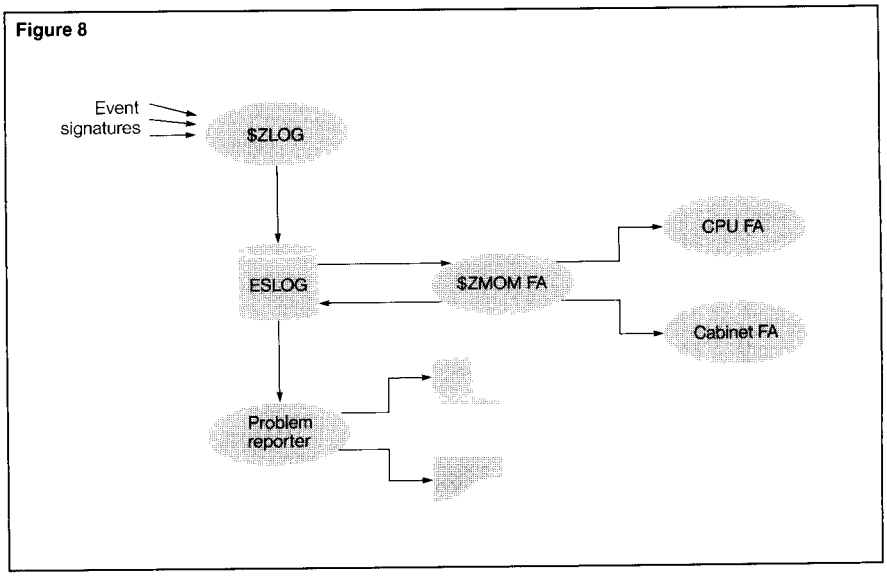


Figure 8.
TMDS fault-analysis components. Event signatures are sent to the TMDS $ZLOG process by many system components. The $ZMOM process looks at all arriving events and determines if a SPECFA should be run. CPU FA and Cabinet FA are examples of SPECFAs which are run only when required. The results of fault analysis can be viewed using the TMDS problem reporter, which is invoked using the TMDS DISPLAY command.

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Acknowledgments

The authors wish to acknowledge the efforts of the NonStop VLX system and TMDS development teams, and the many individuals in the Tandem support organizations who made the features described in this article (and, therefore, the article) possible.

Jamie Allen joined Tandem in 1980 as a firmware designer on the 6530 terminal project. He was also technical leader for the FOX microcode/firmware. For the past three years he has managed the Processor Projects Section of Software Development. Before coming to Tandem he designed automatic test systems.

Rick Boyle has been with Tandem since 1984. He was technical leader for the maintenance and diagnostic hardware design on the NonStop VLX system and is currently a manager in the Processor and Memory Engineering Group. He has been involved with design of mainframe VLSI-based systems for over eight years.

Remote Support Strategy

Remote support is an approach that has been evolving within Tandem for several years. This article traces that evolution from its inception in 1979 to the present.

Tandem is committed to providing outstanding customer support, a commitment that requires meeting or exceeding customer expectations for quality support. Those expectations include greater system reliability, availability, and serviceability. Therefore, in order to meet our customers' expectations yet remain cost-effective, our strategy is not limited to on-site system support but includes the capability for remote system support. With the introduction of the NonStop VLX system, Tandem announced the On-line Support Center (OSC). As part of the Tandem National Support Center (TNSC) in Austin, Texas, the OSC provides remote support for VLX systems.

The Evolution of Remote Support

DIAGLINK

The announcement in 1979 of Tandem's DIAGLINK for the NonStop 1+™ system marked the first stage in Tandem's remote support plan. DIAGLINK, the diagnostic interface used by Tandem support personnel, was provided to all maintenance contract customers. Included was an async modem for remote access to the system. It was possible for authorized Tandem personnel to dial in to a customer's system and obtain system status through GUARDIAN 90 utilities, execute diagnostics with customer assistance, and do remote low-level debugging.

Operations and Service Processor (OSP)

In 1981, Tandem introduced the NonStop II™ system with its Operations and Service Processor (OSP). The OSP replaced DIAGLINK as the maintenance interface for the NonStop II system. The OSP, like DIAGLINK, included an async modem for remote access to the system. The OSP also incorporated new features, making it possible to diagnose failures and operate a system remotely.

The OSP, a Z80-based maintenance processor, is capable of sending and receiving messages from each CPU via the Diagnostic Data Transceivers (DDTs). Upon receipt of these messages, the OSP displays internal status information on an OSP terminal. On the local system this gives the operations personnel or Tandem support personnel an internal view of the status of each CPU.

Remote support personnel can operate the OSP in a passthrough mode, which means that the local OSP passes information through to the remote OSP. The advantage of this configuration is that the local OSP logs messages that local operations personnel can monitor. They can view the same information that is used by Tandem support personnel in diagnosing hardware and software failures.

The microdiagnostics resident on the local OSP also may be run remotely, and even downloaded from a remote OSP should they not be available on the local OSP. This makes it possible to run diagnostics remotely and to download special diagnostics to a CPU. Additional features include remote reload of processors, system cold load, and system operation via the OSP.

The TXP Version of the OSP. The next step in Tandem's remote support evolution was the NonStop TXP™ system. The TXP system also used the OSP with an async modem, enhanced microdiagnostics, remote operations facilities, and remote support capabilities.

The most important remote support feature introduced by the TXP processor was the use of scan design logic which makes the state of the processor accessible from the OSP at the time of a failure. The addition of scan design logic shortened the time required by the Tandem support person to diagnose a failure by providing more meaningful failure data.

By increasing the memory size of the TXP version of the OSP over the NonStop II version it was possible to implement enhancements such as configuration of power on (PON) operation mode (i.e., local, remote, etc.) and remote-port password checking.

Tandem's Maintenance and Diagnostic System (TMDS)

In 1984 Tandem introduced Tandem's Maintenance and Diagnostic System, or TMDS (Troisi, 1985). TMDS is the latest support tool developed for Tandem, by Tandem. Unlike Shadow, Tandem's first diagnostic system, TMDS operates on-line without requiring significant system resources.

Remote Maintenance Interface (RMI)

In July 1986 Tandem introduced their newest system, the NonStop VLX. The VLX system uses TMDS and the new remote maintenance interface (RMI).

The RMI included with the VLX system provides significant improvements over the OSP and DIAGLINK. The RMI uses a synchronous protocol for communicating with the remote service location versus an async protocol. This protocol change greatly reduces the chance that an unauthorized user could access a customer's system. Additional system security is realized by the RMI's requirement of a special remote access process (RAP), which is used in the Support Center for communicating with the RMI. By implementing the synchronous protocol and adding a special communication process (RAP), we have virtually eliminated the risk of unauthorized users gaining access to the system via the RMI. The RMI also requires password authentication with each attempt made to communicate with the VLX system. The RMI, when communicating with the RAP, can accept data downloaded from the support system, e.g., microcode downloads directly into the RMI memory.

Figure 1

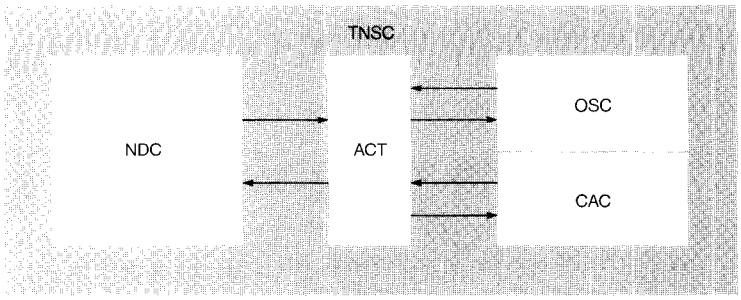


Figure 1.
The TNSC, located in Austin, Texas, consists of the NDC, the CAC, and the OSC. The ACT links the groups in the TNSC with the field support groups.

Enhanced TMDS

Significant enhancements were made to TMDS in conjunction with the VLX introduction. TMDS is now equipped with subsystem fault analyzers and an automatic dial-out feature that operate together, allowing the VLX system to detect events as they occur. These events are then analyzed, and based on the analysis, the VLX system dials out to the Support Center to report a possible failure. The heart of this capability is a rules-based expert system that selectively starts the fault analyzers to analyze events that have occurred and are logged in TMDS.

There are several other features in the VLX system that are very important to remote support. They include temperature monitoring, power monitoring, fan monitoring, a fault-tolerant RMI, availability of all fault information via the RMI, and a processor fault analyzer. (The previous article, "The VLX: A Design for Serviceability," contains more detailed information on VLX features.)

Tandem's National Support Center

Tandem has been developing the tools required to support systems remotely for the past seven years. These tools have been used to varying degrees throughout the field. In most cases, they were used by the customer engineering and systems analyst organizations to dial in to a system prior to making a service call. With the advent of the VLX system and the TNSC, remote support moves into an even more prominent position.

In 1986 Tandem set up the On-line Support Center (OSC) to use and support the existing tools for remote support. The OSC, part of the TNSC in Austin, Texas, extends the use and the benefit of Tandem's remote support capabilities. The TNSC, as shown in Figure 1, is made up of three groups:

- The National Dispatch Center (NDC).
- The Customer Assistance Center (CAC).
- The On-line Support Center (OSC).

The NDC, the link between Tandem customers and the Tandem support organization, is responsible for accepting all support service requests, logging them into a central database, and dispatching the request to the appropriate support group. This link-up provides Tandem customers with centralized access to hardware and software support personnel 24 hours a day, 365 days a year.

The CAC is responsible for supporting Tandem's workstation products. The center also provides support on selected software products for Tandem Alliance members (Independent Software Vendor Support) and, most recently, first-call Tandem Software Support for several U.S. locations.

The OSC is responsible for first-level remote hardware and software support for the VLX system. In the future, other Tandem mainframe products will have the capability of being remotely supported from the OSC.

Tandem's Automated Call Tracking (ACT) Software

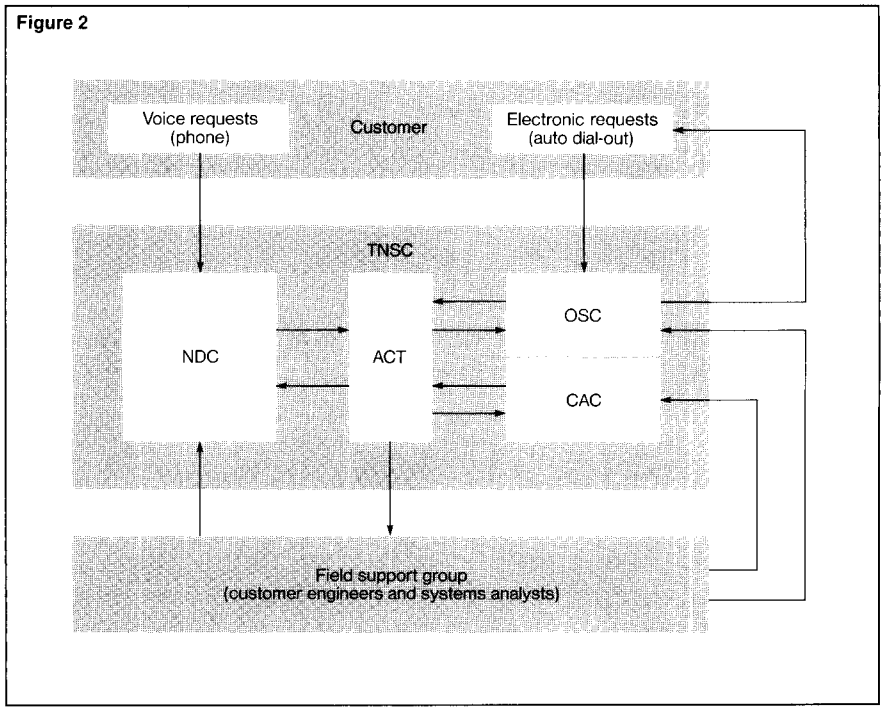
Linking these TNSC groups with the field is Tandem's Automated Call Tracking (ACT) software. This connection provides Tandem customers with "on-line" first-level hardware and software support from a centralized location. The main objectives of the TNSC are to:

- Complement the support currently provided by the field customer engineering and systems analyst organizations.
- Reduce the time required to respond to customer service requests.
- Reduce the time needed to detect and repair failures.
- Enhance customer satisfaction.

Figure 2 illustrates a customer's interface with the TNSC and the field organizations. The customer places a service request by phone or electronically (by automatic dial-out from their VLX system) to the TNSC. The request is logged into the ACT system for tracking purposes. The request is then directed to the appropriate support group, based upon contract coverage, severity of the request, and local commitments. All Tandem support groups have access to the latest information contained in ACT and can track the status of any call logged into the ACT system. Service requests are automatically escalated if they are not closed within the defined amount of time.

Upon receiving a VLX service request, the OSC specialists dial in to the RMI to review the TMDS event log and evaluate the status of the system using TMDS and GUARDIAN 90 utilities. The problem is diagnosed and fixed if possible. If the service request cannot be closed it is dispatched to the appropriate customer engineer (CE) or systems analyst (SA) for on-site trouble-shooting or parts replacement. When a request is handled in the OSC and dispatched to a CE/SA, the probable failing field-replaceable unit (FRU) or subsystem is identified. This enables the support person responding on-site to be better informed and to make a quick repair.

Figure 2



How On-line Support Works

In the NonStop VLX system, significant enhancements were made within TMDS. Fault analyzers were added to various subsystems in TMDS to analyze events reported to TMDS. The fault analyzers react to events logged by TMDS. The event log is monitored for new event signatures received by TMDS. Subsystem fault analyzers are started automatically by TMDS. The fault analyzers, rules-based expert systems, analyze the logged events and attempt to determine what has occurred. After completing its analysis, TMDS may request to dial out to the OSC, or log the analysis in the event log (depending on the subsystem and the results of the fault analyzer). (See the preceding article for more detail.)

Figure 2.

Tandem customers can place service requests by voice to the NDC or electronically (VLX dial-outs) to the OSC. All service requests are logged in the ACT system and tracked until closure is reached.

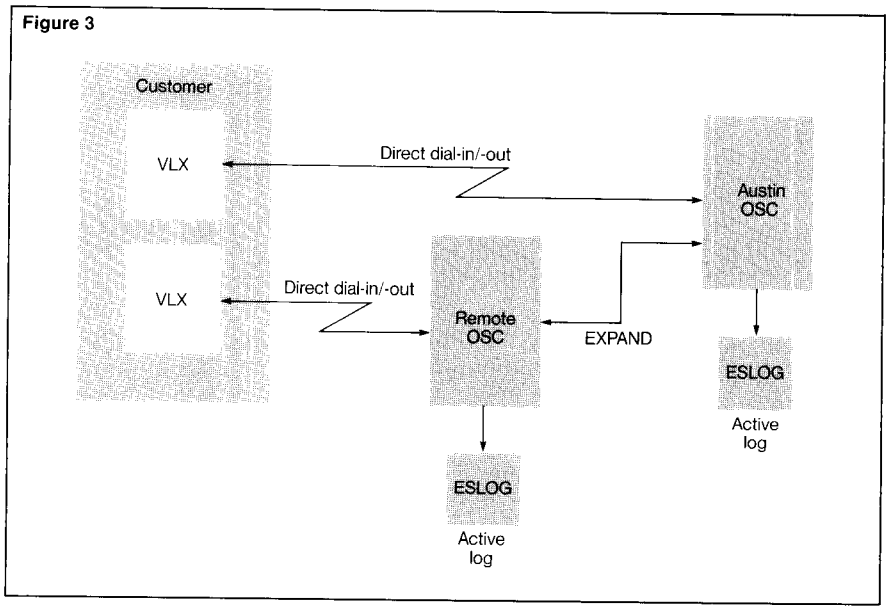


Figure 3.

On-line support configuration. VLX systems are capable of making connections to the designated OSC for reporting system problems. VLX systems can be connected directly to the OSC in Austin via the RMI and RAP interface. Event logs are maintained at the OSC in Austin. Customers outside the United States can interface with an international OSC and log their events to the local event log. All logged events are archived in Austin.

Figure 3 illustrates the flow of events occurring between a customer system and the OSC in Austin. When a customer's system encounters an event that results in the start of a dial-out fault analyzer, the system dials out to the OSC. At the OSC the TMDS logfile is monitored by a program for incoming events. When a dial-out event is detected, the monitor process alerts the personnel in the OSC. The problem is logged into the ACT system for tracking and escalation, then assigned to one of Tandem's OSC specialists.

Upon receiving notification of a dialed-out event, the specialists in the OSC dial in to the reporting system. During the dial-in session the OSC specialist runs TMDS to review the local event log and runs TMDS diagnostics if needed. In addition, it may be necessary to run GUARDIAN 90 utilities to determine the status of various subsystems or components.

Benefits of the Tandem National Support Center

There are several benefits that can be realized from the implementation of the TNSC.

- The TNSC is a single point of contact for the customer when placing hardware or software requests.
- All hardware and software service requests placed through the TNSC are logged, tracked, monitored, and escalated as appropriate.
- The TNSC is staffed by Tandem professionals committed to responding to service requests in the least amount of time and with the appropriate resources.
- A high level of service is provided to customers without incrementally increasing their maintenance costs.
- The time required to repair is reduced.
- The cost of maintenance, which is directly related to the customer's cost of ownership, is better controlled.

Conclusion

The implementation of Tandem's National Support Center is a major step toward providing additional services to our customers without incrementally increasing their maintenance costs—more is provided for less. For example, Tandem's ability to control service costs on newer products is directly related to reduced maintenance costs. In addition to the cost savings, there is greater system availability as response time and repair time are reduced.

Plans are under way to make full use of the TNSC through a gradual process of providing more sophisticated products, diagnostic tools, and support channels.

References

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Acknowledgments

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John Eddy joined Tandem in 1978 as a customer engineer in the Dallas office. In 1980 he moved to to Detroit as the District Customer Engineering manager. Prior to moving into his new position as manager of the On-line Support Center, John was the Region Customer Engineering manager in South Central Region. He worked as a field engineer prior to joining Tandem.

SNAX/APC: Tandem's New SNA Software for Distributed Processing

Tandem's newest Systems Network Architecture (SNA) product, SNAX Advanced Program Communication (SNAX/APC) software, enhances Tandem's networking and transaction processing capabilities. It allows applications on a Tandem system to participate in conversations as peer partners to applications on any other systems or devices offering similar functional protocols. Prior to SNAX/APC availability, applications were required to emulate some device protocol in order to communicate with applications in other systems.

This article provides the following information about SNAX/APC:

- Introductions to SNA logical units, Advanced Program-to-Program Communications (APPC), and LU 6.2 protocol.
- A description of the highlights and components of SNAX/APC.
- A discussion of application design considerations for SNAX/APC.

SNA Logical Units

IBM announced SNA in 1974 to provide terminal, line, and application sharing. The primary objectives of SNA were to allow the sharing of network resources and connection of unlike devices.

The Virtual Teleprocessing Access Method (VTAM), a common access method for all mainframe applications, was the first access method to support SNA. Before VTAM was introduced, each host or mainframe application owned all of its associated lines and terminals. Communication protocols were not capable of supporting different device types on the same line, and end users were required to have different terminals for each application accessed.

SNA introduced the concept of the *logical unit (LU)*. Described as the end user's "port into the network," the LU is an SNA network-addressable unit that provides protocols for end users to gain access to the network and to the functional components of the LUs.

End users were defined to be terminal operators or application programs, thus the concept of LU-to-LU sessions. A *logical unit type* is defined by selecting a set of optional protocol parameters that define the rules for establishing and controlling sessions between LUs.

LU Type 0 is an undefined protocol that allows implementors to select any set of available protocol rules, as long as the two LUs are able to communicate with each other successfully according to the rules chosen. Therefore, all LU types are an implementation of LU Type 0.

The very first LU types implemented by IBM products were for devices. LU Type 1 was associated with a Physical Unit (PU) Type 1, a relatively dumb terminal, and LU Type 2 was associated with a PU Type 2, a more intelligent terminal cluster controller, such as the 3270 Display System. Most IBM VTAM applications supported LU Type 1 and LU Type 2.

The evolution began when support for devices with characteristics different from the original implementations were required. LU Type 3 was implemented to support printers with a different data stream format, and LU Type 4 was implemented so that office system products could transfer documents.

IMS/VS support for the 3600 Finance Communication System was named Secondary Logical Unit Type P, for "programmable." Not being a numbered LU type, SLUTYPEP was considered an implementation of LU Type 0. In addition to adding confusion to the nomenclature, it was also the first implementation of a program-to-program protocol.

If the LU numbering and naming scheme were to continue in this fashion, new LU types would be introduced almost as quickly as new device capabilities were developed. A common LU type that would suffice for all devices and possibly for all programs was needed.

User requirements to communicate between two or more CICS/VS systems, two or more IMS/VS systems, and ultimately, between these two systems, led to the development of Intersystems Communication (ISC) and LU Type 6, the development and proving ground for LU Type 6.2 (or LU 6.2).

The development of LU 6.2 included the definition of protocol boundaries between the upper SNA layers and a more comprehensive definition of an LU. In addition to serving as a port into the network, LU 6.2 defines a specific set of services, protocols, and formats for communication between logical processors.

IBM has indicated that LU 6.2 is the basis for all future SNA communication between processors. There will, no doubt, be enhancements to all layers of the architecture, but the implications are that those changes will provide upward compatibility for existing LU 6.2 implementations.

APPC

APPC is a synchronous protocol for moving information between two application programs. It can be used for transaction processing, database query support, and file transfer applications. As an extension to SNA, it provides communication support for distributed processing.

The term *APPC* is used generically to describe a set of services and protocols for communication between distributed applications on similar and dissimilar systems. First introduced by IBM in 1982 and off to a seemingly slow start, it is now rapidly becoming the standard for intersystem communication. The advent of personal computers in the business community has highlighted the need for intelligent program-to-program interfaces.

APPC encompasses LU 6.2 and PU Type 2.1 implementations upon which the following architectures are based: SNA Distributed Systems (SNADS), Distributed Data Management (DDM), and Advanced Peer-to-Peer Networking (APPN). APPC offers new functional capabilities not provided by former LU types.

Through its synchronous-commit protocols, APPC is the first protocol to support distributed processing and distributed databases between unlike systems. APPC is also system- and device-independent, making it the primary candidate for future product implementations.

In addition to providing an architectural base for functional enhancements, APPC offers three distinct advantages over earlier LU type implementations:

- Distributed processing among unlike systems.
- Commit processing.
- Session sharing.

Distributed Processing Among Unlike Systems

The APPC architecture, with its unique protocols, provides the capability to develop distributed processing applications across SNA networks of unlike systems. Application programs can be developed to communicate with application programs independent of the processor type or operating systems providing the lower levels of support.

APPC provides the base for the SNADS, DDM, and APPN architectures. SNADS employs APPC for the asynchronous retrieval and distribution of information, DDM uses it for accessing file records on remote systems, and APPN uses it to route information between peer nodes in a peripheral network.

Commit Processing

Commit processing is the first SNA implementation of a communication protocol that provides support for distributed processing and distributed databases. APPC protocols allow application programs to request confirmation of activity from the remote application program. The highest level of protocol provides for the synchronization of resources in multiple nodes. Commit processing allows a choice of implementations depending on the degree of remote commitment required. Three levels of confirmation are defined by the architecture:

- *None* is for applications that do not require confirmation of remote activity and is therefore the easiest to design and implement.
- *Confirm* allows an application program to confirm with the partner application program that data was delivered or a function was performed.
- *Sync-point* employs a two-phase commit philosophy. It ensures data integrity among multiple nodes by providing the protocol to synchronize resources at the previous sync-point. This implies the ability to back out changes to resources.

Session Sharing

A *session* is defined by SNA as the connection between two LUs. Sessions are expensive to establish and terminate. A *conversation*, on the other hand, is started and ended with efficient SNA bracket protocols. A conversation is conducted between two application programs and is, by definition, shorter than a session. Sessions are allocated to conversations for the duration of the conversation.

APPC sessions are serially reusable resources, meaning they can only be used by one conversation at a time. The LU controls application program access to the session resource.

A session that is serially shared by conversations may become a resource bottleneck. At what point the bottleneck occurs depends on the volume and length of the conversations. APPC solves this contention problem by using an optional function called *parallel sessions*. Parallel sessions are more than one session between the same two LUs. Parallel session LUs allow concurrent conversations by allocating new conversations to available sessions.

LU 6.2

LU 6.2 provides a group of services to end-user application programs. These services are generally described in four categories:

- *Presentation services* for presentation of data to the end user.
- *Transaction services* for performing transaction processing on behalf of the end user.
- *LU services* for managing the resources of the LU.
- The *half-session component*, representing one half of the SNA LU-to-LU session.

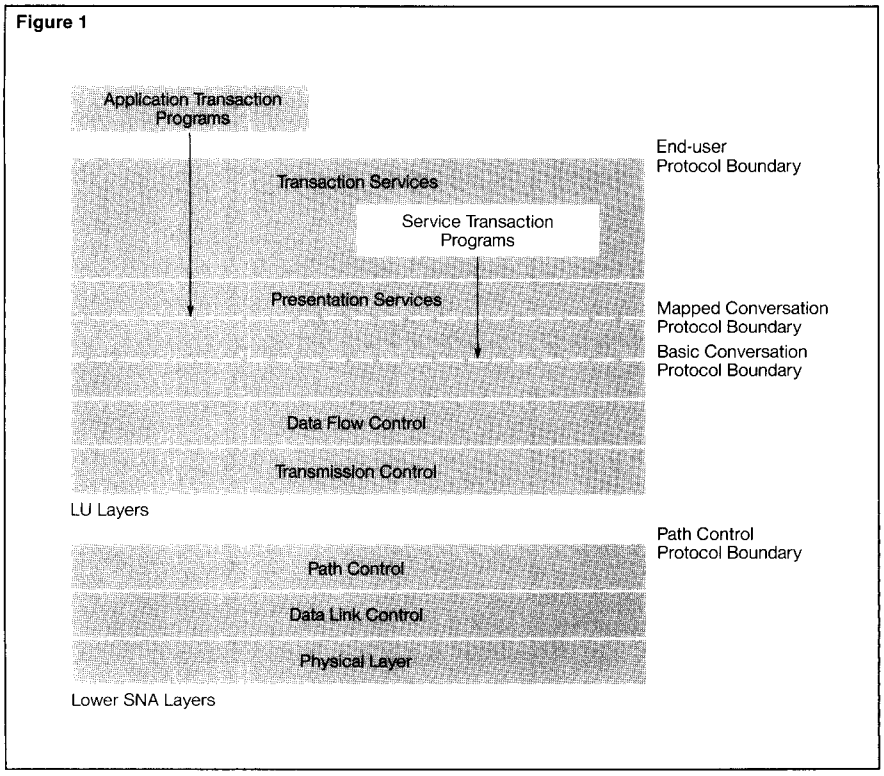

Figure 1.

SNA layers and protocol boundaries. The logical unit, here LU Type 6.2, represents the upper four layers of the SNA architecture. Protocol boundaries between functional layers and between peer components are implemented with a defined set of verbs, parameters, and protocols.

Of the several functional components of LU 6.2, two concepts are important for implementors of applications to understand: the concepts of protocol boundaries and transaction services. (Refer to Figure 1 during the following discussion.)

Protocol Boundaries

The LU comprises the upper four layers of the SNA architecture. The two upper layers, Presentation Services and Transaction Services, provide data handling and end-user services for the LU. The two lower layers of the LU represent the LU Half Session, which is responsible for Data Flow Control and Transmission Control, and is essentially the same for all LU types.

A major function of the LU is to convert between the End-user Protocol Boundary and the lower layers of the architecture at the Path Control Protocol Boundary.

Protocol boundaries are defined by a set of verbs and parameters that represent control values and functions to be performed. These boundaries define the protocols for communicating between layers or between peer components of the architecture. Protocol boundaries also exist between functional components within the SNA layers that represent sublayers.

Layer protocol boundaries occur between layers, and *peer protocol boundaries* occur between components of the same layer. An example of a layer protocol boundary is the Path Control Protocol Boundary between the Transmission Control layer and the Path Control layer. It defines a specific protocol for communicating with Path Control.

The LU 6.2 architecture defines the Mapped Conversation Protocol Boundary and the Basic Conversation Protocol Boundary, which represent logically different sublayers within presentation services. There is also the End-user Protocol Boundary or application program interface, which may be implemented differently in various LU 6.2 products.

An example of a peer protocol boundary is two transaction programs communicating with each other through the Mapped Conversation Protocol Boundary. (Note that the layer protocol boundary and the peer protocol boundary would be the same for peer components in the network.)

Transaction Services

Presentation services and transaction services functions have been significantly enhanced in LU 6.2. Components within these layers convert requests from one layer format to the adjacent layer. One example in presentation services is the *mapper*, which converts mapped conversation verbs to basic conversation verbs.

Conceptually, transaction services are an extension of LU functions, performing work for users that would otherwise have to be performed by user applications. Transaction services are performed by service transaction programs (Service TPs). For example, if a user application required movement of a data file, the user program would normally have to read each record of the file and send it to the receiving application. With distribution services implemented, the user application can request movement of the file, which is then performed by the Service TP.

An LU 6.2 may also exist in an intermediate node where service functions are performed without end-user participation. A good example is a distribution system in which information is being transferred from node A to node C through node B. The LU at node B performs the intermediate storage and retrieval of the information, and no user application is required.

Transaction Programs

LU 6.2 defines two types of *transaction programs (TPs)*: application TPs and Service TPs. Application TPs are the end-user business application programs, generally written by users. Service TPs are defined within the LU to provide services to the end user.

Service TPs are intended by architectural definition to be provided by the vendor. They provide control operator functions, distribution services, and synchronization services. Application TPs are intended to use the Mapped Conversation Protocol Boundary, and Service TPs to use the Basic Conversation Protocol Boundary. (In the rest of this article, the term *TP* represents *application TP* unless it is otherwise identified.)

TPs communicate with each other over conversations using LU 6.2 verbs and protocols. All application-to-application conversations are half duplex, in which one TP is in send state and the other is in receive state. The protocol specifies proper use of the verbs in each state.

LU 6.2 Verbs

Verbs and their associated parameters are used to implement the LU 6.2 protocol boundaries. LU 6.2 defines a base set of verbs for basic and mapped conversations, and two additional groups of verbs that add functionality. It also defines many option sets that are implemented through these optional verbs or through additional parameters on the base set. Some option sets are independent, and others have prerequisite option sets. Three of the more significant options available are support for data mapping, control operator verbs, and sync-level commit processing.

Basic Conversation Verbs. Every 6.2 product is "required" to implement the *base set* of *basic conversation verbs*. The base set is the minimum required to initiate, carry on, and terminate a conversation between two application programs. SNAX/APC supports the base set of basic conversation verbs.

Mapped Conversation Verbs. *Mapped conversation verbs* provide a higher-level application program interface that frees the application programmer from the rigors of formatting the user data into the generalized data stream (GDS) and, of course, unformatting the data on the receiving end.

GDS is a standard data stream format that allows unlike systems to send and receive recognizable data records. It includes length fields, data-type variables, and control information for logically blocking and unblocking records. GDS variables for mapped conversations are created by the mapped support within the LU. TPs written for basic conversations are responsible for appending and interpreting the GDS variables.

A second optional function called *data mapping* should not be confused with mapped conversations. Data mapping support allows TPs to request the mapping services of the LU, including sending map names to partners. The map names are used to retrieve stored maps for mapping the data into the desired format.

Figure 2

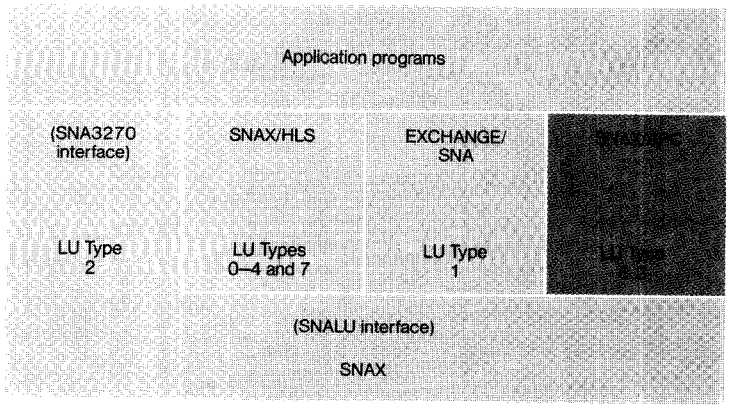

Figure 2.
SNAX LU support. SNAX/APC is similar to the SNA3270 interface, SNAX/HLS, and EXCHANGE/SNA in that it shelters application programmers from the complexities of SNA and the SNALU interface.

Mapped conversation verbs are generally the same format as the base conversation verbs with the exception that they are prefixed by the characters *MC_* for *mapped conversation*, and some associated parameters are different.

Control Operator Verbs. *Control Operator Verbs* are used by programs to control functions of the LU. Such functions include activating and monitoring sessions, changing the number of sessions, and coordinating with the partner LU. The majority of operator verbs deal with the operation of parallel sessions.

Type-independent Verbs. Currently four verbs are defined as type independent, meaning they can be used for either basic or mapped conversations. All four verbs are associated with option set implementations. The type-independent verbs are BACKOUT, GET_TYPE, SYNCPT, and WAIT.

SNAX/APC Highlights and Components

SNAX/APC extends Tandem's family of SNA products to include support for APPC. It allows Tandem applications to communicate with applications in another system that supports LU 6.2. SNAX/APC supports basic conversations over single SNA sessions. It is a system of components that provides a means of configuring, operating, and tracing the environment, in addition to converting from the high-level application program interface to SNA protocols. SNAX/APC was designed to use the facilities of Tandem's PATHWAY transaction processing system.

SNAX/APC Highlights

Extended Distributed Processing. SNAX/APC enables users to implement distributed processing applications that include other logical processors in an SNA network. The commit protocols of LU 6.2 allow applications to confirm processing in other nodes.

PATHWAY Integration. The APC communications process is implemented as a PATHWAY server, and SNAX/APC application TPs can be written as PATHWAY requesters or servers. The APC dispatcher uses the process-creation function of PATHMON to create new TP servers. TPs may also be run outside the PATHWAY environment.

Application Program Interface (API). The SNAX/APC End-user Protocol Boundary is the high-level API that acts as an interface between user-written TPs and the APC server. It protects the application programmer from the complexities of the lower levels of the SNA architecture.

Languages. Application TP servers can be written in any language supported by Tandem. Requester TPs are written in SCREEN COBOL.

Multiple LUs. One APC server can be configured to support up to 32 LUs, allowing up to 32 concurrent conversations. Additional APC servers can be started for more LUs.

Configuration Database. Database files contain a predefined list of local transaction programs and their allowed associations with partner LUs.

Trace File. An on-line trace can be activated to record all interprocess messages sent and received by SNAX/APC.

Log File. SNAX/APC also writes an activity log, containing initialization statistics and configuration errors, to a user-defined external file.

SNAX/APC System Components

The SNAX/APC system is composed of:

- A multithreaded server process (written in TAL™, Tandem's Transaction Application Language) that implements LU 6.2 services.
- An application dispatcher (written in SCREEN COBOL) that initiates TP servers.
- A configurator interface (written in SCREEN COBOL) that defines the authorized configuration.
- A trace facility for problem determination.

Figure 3 illustrates the structure and components of the SNAX/APC system; refer to it during the following discussion.

The *APC server* provides a program interface for user applications. It uses GUARDIAN 90 File System calls to interface to SNAX. Each server can be configured for up to 32 LUs, and multiple servers can coexist in a single SNAX/APC environment. The APC server links local TPs with remote LUs through definitions in the configuration database. It enforces the correct application TP protocols by parsing requests and maintaining conversation status. Multiple APC servers can be started, depending on the number of LUs or other application requirements. For example, different network configurations, destinations, or applications may use different APC servers.

The SNAX/APC API is based on the concept of a *unit of work (UOW)*. Application TPs communicate with the APC server by sending interprocess communication messages (IPCs) containing UOWs. In some instances, IPCs may contain multiple UOWs (see Figure 4), reducing the cost of interprocess communication.

Two types of UOW are defined for interprocess communication:

- Service UOWs establish contact between TPs and the APC server. Each IPC can contain only one service UOW.
- Conversation UOWs carry LU 6.2 conversation-verb requests and replies between the TP and the APC server.

Figure 3

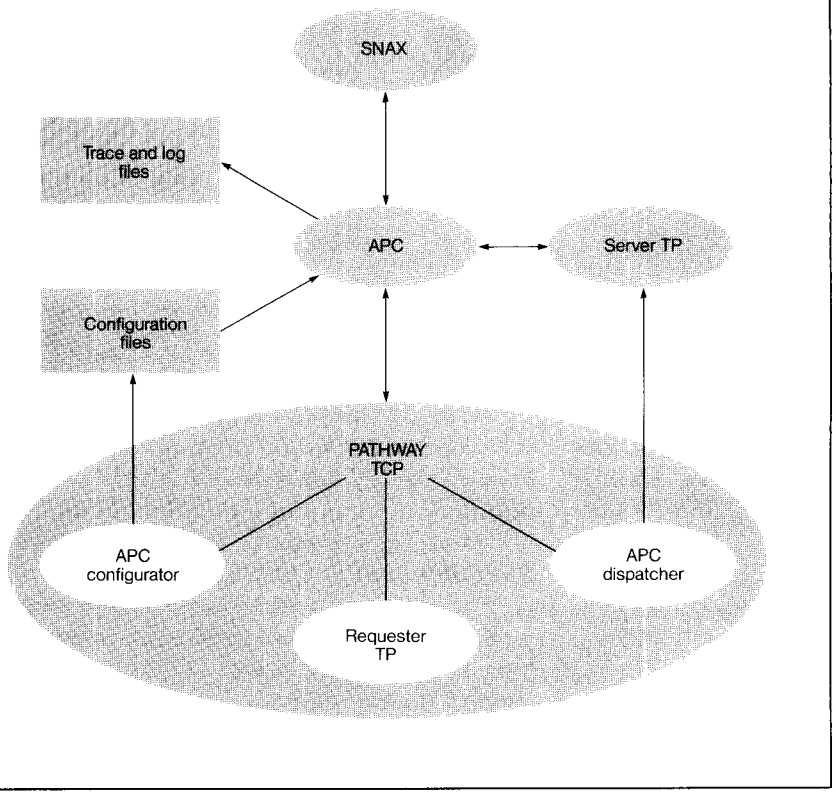

Figure 4

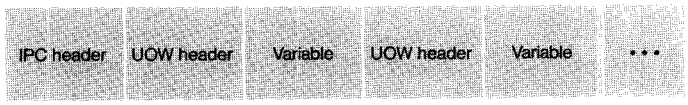

Figure 3.
SNAX/APC system structure. SNAX/APC is a system composed of an operator process for defining the network configuration, a dispatcher to invoke application server processes, and the APC server, which provides a high-level API for transaction programs.

Figure 4.
Format of interprocess communication messages (IPCs). The IPCs passed between the TP and SNAX/APC contain an identifying header and units of work containing the LU 6.2 verb, parameter, and return codes.

Figure 5

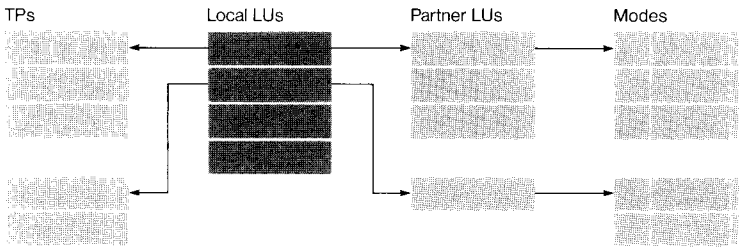

Figure 5.
SNAX/APC configuration objects and linkage. The SNAX/APC configuration process includes definition and linkage of the local objects and the partner LU and mode. The mode identifies the BIND image for the SNA session.

The *APC dispatcher* invokes local TPs when requested to do so by the APC server, as the result of an ATTACH request from a remote TP. When the APC server processes a remote request, it first checks to see if the TP is active, and if not, the APC dispatcher creates the local TP through the PATHWAY monitor's (PATHMON's) process creation facility.

The *APC configurator* is provided to configure the SNAX/APC environment. It presents menus for defining SNAX/APC objects and linking the objects into the desired configuration. The results are stored in configuration database files.

The APC configurator provides ENABLE menus to define the local LU, the partner LU, the mode for the partner LU, and the local TPs. Once these objects have been defined, the APC configurator provides additional menus to link the TPs to a local LU, the local LU to a partner LU, and the partner LU to a mode entry, thus completing the configuration process. Figure 5 represents the configured objects and the required linkage. The partner TP is not defined in the configuration; it is supplied by the local TP at execution time.

The *trace facility* consists of an internal trace generator and the trace formatter. The trace generator captures information flows between the TP and the APC server and between the APC server and SNAX. The trace formatter formats and prints the trace data according to user-specified parameters.

In addition to these system components, the SNAX/APC environment includes the user-written application TPs, which supply the business-function logic. These can be written in any language and can be implemented as PATHWAY servers or requesters or as independent processes.

Application Design Considerations

Many design alternatives exist for applications that are to use SNAX/APC. It is not practical to address all the design considerations in this article, but the following discussion should provide a general understanding of the alternatives. While detailed knowledge of SNA is not required for designing APPC applications, application designers should be familiar with basic SNA concepts and facilities.

Use of Proper Terminology

As with most new protocols, APPC has generated its own new terminology. Some of the terms may be confused with other similar ones, and some are confusing even within the context of APPC. The glossary on the opposite page contains definitions of commonly confused LU 6.2 terms and their relationship to each other.

Each term describing a TP has a meaning relative to its antonym, but each pair of terms is independent of the other pairs. For example, the source TP may be on the primary or secondary LU, may be in send or receive state, and may be local or remote, depending on the speaker's point of reference.

Potential Environments for SNAX/APC

SNAX/APC extends Tandem's already strong SNA capabilities by providing a base on which to build applications involving different types of distributed processors. It enhances the role of the Tandem system as a gateway, as a host supporting a wide variety of devices and personal computers, and as an interface for applications communicating with applications in other Tandem networks.

Session and Conversation

An *SNA session* is established between two LUs. An *LU 6.2 conversation* is conducted between two transaction programs (TPs) over a session. SNA bracket protocols are used to delineate conversations within a session. The ALLOCATE verb requests allocation of a conversation to a session.

Primary and Secondary

Primary and *secondary* are SNA terms for describing the LU's role when the session is established. The primary LU sends the BIND request that causes the session to be established, and the secondary LU receives the BIND request. Rules defined in the BIND request determine which of these is the first speaker in the exchange of information. (TP design is independent of this LU status.)

Allocate and Attach

A TP issues an *ALLOCATE* verb to allocate a conversation to a session and provide the local LU with the name of the partner TP to be attached. The ALLOCATE request causes the local LU to generate an *SNA ATTACH* Function Management Header (FMH-5) and send it to the partner LU to attach the partner TP.

Source and Target

These are adjectives describing LU 6.2 TPs. The *source TP* is the program that initiates a conversation by sending an ALLOCATE verb. The *target TP* is named in the ALLOCATE request as the conversation partner.

Send and Receive States

The source TP is in *send state* when a conversation is started, and the target TP is in *receive state*. LU 6.2 conversations are half duplex, meaning that only one TP is in send state at a time. Protocol dictates which verbs can be issued in each state and which verbs result in state changes.

TPs can be in states other than send or receive. Other program states define pending actions, such as confirmation and deallocation, or reset, which indicates that no conversation is allocated.

Local and Remote

Local and remote are used to describe geographic points of reference. The *local TP* is here; the *remote TP* is there. For example, when the Tandem environment is the focus of the discussion, the local LU and local TP are in the Tandem system and the remote LU and TP are in the other system. If the discussion is centered on the IBM system, the Tandem system becomes the remote one. Partner is also commonly used to mean the other TP or LU.

Gateway to IBM Host Applications. Using SNAX/APC, Tandem systems can provide a gateway to IBM mainframe applications in an LU 6.2 environment. The added functionality of commit processing makes it possible to confirm receipt of data on either node. In some instances, SNAX/APC could help to reduce the number of sessions required between nodes by sharing the sessions, to the extent allowed by performance requirements.

Workstations in a Tandem Network. SNAX/APC applications can communicate with mainframe computers, personal computers, and other workstations implementing APPC. A program called APPC/PC is available for personal computers. The IBM System/36 and System/38 have APPC support. Other vendors have announced or intend to support APPC, and new devices will be supported when they are introduced.

Other Networks. SNAX/APC can be very effective at connecting independent Tandem systems or networks across SNA links. It may be useful for connections with other networks as well. For example, an organization offering networking services may wish to provide applications to other Tandem customers through program-to-program communication. For this type of connection, APPC protocols remove some of the burden of application design and implementation. In some cases it may offer an SNA alternative to existing protocols.

Communication Between Transaction Programs

Program-to-program communication imposes some of the burden of protocol management on the application program designers. The protocols are half duplex, meaning that only one TP can send data at a time and the other must be in receive mode. The protocol allows exceptions to this rule for control information. Each TP's activity must be carefully coordinated with that of the conversation partner. The source program is put in send state after allocation, and the target program is put in receive state.

TPs can be involved in more than one conversation at a time (e.g., a business transaction may require conversations with multiple partners concurrently). TPs can also be written as multithreaded programs capable of handling unrelated conversations concurrently.

One of the major differences between mapped and basic conversations is the creation and interpretation of the GDS. TPs written for basic conversations are responsible for handling the GDS variables.

Some implementations of APPC support only mapped verbs and, thus, only mapped conversations. Other implementations allow applications to use either basic or mapped verbs. SNAX/APC does not support mapped conversation verbs, but it does provide the capability to communicate with remote TPs that use mapped verbs. This capability requires the application TP to create and recognize the additional GDS variables that may flow in mapped conversations and to respond correctly. Supporting communication with remote TPs that use mapped verbs provides an interim solution until SNAX/APC support for mapped conversation verbs is available.

Use of SNAX/APC with PATHWAY

PATHWAY is Tandem's transaction processing system. As mentioned earlier, the APC server is a PATHWAY server; TPs can be PATHWAY servers or SCREEN COBOL requesters; and the SNAX/APC system is configured with ENABLE screens. PATHWAY is not an absolute requirement for SNAX/APC; however, implementation without PATHWAY would involve a great deal more effort as configurator and dispatcher functions would not be available.

The APC dispatcher uses PATHMON's process creation mechanism as one way to create new TP server processes. TP servers are sensitive to conversation context, so the entire conversation must be completed within a single execution of a TP. The TP should not reply to the APC dispatcher until communication with SNAX/APC is complete.

SCREEN COBOL TPs provide a way to connect devices supported by PATHWAY to remote APPC applications. SCREEN COBOL is viable for many application programs, and it offers the advantages of PATHWAY's server management for database access.

Starting Conversations

A conversation can be started in several ways. TPs can become a partner in a conversation either by issuing the ALLOCATE verb to attach a remote TP or by being attached by a remote TP. In either case, the program must be active and must notify SNAX/APC of its presence by sending a program initialization parameter (PIP) request. The PIP request is a service UOW indicating the program's start-up intentions through the parameter specifications.

TPs can be started locally by CI or TACL commands or by another process. TPs started in this manner can either allocate a conversation or wait to be attached by a remote TP.

TPs can also be started as the result of an ATTACH request from a remote TP. When the attach is received for a local TP that is not active at the time, SNAX/APC directs the APC dispatcher to create the TP. (Note that SCREEN COBOL TPs cannot be started through the APC dispatcher.)

Performance Considerations

The most significant performance variable users are likely to encounter when designing SNAX/APC applications is contention for the SNA session resource. APPC allows conversations to share a session as a serially reusable resource. To guarantee availability of a session for each conversation, one session must exist for each potential conversation. Since sessions are longer than conversations, it is possible to allocate many short conversations to a session serially without significantly affecting performance. The duration of conversations obviously affects the availability of the session.

When parallel sessions are used, available sessions can be selected by the LU dynamically, thus reducing the contention problem. SNAX/APC does not currently support parallel sessions; however, it does allow multiple single sessions to exist concurrently. Performance can be improved with this capability. Since there is no dynamic selection, application designers must determine which conversations are to use which sessions.

The application program interface significantly reduces the interprocess communication.

The application program interface allows multiple UOWs to be sent in the same interprocess message. For example, a single WRITEREAD statement can send three verbs at a time to the APC server to allocate a conversation, send data, and deallocate (end) the conversation. This capability significantly reduces the interprocess communication overhead for transaction processing environments.

Logical and physical data record sizes are important performance variables. The ratio of physical and logical record sizes determines the number of interactions required to transfer logical records between processes. In SNAX/APC the physical record sizes affect the buffer requirements for the APC server. Each TP can potentially use two maximum-size buffers. Users should attempt to configure their systems to avoid use of extended memory segments.

Physical record sizes need not be the same for both TPs in a conversation. The access method and LUs segment and chain the physical records into logical records. Performance characteristics of each system may dictate different buffering requirements for their respective TPs.

Conversation Verbs Supported by SNAX/APC

The following verbs are supported by the current release of SNAX/APC. Additional levels of support (option sets) are implemented by adding new parameter variables, so all parameters of a verb are not automatically included. A review of the basic verbs and their functions should convey the type of logic required in an application TP. Refer to the *SNAX/APC Programmming and Operations Guide* for the format of the verbs and parameters.

ALLOCATE indicates a request to initiate a conversation. The following parameters are supported:

- SYNC_LEVEL specifies the sync level of the conversation. *None* or *confirm* can be specified.
- LUNAME (other) specifies the name of the partner LU.
- MODENAME specifies the name of a set of LU session parameters.
- TPNAME specifies the name of the partner TP that is to be attached.

CONFIRM indicates a request for the partner TP to confirm one or more events, such as the receipt of data.

CONFIRMED is the response from the partner TP to a CONFIRM request or a DEALLOCATE CONFIRM request.

DEALLOCATE is a request to deallocate (terminate) a conversation. The TYPE parameter can have one of four values:

- SYNC_LEVEL flushes the output buffer and requests the partner TP to confirm at the sync level agreed upon.
- FLUSH flushes the output buffer and tells the partner TP to deallocate.
- ABEND_PROGRAM tells the partner TP to deallocate and ignores the transmission status and data. This is an abnormal termination.
- LOCAL requests the local LU to deallocate the local resources. This is issued locally after receipt of one of the above types of deallocate request from the partner TP.

GET_ATTRIBUTES allows a TP to retrieve the partner LU name, mode name, and conversation sync level of the partner LU.

RECEIVE_AND_WAIT puts the sending TP in receive state to receive data and control information. TPs perform receive-and-wait loops until all data is received and then respond to control information according to conversation protocol rules. A WHAT_RECEIVED indicator tells the TP whether the LU has received data or control information.

REQUEST_TO_SEND allows a TP in receive state to notify the partner TP that the local TP has data to send. The partner TP has the prerogative of when to turn the conversation around.

SEND_DATA sends data to the partner TP.

SEND_ERROR notifies the partner TP that a problem has been detected in the data or application logic.

Conclusion

SNAX/APC takes full advantage of SNAX and the PATHWAY transaction processing system. It provides a high-level application program interface that uses standard GUARDIAN 90 File System calls and employs an efficient unit-of-work concept. Applications using SNAX/APC can be written in any language supported by Tandem.

SNAX/APC supports LU 6.2 basic conversations over single-session LUs, meaning that it can support only one session, and therefore one conversation, at a time on each LU. SNAX/APC does, however, support up to 32 LUs per APC server. This unique implementation allows multiple concurrent conversations with CICS/VS.

The next release of APC will provide primary LU support, allowing APC to act as the primary to secondary LUs such as the PC.

SNAX/APC's internal structure is designed according to the *IBM Formats and Protocols Manual* for LU 6.2 and, thus, provides a base for additional option-set enhancements.

Application-program design for APPC requires a great deal of coordination between the designers of application programs, unlike former protocols in which the remote object is a relatively inflexible device.

The introduction of SNAX/APC enhances Tandem's networking and transaction processing capabilities. It allows Tandem systems to participate as peers to any systems offering similar APPC capabilities. Finally, it allows Tandem systems to become intermediate nodes for distributed systems or host nodes for devices implementing LU 6.2.

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Enhancements to PS MAIL

The PS MAIL™ electronic mail systems let correspondents send messages through a Tandem network to other PS MAIL correspondents. Tandem employees rely on it for their corporate communication, as do many Tandem customers.

In the B40 software release, PS MAIL was enhanced in response to user requests, including the results of a user survey. Also, PS MAIL can now access documents sent by Tandem's new WORDLINK™ document exchange facility. WORDLINK allows users to transfer documents between stand-alone word processors or word processing programs via the Tandem system. Finally, PS MAIL now supports national languages, allowing Tandem's international customers to have multilingual mail interfaces on a single system.

The next four sections of this article present the following:

- *An overview of PS MAIL*. This section describes the PS MAIL user interfaces and the TRANSFER™ information delivery system. It uses some terms specific to the product; the glossary, at the end of the article, defines them.
- *New features in PS MAIL*. This section, intended for all users of PS MAIL, describes new functions and enhancements to existing ones.
- *WORDLINK*. The beginning of this section, of interest to PS MAIL contacts and analysts, describes WORDLINK and how documents are stored and retrieved within TRANSFER. The end of the section, useful to all users receiving WORDLINK documents, describes enhancements to PS MAIL functions for handling these messages.
- *National language support*. This section is intended for readers interested in TRANSFER's approach to national language support.

Refer to the glossary for definitions of PS MAIL and TRANSFER terms used in the discussion. Refer to the latest versions of the appropriate PS MAIL manuals, listed at the end of this article, for complete descriptions of the new features and their use.

An Overview of PS MAIL

PS MAIL allows users to create, send, receive, and store messages. A message can contain many kinds of data, such as a text file, a word processor document, a PC text or object file, or facsimile data.[1] Messages received are automatically stored in an electronic folder called the INBOX. From the INBOX, they can be sent to other correspondents, filed into other folders, output to a printer or disk file, or deleted.

A message is composed of several parts:

- The envelope, containing the address and subject of the message.
- The text of the message.
- Optionally, attachments, such as other messages or files.

A message can be sent to one or more recipients. A simple way to specify many recipients is to use a distribution list containing correspondent names and/or the names of other distribution lists.

PS MAIL User Interfaces

There are three PS MAIL user interfaces:

- *PS MAIL for TTY terminals* is a command-driven, line-oriented interface. It is used on any terminal, including teletype (TTY) terminals, connected to a Tandem system.
- *PS MAIL for 6530 terminals* is a menu-driven, screen-oriented interface used on any Tandem terminal or workstation.
- *PS MAIL for 3270 terminals* is used on IBM 3270 terminals (or those that emulate the 3270). It is virtually identical in function to PS MAIL for 6530 terminals. One visible difference is that the two versions use different function keys for command functions because the layouts of their keyboards differ.

In this article, for simplicity, the name *PS MAIL 6530* indicates both PS MAIL for 6530 terminals and PS MAIL for 3270 terminals. *PS MAIL TTY* indicates PS MAIL for TTY terminals.

[1]In the context of this article, *PC* refers to Tandem PCs, IBM PCs, or IBM-compatible PCs. PS MAIL requires Tandem's PC LINK software to transfer files between the Tandem system and a PC.

TRANSFER and PS MAIL

TRANSFER is an information delivery system that supports communications between people, input/output devices, and processes. The PS MAIL products are requester programs that provide the interface between correspondents and TRANSFER. Other products mentioned in this article that are used with TRANSFER are FAXLINK™, which allows correspondents to transfer documents to and from facsimile devices, and WORDLINK, which allows correspondents to transfer documents created with word processing devices or programs via the Tandem system.

New PS MAIL Features

The following are PS MAIL's major new features:

- The PRINT function has been split into three parts, each having specific capabilities, giving users greater control of their output.
- More defaults in the correspondent profile (such as the default printer location and extended editor) can be changed by users.
- Users can copy any distribution list on their node to a new or existing distribution list belonging to them.
- Adding attachments to the workspace has been enhanced.
- Each PS MAIL user interface has additional enhancements.

New Method for Output of Messages

The PRINT function has been split into three separate output functions:

- COPY is used to copy messages to a GUARDIAN 90 or PC file.
- PRINT is used to output messages to a printer or facsimile machine.
- FORMAT is used to output messages to a printer under the control of a text formatter.

Also, multiple messages can now be copied or printed in a single job.

COPY. COPY copies messages to a GUARDIAN 90 or PC file specified by the user. Descriptions of the COPY options follow.

MSGONLY (MO) copies just the message, not its attachments. ALL, signifying all of the attachments, is the default.

NOHEADER tells PS MAIL to copy the message but not the envelope (header) of the message. HEADER is the default. This option is useful for messages that will be formatted later.

PURGE automatically purges the contents of the file (if it exists) before copying the message. This option can be used when copying messages to GUARDIAN 90 files and must be used when copying messages to existing PC files.

TRANSLATE, followed by a language name, is used by PC users to identify the character set of the GUARDIAN 90 file so that any non-ASCII national characters in the file can be translated to their equivalent codes on the PC. The language can be any of the following:

DANSK	NORSK
DEUTSCH	SVENSK
ESPANOL	UK
FRANCAIS	USASCII
NONE	

COPY also has options specifically for handling WORDLINK documents. These options and their effects on WORDLINK documents are described in the WORDLINK section of this article.

PRINT. PRINT prints messages to a printer or facsimile machine. A printer can be given as a parameter; if it is not, the message or messages are printed on the default printer specified in the correspondent's profile. Descriptions of the PRINT options follow. (The FAXLINK options have not changed and are not listed here.)

MSGONLY (MO) and NOHEADER options are the same as for COPY.

PAGE is used when a range of messages is specified for printing from PS MAIL TTY or when several messages are selected for printing from PS MAIL 6530. (Message ranges in PS MAIL TTY are discussed later.) The PAGE option forces each message to be printed on a separate page. PAGE is the default; NOPAGE causes the messages to be printed with no page separation between them.

FORMAT. FORMAT is used to print messages to a printer under the control of a text formatter. A printer can be given as a parameter; if it is not, the message or messages are printed on the default printer specified in the correspondent's profile. The same is true for the text formatter used. Descriptions of the FORMAT options follow.

MSGONLY (MO) and NOHEADER are the same as for COPY and PRINT.

TFORM and TGAL override the correspondent's default formatter. (TFORM is the program name for PS TEXT FORMAT™, a command-oriented text formatter.)

Printing Multiple Messages in One Job. When multiple messages are selected in PS MAIL 6530, or selected as a range in PS MAIL TTY (e.g., PRINT 1/3), they are now output in one job. This means the output will have one banner page followed by all the printed messages instead of one banner page for each message. In PS MAIL TTY, messages selected as a list (e.g., PRINT 1 2 3) are output as multiple jobs.

Customizing the Profile

More items in a correspondent's profile can now be altered by the correspondent instead of the PS MAIL contact. These are:

- The default formatter, used when the FORMAT command is used and a formatter is not specified.
- The GUARDIAN 90 user ID and password, used on behalf of the correspondent to start programs and to create files.
- The correspondent's password, used to log on to PS MAIL.
- The default printer, used when no printer or facsimile device is specified for the output of messages or when no facsimile device is specified for adding attachments to the workspace.
- The default system, volume, and subvolume, used on behalf of the correspondent to fully qualify file names.
- The default extended editor, TEDIT, EDIT, or T-TEXT, used when editing messages or attachments. (TEDIT is the program name for PS TEXT EDIT™, a full-screen text editor.)

In PS MAIL 6530, these settings can be changed on the new PROFILE screen, accessed by pressing F14.[2] In PS MAIL TTY, they can be changed with the new commands, ALTERFORMATTER, ALTERGUARDIANID, ALTERPASSWORD, ALTERPRINTER, ALTERSYSTEM, ALTERVOLUME, and ALTERXEDIT.

Display settings in PS MAIL TTY, such as whether confirmation messages are displayed or explanations are included with prompts, can be changed with the new command ALTERDISPLAY. Note that the ALTERDISPLAY, ALTERGUARDIANID, and ALTERPASSWORD commands replace the former PROFILE command.

Copying Distribution Lists

Correspondents can now copy any distribution list on their local node to a new or existing distribution list belonging to them. They can do this in PS MAIL TTY with a new command, COPYDISTRIBUTION, and in PS MAIL 6530 with the new MERGE key (F8). Duplicate correspondents are automatically removed.

Adding Attachments

Adding attachments to the workspace has been enhanced. The enhancements give increased functionality to PS MAIL TTY and PS MAIL 6530, and provide extra features for PC and WORDLINK users. (The WORDLINK features are described in the WORDLINK section.)

Automatic Workspace Creation from PS MAIL TTY. A workspace no longer must be created with the CREATEMAIL command before an attachment can be added. The ADDATTACHMENT command now automatically creates a workspace of type ORIGINAL if the workspace is empty. This is useful for storing GUARDIAN 90 or PC files in PS MAIL folders with the COPYWORKSPACE command. For example, the two commands

Correspondents can now copy any distribution list on their local node.

```
ADDATTACHMENT PC:records7
COPYWORKSPACE all_records
```

put the PC file records7 into the PS MAIL folder all_records. (The feature was available in the previous release of PS MAIL 6530.)

More Attachments in PS MAIL 6530. Up to 100 attachments can now be added to a message being created. Correspondents can add multiple attachments with the same keystroke by marking one or more messages from the SCAN screen or the new SHOW ATTACHMENTS screen and then pressing the ADD key (F7). In PS MAIL TTY, as before, up to 100 attachments can be added to the workspace, but they must be specified in separate commands.

[2] In this article, all function keys mentioned are for PS MAIL for 6530 terminals. For the corresponding keys for PS MAIL for 3270 terminals, see the *PS MAIL Users' Guide and Reference Manual for 3270 Terminals.*

Character Mapping Option for PC Users. A new key word, TRANSLATE, followed by a language name, is used to identify the character set of a PC file that is to be added as an attachment. This is so that any non-ASCII national characters on the PC can be translated to their equivalent codes on the Tandem system. The language can be any of those listed for the COPY command, described earlier.

Highlights of PS MAIL TTY Enhancements

Aside from supporting the features just described, PS MAIL TTY has many other new features. Users will also see more informative advice messages and an improved display of information. Only the major new features are discussed here, including:

- Message ID ranges.
- FC command for changing the TO, CC, and SUBJECT lines.
- New DIRECTORY command.
- Enhanced SHOWFOLDERS command.
- Enhanced READ command
- New EDITMESSAGE command.
- Enhanced CLEAR command.
- PS MAIL TTY commands in the start-up message.
- BREAK key operation.

Message ID Ranges. The COPY, DELETE, FILE, FORMAT, PRINT, and READ commands now support message ID ranges, a shorthand way to specify sequential message IDs without denoting each one separately. The range is defined by two message IDs separated with a slash (/). Message ID lists and ranges can be combined (e.g., PRINT 1/3, 5, 7/9). The command line can contain as many message IDs and/or message ID ranges as will fit.

PS MAIL TTY confirms action on a range with a single confirmation message per range. If some of the message IDs have already been deleted, it does not report that the message has been deleted. If the entire range is empty, it reports this in an advice message.

FC Command for Changing the TO, CC, and SUBJECT Lines. Correspondents can now use the FC command to change the TO, CC, and SUBJECT lines when creating, forwarding, and replying to messages. This feature is useful for correcting typing errors and adding or deleting recipients.

New DIRECTORY Command. This new command lets users show the directory of correspondent names on a given node. This command accepts a partial correspondent name and a node name to list matching correspondents. For example, DIRECTORY * @PARIS lists all of the correspondents on the PARIS node and DIRECTORY SMITH_* lists all of the correspondents on the current node whose last names are SMITH.

Enhanced SHOWFOLDERS Command. Users can now give the SHOWFOLDERS command a partial folder name to list a subset of their folders. For example, SHOWFOLDERS P* lists all of the correspondent's folders that start with the letter P.

Enhanced READ Command. Users no longer need to give an additional READ command to read a single attachment to a message. READ automatically displays an attachment to a message if the message has only one attachment. (PS MAIL 6530 displays all of the attachments to a message.)

New EDITMESSAGE Command. To continue to edit a message in the workspace, users can issue a new command, EDITMESSAGE. They can use this command, in place of CREATEMAIL, to bypass the address prompts and begin editing the message immediately.

Enhanced CLEAR Command. Now when users clear the workspace so that another message can be created, the workspace is automatically copied to the WASTEBASKET folder before it is cleared. (This feature was in the previous release of PS MAIL 6530.)

PS MAIL Commands in the Start-up Message. Users can now include PS MAIL commands as parameters when starting up PS MAIL TTY. For example, to start up PS MAIL and index the INBOX, the start-up message would be

PSMAIL INDEX INBOX.

BREAK Key Operation. The BREAK key can now be used to terminate the processing of a single command, multiple commands on a command line (e.g., PRINT; FILE reports), or an OBEY file containing commands.

Highlights of PS MAIL 6530 Enhancements

In addition to the new PS MAIL features already mentioned, PS MAIL 6530 has other new features that make it easier to use and more powerful. Three new screens and new function key capabilities have been added. The major new features are:

- Persistent selection marks.
- Previous screen function.
- Last page function.
- Increased EXTRAS availability.
- Folder functions on the MAIN screen.
- New SHOW ATTACHMENTS screen.
- New READ ATTACHMENT screen.
- Enhancements to creating mail.
- Simultaneous filing and deleting of messages.

Persistent Selection Marks. Previously, selection marks on the MAIN and SCAN screens were erased after every action executed. To simplify multiple actions on an item, the marks now remain. Users can print and then delete messages, for example, by marking the messages, pressing the PRINT key, and then pressing the DELETE key. Also, to allow multiple actions on distribution lists, users can select multiple items on the DISTRIBUTION LISTS and DISTRIBUTION NAMES screens.

Previous Screen Function. F16 now returns users to the previous screen, not the MAIN screen as before.

Last Page Function. The shifted NEXT PAGE key now displays the last page of a screen.

Increased EXTRAS Availability. The EXTRAS key (SF15) is now available from all screens except the LOGON and HELP screens.

Folder Functions on the MAIN Screen. Users can now list a subset of their folders from the MAIN screen by typing a partial folder name on the options line and pressing F16. As before, this key also refreshes this screen.

Correspondents can delete up to ten folders from the MAIN screen at once, instead of one at a time, by marking the folders and pressing the delete key.

Multiple folders can also be selected and merged with the FILE key (F8) from this screen by marking the folders to be merged and typing the destination folder on the options line. The destination folder can be either a new or existing one.

New SHOW ATTACHMENTS Screen. A new screen, SHOW ATTACHMENTS, accessed by pressing SF1 from the CREATE, READ, and SCAN screens, lists attachments to the workspace or to the message and presents the hierarchy of the attachments with level numbers. From the CREATE screen, SF1 shows attachments to the workspace; from the READ screen, it shows attachments to the message being read; and from the SCAN screen, it shows attachments to the selected message.

New READ ATTACHMENT Screen. A new screen, READ ATTACHMENT, accessed by pressing F2 from the SHOW ATTACHMENTS screen, reads an attachment shown on the SHOW ATTACHMENTS screen.

Enhancements to Creating Mail. In addition to the MAIN screen, the CREATE screen can now be accessed from the SCAN, READ, SHOW ATTACHMENTS, and READ ATTACHMENTS screens.

Also, a correspondent creating a message can now copy, format, or print the workspace directly from the CREATE screen (instead of filing the workspace to a folder first) with the COPY key (SF9), FORMAT key (SF8), or PRINT key (F9).

Finally, the message in the workspace can be filed and sent using a single keystroke by typing the folder name on the options line and pressing the SEND key (F11).

Filing and Deleting Messages Simultaneously. Correspondents can now file and delete messages in a single keystroke by typing the folder name on the options line and pressing the DELETE key (F6).

WORDLINK

WORDLINK, a new product available in the B40 software release, allows users to transfer documents between various word processing programs or devices and the Tandem system. WORDLINK has two parts: the WORDLINK batch gateway to TRANSFER and a collection of translator programs.

WORDLINK allows users to transfer documents between various word processing programs or devices and the Tandem system.

The *batch gateway* is used to send documents from a word processor to any PS MAIL correspondent. For example, a correspondent using a Wang OIS or a Wang VS system can send a Wang document, via the WORDLINK batch gateway to TRANSFER, to a correspondent who is using a Tandem 6530 terminal. When the message is delivered, the *translator programs* convert the message from Wang format to a form accessible by the recipient. (This step is completely transparent to the recipient.)

How TRANSFER Stores WORDLINK Messages

A document sent through the WORDLINK batch gateway to TRANSFER generally appears in the INBOX as a message attachment of type DOCUMENT and can be handled just as most other messages received. Unlike other types of messages, however, a message of type DOCUMENT is stored as an external object; i.e., it is external to the TRANSFER database but can still be accessed and used by TRANSFER. Translations of the message are stored as alternate external objects to the message, transparently attached to the primary external object.

Message Translation upon Delivery

Messages are translated when they arrive in the INBOX by the Translate-On-Delivery TRANSFER agent. (An agent is a TRANSFER program that is automatically invoked to handle messages on the correspondent's behalf.) This agent can be configured through the TRANSFER Administrative Application (ADMIN) to automatically translate documents into one or two specific formats. Once a message of type DOCUMENT is translated to a particular format, it need not be translated again for any other user on that node. This is because only one copy of a message resides on the node, regardless of the number of recipients.

Occasionally, a translation of the message may not be immediately available to a correspondent because the message has not yet been translated. This happens, for example, when an attempt to read the message is made immediately upon delivery or when the correspondent needs a translation that is not specified in the Translate-On-Delivery agent. In this case an advice message is displayed; the user can access the message after it has been translated.

The WORDLINK document translators currently available are:

- ANSI.
- ASCII.
- DISPLAY.
- MultiMate.
- RFT (Revisable Format Text for DisplayWrite2 or 3 on a PC).
- Textpack (for IBM Displaywriter).
- TFORM.
- Wang.

The Wang, MultiMate, RFT, and Textpack translators are sold and licensed separately, so a node can be licensed to support just a few or all of these formats, depending on the users' needs. The other translators are included with WORDLINK.

Translation of WORDLINK Documents

When a message of type DOCUMENT is *read*, *printed*, or *added to the workspace for editing*, PS MAIL automatically selects a DISPLAY translation of the document. This translation appears as though the document has been formatted. Embedded printer attributes, such as pagination, boldfacing, and underlining, are not in the translation because they cannot be interpreted by the terminal.

When the message is *edited as an attachment* to the workspace, *formatted* to a printer, or *copied* to a GUARDIAN 90 or PC file, PS MAIL selects a translation containing formatting commands. For most users of Tandem terminals, the translated format is TFORM. As the formatting information remains intact, the recipient may, for example, copy a message containing MultiMate commands and escape codes to a GUARDIAN 90 file in TFORM format, add text and TFORM commands to the file, and then use TFORM to print the file to a Tandem printer.

PS MAIL Enhancements for WORDLINK Documents

Most of PS MAIL's support for WORDLINK documents is transparent to users; however, some PS MAIL command options specific to this new product have been added. When correspondents add a WORDLINK attachment to the workspace, the document format (such as MultiMate) must be specified. The attachment is then added to the workspace as type DOCUMENT.

The document format can be specified, but is not required, when an attachment is copied to a GUARDIAN 90 or PC file. The document format is implicit when correspondents edit an attachment of type DOCUMENT in the workspace and when they read, format, and print these messages.

Adding WORDLINK Documents as Attachments. A new keyword, AS, followed by the document format tells TRANSFER the format of the attachment to be added. The document format is one of those listed earlier. From PS MAIL TTY, for example,

ADDATTACHMENT results AS TFORM

adds the file results to the workspace as a TFORM document.

Printing and Formatting WORDLINK Documents. A message of type DOCUMENT is printed or formatted just as any other message received. When the PRINT command prints a message of type DOCUMENT, a DISPLAY translation of the message is printed. When the FORMAT command prints a message of this type under the control of the TFORM formatter, a TFORM format translation of the document is given to TFORM to format. When the TGAL formatter is selected, a DISPLAY format translation of the message is given to TGAL to format.

Copying WORDLINK Documents to a File. The new optional keyword, AS, followed by the document format, tells TRANSFER which translation of the message to copy. From PS MAIL TTY, for example,

```
COPY 1 PC: forcasts AS MULTIMATE
```

copies a MultiMate translation of the message to a PC file named forcasts.

If no document format is specified, PS MAIL copies a TFORM translation when the default formatter is TFORM; otherwise, it copies a DISPLAY translation. TFORM translations add special TFORM commands so that when the document is formatted, the envelope (header) information is printed on a separate page. Separate messages copied to the same file each start on a new page, and formatting commands used in one attachment do not affect the next one.

PS MAIL now provides many alternative language versions and corresponding character maps to its international users.

National Language Support

PS MAIL now provides many alternative language versions and corresponding character maps to its international users. An unlimited number of the PS MAIL language versions can exist on a single TRANSFER system. Currently PS MAIL for 6530 terminals is available in Danish, Finnish, French, German, Hebrew, Norwegian, Spanish, and Swedish. PS MAIL for 3270 terminals is available in Danish, Finnish, Norwegian, and Swedish. And finally, PS MAIL for TTY terminals is available in Finnish. Additional language versions will be supplied as demand requires. The following sections present the user's view of these alternative language versions, how the alternative language text is stored, and how a single TRANSFER system supports these multiple language versions.

The User's View

National language support allows help text, advice messages, prompts in PS MAIL TTY, and screens in PS MAIL 6530 to appear in the correspondent's language. Correspondent names appear as they would normally in the native language; for example, a Danish recipient of a message sent through PS MAIL, whose name contains "ø," can now be registered and referenced by the correct name. The special folder names, INBOX, OUTLOG, and WASTEBASKET, have names that are meaningful for each language on the system. Finally, TRANSFER system messages, such as acknowledgments for certified mail, are also translated.

Text Storage

The text generated by PS MAIL TTY, such as command names and help text, is stored in its own command and message files. The screen text for PS MAIL 6530 is stored in a special TRANSFER database. The text generated by TRANSFER, used by all PS MAIL user interfaces, such as the special folder names and TRANSFER system messages, is also stored in a special TRANSFER database.

PS MAIL Glossary

Attachment

A message or a file (such as a GUARDIAN 90 file or facsimile document) that is attached to another message.

Character map

A set of codes that establishes a correspondence between the native form of a character and a base character set. A base character set is the set of all characters that TRANSFER stores and makes available for text. In effect, this map is a set of rules for encoding or representing characters in that set. It determines how characters entered from the keyboard are interpreted, and how characters output to various devices are generated by TRANSFER.

Correspondent

A PS MAIL user who creates, sends, receives, and handles mail messages.

Directory

A list of all correspondents on a node.

Distribution list

A list of recipients to whom messages can be sent. Distribution lists allow PS MAIL users to specify many correspondents with just one reference.

Envelope

The information that identifies a message. It contains the name of the sender, the message type, the subject of the message, and the date and time the message was sent. When a message is read, the envelope appears just before the text of the message.

Folder

An area where messages are stored. Correspondents can organize their mail by creating folders, storing messages in them, and deleting them when they're no longer needed. Folders are private; no one but their owners can create, view, use, or delete them. Each PS MAIL correspondent owns three special permanent folders: INBOX, OUTLOG, and WASTEBASKET.

INBOX

Messages received by the correspondent are automatically filed in this folder.

Message type

A designation that describes how the message was created. It is displayed in the message envelope. Some of these types are: DATA, DOCUMENT, FAX, FORWARD, ORIGINAL, PCDATA, REPLY, TEXT, and TTEXT.

Node

A Tandem computer system that is part of a network of other Tandem systems.

OUTLOG

This folder contains a record of messages sent by the correspondent. These messages are generally filed for just 24 hours.

Profile

A portion of the TRANSFER database that contains the correspondent's password and default information such as the default printer and formatter.

PS MAIL contact

A person in an organization who is responsible for general administrative assistance to PS MAIL users.

WASTEBASKET

This folder contains messages deleted from other folders and is emptied when the correspondent exits PS MAIL.

Workspace

A temporary area where PS MAIL saves the address, message text, and attachments to the message that is being created. The workspace remains intact until the correspondent sends the message, explicitly clears the workspace, or exits PS MAIL.

Multilingual Systems

Generally, when a correspondent starts PS MAIL, TRANSFER uses the default language and character map configured for the node. When a correspondent needs to start PS MAIL in an alternate language and character map, a front-end program specifying the alternate language and character map is used to start TRANSFER and PS MAIL.

Conclusion

The B40 release of PS MAIL extends the capabilities for using electronic mail in several ways. First, the PS MAIL user interface is more powerful and flexible, so that users can handle their mail more efficiently. Second, PS MAIL now allows users of word processors on PCs or stand-alone systems to exchange documents with other PS MAIL users through WORDLINK, so that users can use their normal word processor. Third, PS MAIL can be converted into a number of foreign languages and character sets, so that users can handle their mail in their native language. These enhancements make the PS MAIL products more attractive to current and potential customers, and more useful for Tandem employees.

References

PS MAIL Reference Manual for TTY Terminals. Part no. 84036. Tandem Computers Incorporated.

PS MAIL User's Guide and Reference Manual for 3270 Terminals. Part no. 84042. Tandem Computers Incorporated.

PS MAIL User's Guide and Reference Manual for 6530 Terminals. Part no. 84043. Tandem Computers Incorporated.

PS MAIL User's Guide for TTY Terminals. Part no. 84044. Tandem Computers Incorporated.

Acknowledgment

The author would like to thank Sue Francis for providing information about PS MAIL 6530.

Rhoda Funk joined Tandem in 1983 after completing a B.S. in Applied Mathematics and Computer Science at Carnegie Mellon University. She is the current developer for PS MAIL TTY and other Information Management Technology (IMT) software.

Tandem customers need a variety of up-to-date product information to use their Tandem equipment effectively. Until recently, their primary means to obtain this information was by contacting their local systems analyst or sales representative. The analysts have several tools at their disposal to answer the query: Tandem's internal mail network, where information from other analysts is requested; an on-line internal information system, where prior queries are archived and indexed for easy access; or any of the other internally accessible collections of data.

Now, customers can access a similar collection of information *directly* through Tandem's new on-line Customer Information Service (CIS). In addition to information retrieval, customers can share their knowledge and experience through CIS's information exchange facility.

Why CIS?

A customer information service, as the name implies, puts information into the hands of the customer. With the levels of interpretation removed, the customer has direct access to information.

An important reason for such a service is the immediate availability of the information. Customers need the information when they say they need it, not the next day or the next week. If a problem occurs at 4 A.M., that's when the answer is needed. Without the delays associated with phoning someone for information (who must research it and phone back), an on-line information system provides round-the-clock accessibility.

Further, information which is centrally maintained is frequently more up-to-date and consistent than otherwise possible.

Customers can expect this service to help solve many of their day-to-day problems:

- Verifying the installation of the most recent emergency bug fixes (EBFs).
- Searching for problems similar to those being experienced.
- Searching Tandem publications (such as the *Tandem Systems Review*) for applications/operations suggestions.
- Exchanging ideas or information about software or hardware products with other Tandem customers. (Data placed into the information exchange expires after 30 days, though particularly useful information is collected into an information *archive*.)
- Locating classes that fit the customer's educational and scheduling needs.

Several information systems predate CIS. The earliest was a system designed for Tandem analysts only. It was used by field analysts to search for previously submitted questions and answers, and by customers to access SOFTDOCs and other information. The system that followed was designed to ease maintainability and to keep the information up-to-date.

Features

The features provided on CIS cover a wide range of areas, from directories and schedules to general information about software. As presently configured, the CIS system supports the following features:

- *Alliance*, a directory of companies that are members of Tandem's Alliance program. This feature allows the customer to search for Alliance members by name, product name, or area of expertise. For example, a customer can search for CIM and find all members with computer-integrated manufacturing experience.
- *Classes*, schedules for Tandem education classes. With this feature, a customer can search current class schedules by class name (or fragment of the name, e.g., TMF), class code, class location, class region (North America, Europe, Pacific), or date range. For example, with date range, one can search for all TAL classes between January 15 and March 2.
- *EBF information*. This feature gives customers access to information about EBFs (reported bugs for which a fix is available). EBFs can be searched for by Tandem product number, product name (such as DP2-related problems), HOTSTUFF number, or by some symptoms (such as CPU crash or directory corruption).
- *Electronic store*. This feature allows customers to peruse the items in the electronic store, make selections, submit a purchase order number, and be automatically billed for the selections. Software manuals are currently available. Access to this feature can be restricted to certain individuals at a company site.
- *Help*. With this feature a customer can find which features are installed on the system, what they are, and how to use them. This online help facility is available to all users. If the customer is familiar with the standard Tandem command interpreter (COMINT) syntax, they should have no difficulty using the CIS system.
- *Information exchange*. With this feature a customer can post and read notices on various topics. Users can add themselves to special interest groups and post notices to other members of such groups. (A FORTRAN user's group can exchange information about FORTRAN and special applications using it.) This facility allows customers to share their experiences and gather valuable help from other users.
- *Menu*. With this option, features are invoked by selection from a menu of allowable choices. This feature coexists with the command-driven interface. Customers can access features by their names or by their menu item numbers.
- *News*. This feature allows the customer to view news about the CIS system. Articles cover enhancements, the addition of new databases, new classes, or any other items related to CIS and its use.

- *Press releases*. With this feature a customer can search Tandem press releases by date, product name, or by any string information. (For example, a customer could search for a press release in which Kentucky Fried Chicken was mentioned.)
- *PML*, product maintenance levels. This is an up-to-date listing of products supported by Tandem, dates the product will be supported, and the level of support available.
- *SOFTDOCs*, Tandem software documentation shipped on the product tape. This feature gives the customer the ability to search existing SOFTDOCs for information. The customer can search for SOFTDOCs by Tandem product number, product name (such as DP2), or by any string information that might appear in a SOFTDOC. (For example, a customer can search for all SOFTDOCs mentioning memory.)
- *Suggestion box*. This feature allows customers to submit suggestions and comments about the CIS system and its performance.
- *Tandem Systems Review*. With this feature customers can search *Tandem Systems Review* articles for information. They can search articles by product names (such as VLX), subjects (such as security), or by any other string information.

Refer to Figures 1, 2, and 3 for more information on CIS's features.

Accessing CIS

CIS is currently available to customers in two ways: through dial-up ports available at the Tandem Sunnyvale office and through a broader-based CompuServe network to which CIS is connected.

Customers choosing to access the CIS system directly can call a Sunnyvale, California, telephone number and be connected to the system. The dial-up ports in Sunnyvale are available to any customer. These ports support 300- or 1200-baud terminals.

Figure 1

```
CIS 2> help

The following features are installed on the CIS system:

ALLIANCE                    CLASSES
EBF_LIST                    EBF_SEARCH
EBF_SUMMARY                 HELP
INFO_EXCHANGE               MENU
NEWS                        PRESS_RELEASES
PML                         PRODUCT_MAINTENANCE_LEVELS
SOFTDOC_B30_LIST            SOFTDOC_B30_SEARCH
SOFTDOC_B40_LIST            SOFTDOC_B40_SEARCH
SUGGESTION_BOX              SYSTEMS_REVIEW
TANDEM_STORE

For more information enter: HELP ALL
For more detailed information about a specific feature
enter: HELP featurename
```

Figure 2

```
CIS 3> help all

The following features are available on this system. They may be invoked by
entering the feature name as shown. (Additional help may be obtained for a
specific feature by entering its name after the word HELP.) EXAMPLE:

HELP ALL (will display this information)

ALLIANCE                    - searches for Tandem Alliance Directory information
CLASSES                     - searches Tandem class schedule information
EBF_LIST                    - displays EBF HOTSTUFFs, and EBF SOFTDOCs
EBF_SEARCH                  - searches EBF HOTSTUFFs, and EBF SOFTDOCs
EBF_SUMMARY                 - displays Emergency Bug Fix summary information
INFO_EXCHANGE               - allows users to exchange ideas
MENU                        - allows menu-selection access to features
NEWS                        - displays current Tandem or CIS news
PML                         - alias for PRODUCT_MAINTENANCE_LEVELS
PRESS_RELEASES              - searches Tandem press releases
PRODUCT_MAINTENANCE_LEVELS  - defines software product maintenance levels
SOFTDOC_B30_LIST            - displays B30 SOFTDOCs for individual products
SOFTDOC_B30_SEARCH          - searches B30 SOFTDOCs
SOFTDOC_B40_LIST            - displays B40 SOFTDOCs for individual products
SOFTDOC_B40_SEARCH          - searches B40 SOFTDOCs
SUGGESTION_BOX              - allows user to enter comments or suggestions
SYSTEMS_REVIEW              - searches Tandem Systems Review articles
TANDEM_STORE                - an electronic store that allows ordering of selected
                              products
```

Figure 1.
Initial HELP screen showing all features.

Figure 2.
HELP summary screen with features described.

Figure 3

```
CIS 4> help alliance

The Tandem Alliance Directory contains information on Tandem Alliance
companies. This feature allows the user to search for information by
company name or by the subject area (example: CIM will yield all
Alliance members with Computer Integrated Manufacturing products).
This feature is accessed by entering ALLIANCE.
```

Figure 3.
Detailed HELP information for an individual feature.

CompuServe, a subscriber-based network, provides dial-up access from several hundred locations throughout the United States, Canada, Europe, and the Pacific. Customers simply dial a local number and log onto the CompuServe network. They are then connected to the CIS system in Sunnyvale. In addition, the CompuServe network can be accessed via "bridges" from other network services that provide X.25 access (see Figure 4).

Regardless of the path chosen, once users have accessed the CIS system, they can log onto it just as they would any Tandem system, through the command interpreter. Individual features are invoked by entering their names at the CIS prompt. A list of available features is viewed by entering HELP (see Figure 1). A command of HELP ALL (see Figure 2) gives a brief description of each feature. For additional information on each feature, enter HELP followed by the feature name (see Figure 3).

Each feature on the CIS system can be accessed and controlled separately, making it possible for one feature to be updated without affecting others. This benefits the user by keeping the most features available at any given time. The system also lets the users know the status of any disabled feature. For instance, if a new database were to be installed for the classes feature, the system operator would make that feature unavailable during the installation. If a user attempted to access it, the system would display the following message:

```
CLASSES
   NAMED FEATURE WILL BE
   UNAVAILABLE UNTIL  14:01 15-SEP-87
                      (21:01 15-SEP-87 GMT)
```

Customers have the option of giving their employees complete access to all features or of limiting access on a user-by-user basis. For example, a supervisor at a customer site may be the only person licensed to access an extra-cost feature. This degree of control will become increasingly important as new features are added which could result in additional charges (see electronic store under "Features").

The first-time user might find the new-user information helpful. To access it, simply enter NEW_USER at the CIS prompt. Most users become familiar with the CIS system after their first or second session.

Future Directions for CIS

The CIS system was not intended as a static service; it was designed with a modular architecture to allow for expansion as new needs arise. CIS will change and grow as customers' needs for information change.

One feature currently under development provides Tandem product report (TPR) status information. (TPRs are initiated by the customer and include suggestions for enhancements to products and problems encountered with the products.) This feature will allow customers to view the current status of their own TPRs, but not those submitted by other customers.

Signing Up for CIS

CIS is currently available for use by Tandem customers through their local Tandem analyst or salesperson. Since laws and regulations affecting the use of CIS vary from country to country, the local sales office should be queried for specific ordering procedures.

The basic subscription gives a customer access to CIS through the Sunnyvale dial-up modems. There are other options available, in addition to the basic subscription, that allow customers several methods of access via the CompuServe network.

Comments or suggestions for ways to improve the product are always welcome.

Joe Massucco joined Tandem's Corporate Manufacturing Technology Software Support Group in 1981 with over 15 years of experience in applications and system-level software. While in Manufacturing, he designed the Tandem control software for the NonStop TXP board test system. He joined the Field Productivity Programs Group in 1986 to design and implement the CIS system.

Figure 4

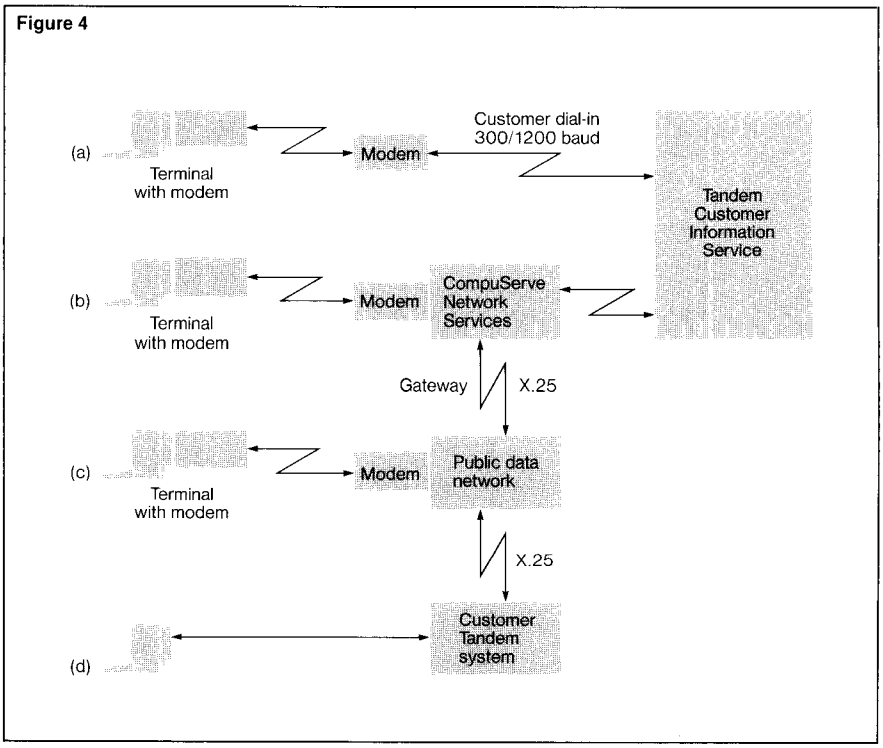

Figure 4.

Customer access to the Customer Information Service. The various methods of access are represented by the following: (a) direct dial-up access to the Sunnyvale, California, number; (b) dial-up access through CompuServe; (c) dial-up access through other public data networks, such as INFONET (internationally); (d) X.25 access using a terminal connected to a customer's Tandem system.

Tandem's Software Support Plan

Tandem's Software Support Plan was developed to give Tandem customers a better understanding of how support is provided. It represents a strengthening of definition of Tandem's support plans for software and an improvement in support practices.[1]

Software Releases

There are two types of software release: unplanned and planned.

An *unplanned* release is produced on demand in response to an emergency situation. Because of its emergency nature, an unplanned release is called an Emergency Bug Fix (EBF). It typically involves a single product and is distributed and installed in the smallest possible package, i.e., the smallest number of files required to fix the problem.

As its name implies, a *planned* release is a planned event. The two types of planned release have different criteria. In the *base release*:

- The foundation products have undergone a major change.[2]
- Any product is eligible for submittal without restriction.
- The release is based on content (i.e., it is not tested and distributed until all of the planned content is present).
- Base releases occur approximately every 18 months.
- The release, as a whole, is beta-tested.
- The release ID indicates a new base version (e.g., B00, C00, etc.).

In the *incremental release*:

- The foundation products have not undergone a major change.
- The set of products eligible for submittal is restricted; candidates for eligibility are scrutinized for risk of regressions.
- This release is based on the schedule (i.e., it is tested and distributed on a schedule; planned content that is not ready must wait for the next planned release).

[1]The Software Support Plan is not intended to conflict with any license agreements that may currently be in effect. The plan itself may be amended periodically. Customers will always receive written notification of such changes at least three months prior to their effective adoption date.

[2]Foundation products are those which would appear at, or near, the root of a tree showing the execution dependencies of Tandem products in relation to the majority of customer applications. Examples of foundation products are GUARDIAN, EXPAND, TMF, and PATHWAY.

- Incremental releases occur approximately every six months.
- The release, as a whole, will not be beta-tested.
- The release ID indicates only a revision to the base version (e.g., the B10, B20, and B30 revisions of the B00 release).

New software products and significant enhancements to existing products undergo beta testing before general distribution in any planned release. New products/features introduced in a base release are beta-tested in conjunction with the release as a whole; new products/features introduced in an incremental release are beta-tested individually, before inclusion in the release.

All products participating in a planned release are tested as a unit and should be installed as a unit. Mixing products or files from different planned releases on a single system may give unpredictable results.

Each planned release will be announced at least six weeks before it is available.

Shipping Planned Releases to Customers

Planned releases are always delivered to customers on a Site Update Tape (SUT). A SUT contains all standard software products, plus those optional software products that a given site is entitled to receive. Three different events can trigger the shipment of a SUT:

1. The shipment of a new system is accompanied by a SUT containing the most recent planned release within the most recent base series.
2. A new order by an existing customer for an optional software product is filled with a SUT containing the ordered product. The SUT contains the most recent planned release within the most recent base series.
3. A request for a planned release by an existing customer is filled by a SUT containing the most recent planned release for the requested base series.

Software Support

Overview

Tandem's support commitments pertain to systems entitled to software maintenance in accordance with a Tandem software agreement. Several areas are involved:

- The release states for planned releases.
- The Product Maintenance Levels of software products.
- The severity levels of reported problems/enhancements.

Release States. A given release is either supported or unsupported.[3]

An *unsupported release* is one for which Tandem provides support on a "best effort" fee basis, with no guarantee that a problem can, or will, be fixed. Charges for support of such releases are assessed in accordance with the Analyst Services Agreement.

In a *supported release*, Tandem provides defect support in accordance with a Tandem software agreement. From its initial date of availability, each planned release is supported for a minimum of 15 (typically 18) months. When a new planned release is announced, definitive dates for the support periods of previous releases will be included in the announcement. The expiration date for any planned release will be announced to customers at least six months before the release becomes unsupported.

The state of any given release (supported or unsupported) is unchanged by the application of any modification (e.g., an EBF) supplied by Tandem.

[3] In order to make a correlation to licensing agreements, the contract terms "Current Release" and "Noncurrent Release" may be generally substituted for the terms "Supported Release" and "Unsupported Release" that are used in this article.

Table 1.
Tandem's Product Maintenance Levels (PMLs).

Level	Description
Active	The product is distributed in planned releases. The product is still evolving functionally and is actively maintained.
Mature	The product is distributed in planned releases. The product is functionally mature and reliably stable. New versions of the product are produced only when necessary to solve significant problems.
Obsolete	The product is no longer supported, and it ceases to participate in planned releases. References to the product will be removed from the price list and other literature.

Table 2.
Severity levels (SLs).

Level	Description
0	Can tolerate the situation indefinitely.
1	Can tolerate the situation, but expect a solution eventually.
2	Can tolerate the situation, but not for long. Need a solution.
3	Cannot tolerate the situation. A solution urgently needed.

Product Maintenance Levels. There are varying degrees of maintenance activity for Tandem's software products. Certain products receive less maintenance effort than others, based on the maturity of the product, the size of its user community, or the existence of a preferred replacement product. Eventually, after sufficient customer notification, Tandem may want to withdraw all maintenance for certain products.

Each Tandem software product is assigned to one of three *Product Maintenance Levels (PMLs)*. The PML of a product is a description of its current maintenance status. At any given time, a product is assigned to only one PML. PMLs are defined in Table 1.

The PML for each product is included in the Release Notes for each planned release, and in machine-readable form on the SUT. Such information reflects the PMLs at the time of initial release and may not be current at a later date.

A current list of PMLs is maintained on the Customer Information Service (CIS), which is available by subscription. An accompanying article, "Customer Information Service," describes the features of the CIS system.

An announcement of a change to the PML of a product will be in terms of a calendar date and will be announced at least six months before the change is effective. Notification will be at least 12 months in advance for a product moving to the obsolete category.

Severity Levels. Problems or enhancement requests are assigned a severity level (SL) dependent on the customer's degree of need for a solution. (See Table 2.)

The severity level is defined by two components:

- The consequences of the problem.
- The urgency of need for a solution.

These two components are not always in direct proportion to one another. There are many problems with dire consequences that are not urgently in need of a solution. Conversely, there is a smaller set of problems whose consequences are tolerable, but whose urgency for a solution is great. Assignment of severity level requires subjective judgment. It is critical that both the Tandem analyst and the customer agree on the severity level when the report is submitted, keeping in mind that if everything is an emergency, then nothing is.

The severity level of a given problem is strictly a function of the problem and is unrelated to its solution. Once established, the severity level in the Tandem Product Report (TPR), as well as Tandem's commitment to fix the problem in a future release, is unchanged by the presence of a temporary solution.

Tandem's support commitment is defined in Table 3.

Solution Alternatives

Any problem has two basic solutions: fix it or work around it.

A single fix is based on a single version of a product, but it may be applicable to multiple supported releases, each containing a different version of the faulty product. Normally, the deliverable form of a fix for a supported release is based on the highest version of the faulty product component that is compatible with the reported version.

A "workaround" instead of a fix may be indicated if the workaround ensures that:

- Delivery is more timely.
- Implementation is less complex.
- Reliability is more certain.

A workaround in lieu of a fix must be acceptable to the customer, and it must have the effect of reducing the severity to a level that the customer can tolerate until the problem is permanently fixed in a planned release.

Permanent vs. Temporary Solutions. There are several ways that Tandem might provide relief from a problem. A temporary solution might be a workaround. This option results in no changes to software supplied by Tandem.

Alternatively, a customer could replace the entire faulty product with a newer version from a more recent planned release or replace the minimum number of files required to solve the problem. The source of the replacement file(s) might be either:

- A more recent planned release containing the desired fix.
- An EBF based on a more recent version of the product.
- An EBF based on the reported version of the product.

For a permanent solution, a customer could install an entire, more recent, planned release containing the desired fix.

Table 3.
Tandem's support commitment, defined as a function of release state, Product Maintenance Level, and severity level.

		Product Maintenance Level		
		Active	Mature	Obsolete
Support component	Release state	SL 0 1 2 3	SL 0 1 2 3	Any SL
Investigate a problem in the reported release	Supported	Y Y Y Y	N N Y Y	F
	Unsupported	F F F F	F F F F	F
Deliver a temporary solution in a form compatible with the reported release	Supported	N N Y Y	N N N Y	F
	Unsupported	F F F F	F F F F	F
Implement a permanent fix in a future planned release	Supported	Y Y Y Y	N N Y Y	N
	Unsupported	Y Y Y Y	N N Y Y	N
Consider an enhancement request for implementation in a future planned release	Supported	Y Y Y Y	N N N N	N
	Unsupported	Y Y Y Y	N N N N	N

Y = Yes, covered by software agreement
N = No, not covered by software agreement
F = Fee based on Analyst Services Agreement

Randy Baker joined Tandem in 1983 after a 16-year career with another vendor. Initially he ran a task force to establish a support strategy for Tandem and later became manager of several support organizations. In 1984, Randy was named director of Customer Support for Tandem.

Dennis McEvoy co-authored the original release of GUARDIAN and later became manager of the Operating Systems Software Group. He helped establish Tandem in 1974. In February 1981 Dennis was named manager of Software Development and, within two years, was appointed vice president of that group. Under his direction, our software development strategy continues to evolve to address the needs of customers and to create state-of-the-art products.

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