HP 3000 900 Series
Computer Systems

General Information Manual

July 1991

HP Computer Museum
www.hpmuseum.net

General Information Manual

HP 3000 Computer Systems

HEWLETT PACKARD

Preface

Purpose

The *HP 3000 Computer Systems General Information Guide* presents a broad overview of the HP 3000 family of business computer systems. It includes information on HP software, networking, and peripherals, as well as related topics such as support services.

This manual is intended for the reader who has a basic understanding of data processing in business environments and who is interested in how HP 3000 systems meet business data processing needs.

Organization

Chapter One summarizes the design and capabilities of HP 3000 systems and discusses in general how these systems can meet business needs.

Chapter Two is an overview of the entire HP 3000 family of business computers.

Chapter Three is an overview of the HP 3000 operating environment.

Chapter Four describes the data management and CASE solutions provided by the HP 3000.

Chapter Five is a summary of the networking and interoperability capabilities of the HP 3000.

Chapter Six describes the HP office information client-server software that works with HP 3000 server systems.

Chapter Seven describes some of the peripheral devices that are supported by the HP 3000.

Chapter Eight summarizes HP's support services, user courses, and user documentation available for the HP 3000.

Appendix A describes HP Precision Architecture-RISC, the architecture upon which the 900 Series is based.

For more information

Primers

For the less technically knowledgeable reader, Hewlett-Packard offers a series of primers that explain the basic concepts of various technical subjects related to the HP 3000 systems and business data processing.

- *Toward Open Systems—A primer on operating environment standards* (5953-6348)
- *The Hewlett-Packard NewWave Environment—Your Window to the Future* (5952-3755)
- *HP Precision Architecture—A New Perspective* (5954-6677)
- *Relational Technology—A Productivity Solution* (5954-6676)
- *Touring Datacomm—A Data Communications Primer* (5957-4622)
- *Connecting to Your Computer—A Workstation to Computer Communications Primer* (5957-4625)

- *Making the LAN Connection—A Local Area Network Primer* (5957-4624)
- *Communicating With IBM—An HP-to-IBM Communications Primer* (5957-4623)
- *Networking with X.25* (5957-4635)

To obtain any of these primers, contact your local HP sales office. Or call HP DIRECT at (800) 538-8787.

HP 3000 Configuration Guide (5091-1731E)

The *HP 3000 System Configuration Guide* provides detailed hardware and software configuration information for the HP 3000 family of business systems. The *Configuration Guide* can be obtained from HP sales offices or from HP's Direct Marketing Division.

The HP 3000 Open System Environment (5952-2490)

The *HP 3000 Open System Environment* is a white paper that describes the HP 3000 open systems framework. The framework consists of the application programming interfaces (API) for the operating system, user interfaces, databases, languages and tools, and networking. The *HP 3000 Open System Environment* can be obtained from HP sales offices or from HP's Direct Marketing Division.

Contents

3. HP 3000 Operating Environment

Figures

General Information Manual

HP 3000 Computer Systems

Introduction

Management Overview

The HP 3000 family offers a broad range of compatible systems and servers optimized for online transaction processing (OLTP). Well known for reliability and ease of use, the HP 3000 products offer a superior solution for business-critical information, facilitating improved operational efficiency and better, faster decision making. The HP 3000 delivers outstanding price/performance system solutions with effortless growth in computing capacity.

Recent independent user polls have rated HP 3000 computers the top minicomputers in the industry. The HP 3000 900 Series rated number 1 overall, including number 1 in 13 of 15 categories in COMPUTERWORLD's Buyers' Scorecard[1] and shared top honors in the PC WEEK Poll of Corporate Satisfaction[2].

The HP 3000 incorporates advanced software and hardware technologies to provide an excellent open foundation for OLTP applications. The HP 3000 incorporates HP Precision Architecture-RISC (PA-RISC), which is based on *reduced instruction set computing* (RISC) technology. The HP 3000 combines PA-RISC hardware architecture with an advanced operating system specifically designed for the high-performance and functionality demands of OLTP applications and traditional batch processing. In fact, the HP 3000 is the only computer system in the industry that combines the benefits of a RISC hardware architecture with an operating system specifically designed for commercial processing. In addition, the HP 3000 supports a wide range of industry and de facto standards in order to provide the open systems benefits of application portability and multivendor interoperability.

A common, open operating environment is provided across the entire family of HP 3000 systems, ranging from systems for fewer than 10 users to products offering mainframe-class performance and functionality. The HP 3000 can serve the needs of the entire enterprise. HP 3000 systems are very easy to use, as illustrated by the midrange and low-end systems, which are fully office-compatible and can be used and managed by non-computer specialists. This ease of use is complemented by robust functionality and high system availability, appropriate for the large-scale, business-critical applications supported on the mainframe-class HP 3000 products.

[1] *Hewlett-Packard Cleans up in Mini Sweepstakes*, COMPUTERWORLD, September 24, 1990, pp 80-81
[2] *Minicomputer Buyers Expect a Lot for Their Money*, PC WEEK, December 24/31, 1990, pp 48-50

Thousands of industry-leading applications are available
for the HP 3000 worldwide. These solutions are available for a wide
range of industries and functional areas, including manufacturing,
distribution, state/local government, finance, and human resources.
New applications, including client-server and enterprise solutions,
are continually becoming available on the HP 3000. In addition,
for organizations that seek a competitive advantage through
developing their own application solutions, the HP 3000 supports
a comprehensive set of *computer-aided software engineering*
(CASE) tools and database products that are optimized for peak
performance. HP's data management systems, relational-model
HP ALLBASE/SQL and network-model HP TurboIMAGE, are
tightly integrated with the HP 3000 operating environment to deliver
superior performance and data integrity.

HP offers a wide array of multivendor networking capabilities, quality
peripheral devices, personal computers, and PC integration products
across the entire line of HP 3000 computers. All these are delivered
by a worldwide HP sales and service organization that is recognized,
year after year, as one of the best in the computer industry.

HP 3000 strategy   The HP 3000 strategy consists of the following key elements:

A. *A broad family of PA-RISC-based compatible systems and servers*
   The HP 3000 offers a very broad family of compatible computers,
   ensuring that customers can easily select the system providing the
   optimal price/performance for a specific application environment.
   Beyond providing object code software compatibility, HP 3000
   systems provide easy growth in capacity via simple, cost-effective
   upgrades consisting simply of faster processor boards. A common
   operating environment across the HP 3000 family ensures that
   not only is software compatibility maintained as applications
   expand, but that the end-user, the programmer, and the system
   administrator interfaces also remain the same. This approach of
   software compatibility and easy hardware field upgrades ensures
   that customer investments in software, hardware, and personnel
   are protected. PA-RISC provides scalable systems to serve the
   needs of the entire enterprise.

B. *Optimized for OLTP*
   The HP 3000 has been specifically tailored to meet the
   demanding needs of online transaction processing (OLTP). OLTP
   environments require fast access to up-to-date, reliable data,
   and systems that are highly available so that the data can be
   accessed when needed. The efficiency of the operating system,
   coupled with powerful PA-RISC processors, provides fast response
   time and high system throughput. In the area of reliability,
   industry surveys continually rank the HP 3000 as one of the most
   reliable products on the market. This high level of reliability
   is complemented with high availability extensions that provide
   virtually uninterrupted 24-hour operation. And the

HP 3000 provides mainframe-class systems management functionality while dramatically lowering operating costs and improving staff productivity through both centralized and remote operations. Hewlett-Packard was the first in the industry to publish results of the Transaction Processing Council's TPC-A industry-standard benchmark and remains a price/performance leader.

C. *Open systems and industry standards*
The HP 3000 will support an open operating environment that provides UNIX application programming interfaces (APIs) together with extensive commercial OLTP capabilities in 1991. Hewlett-Packard is committed to industry standards that provide customers maximum application portability, interoperability, and ease of integration with multivendor environments, including UNIX and IBM System Application Architecture (SAA). This means that applications written for UNIX and POSIX are highly portable to the HP 3000. HP has taken a leading role in developing virtually every major industry standard in use today. The HP 3000 supports industry and de facto standards in the operating system, networking, database, user interface, and compiler products. With HP's commitment to supporting X/Open-compliant and X Window System interfaces, the HP 3000 provides a high degree of application portability and better leverages customers' investments in software, hardware, and personnel.

D. *Multivendor networking*
HP 3000 systems support a wide variety of multivendor networking standards that allow information to be easily distributed and accessed in local-area and wide-area networks. Hewlett-Packard is committed to simplifying multivendor communications and interoperability via a commitment to industry-standard networking protocols such as Open Systems Interconnect (OSI), and key de facto standards such as Advanced Research Project Agency (ARPA) and System Network Architecture (SNA). With a comprehensive offering of networking capabilities, HP 3000 systems integrate effectively with networks of personal computers, midrange computers, and mainframes from HP and other vendors.

E. *Client-server computing*
Hewlett-Packard is recognized as providing leadership products in PC integration and client-server computing. Server database information can be downloaded to PC applications via a simple, intuitive graphical user interface (GUI). The HP 3000 provides centralized administration for functions such as PC software distribution, electronic mail, and shared workgroup resources, data files, printers, scanners, and plotters, and consistent, powerful window-oriented interfaces across both PC and OLTP applications. The HP 3000 application servers support both Novell NetWare and Microsoft LAN Manager.

F. *Application solutions*

HP's Value-Added Business (VAB) program has been rated number 1 for three straight years. Together, HP and these business partners offer thousands of industry-leading solutions for a variety of worldwide industries and functional applications, including manufacturing, distribution, state and local government, finance, human resources, and a host of others. These solutions are complemented by an extensive network of sales and service experts in specific markets and business functions, ready to assist customers in selecting the solution best suited to their business needs.

G. *Support and consulting services*

Hewlett-Packard has long set the standard for effective customer support among computer vendors. For the last eight years customers have rated HP support number 1 in the Datapro survey. A wide array of customer support and consulting services are designed to ensure long-term, productive use of HP 3000 systems. Coupled with HP's worldwide sales and support organization, which has many years of helping customers more easily collect and access information to better run their businesses, the HP 3000 allows customers to use information as a competitive advantage.

HP 3000 Systems

A wide variety of HP 3000 processors are available to meet the price and capacity needs of application environments, ranging from small offices to large computer centers. All of the HP 3000 products support a consistent operating environment, which couples ease of use with a robust set of functionality for online transaction processing and batch processing. From the entry-level 917LX to the top-of-the-line Series 980/200, the HP 3000 family spans from systems for small work groups through mainframe-class applications for hundreds of users.

HP 3000 900 Series products are available in two configurations: first, as multiuser/concurrent batch systems for traditional host-based OLTP and batch applications and second, as application and database servers, which can be used in client-server configurations with PCs connected using local area networks (LANs). Server products are preconfigured solutions for PC-based environments and support traditional host-based and client-server applications. The HP 3000 servers are referred to with the "Server" prefix, while the traditional multiuser HP 3000s are referred to as "Series," for example, Server 947 or Series 947.
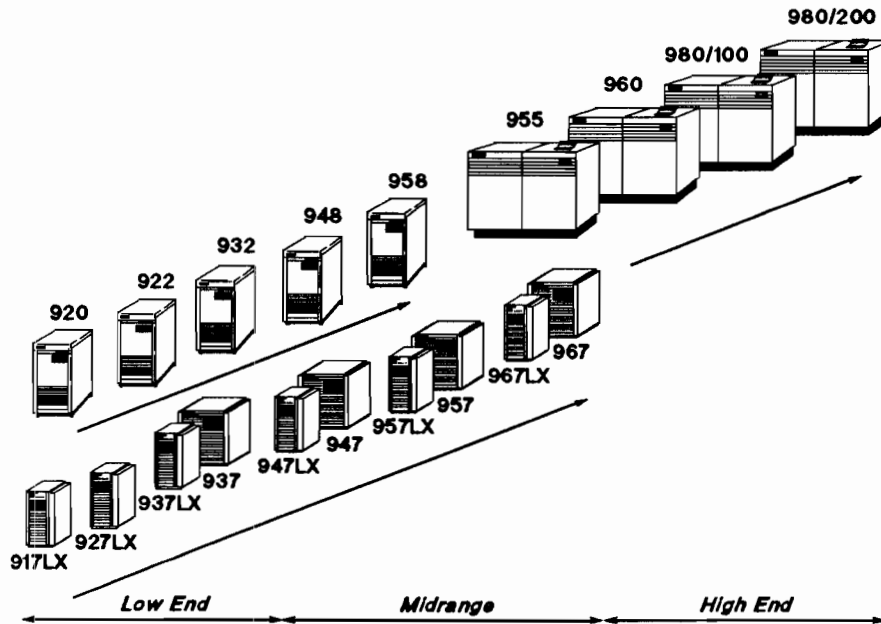
Figure 1-1. HP 3000 Family

HP 3000 high-end systems

There are four mainframe-class, high-performance HP 3000 900 Series systems: the Series 955, 960, 980/100, and 980/200. Each system uses highly reliable VLSI semiconductor technology that delivers a CPU on a single processor board. The Series 960, 980/100, and 980/200 PA-RISC systems are available as simple *board-swap* upgrades that can easily be installed on-site to provide significant increases in processing capacity. Targeted for EDP room environments, these air-cooled systems require significantly less floor space and power than traditional mainframes.

The HP 3000 Series 955 and 960 use NMOS III VLSI technology developed by Hewlett-Packard. The Series 955 and 960 offer high performance for application environments supporting up to 600 users and up to 85 Gbytes of disk storage. The Series 955 and 960 provide greater disk storage capacity than the HP 3000 midrange systems and provide a processor board upgrade path to the top-of-the-line Series 980/200. The Server 955 and 960 also are available for PC client-server computing.
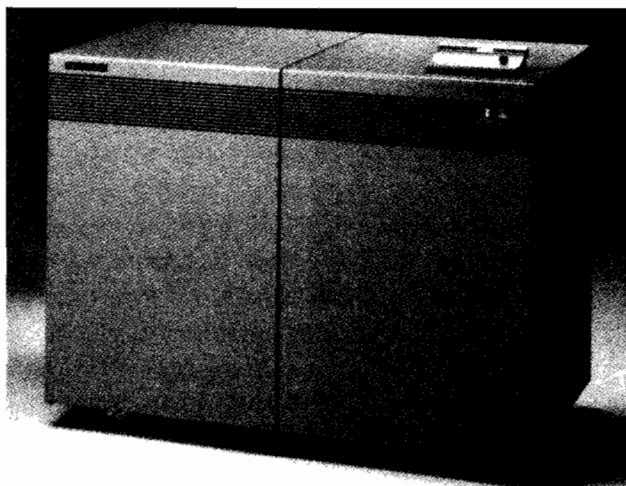
Figure 1-2. HP 3000 High End Platforms

The Series 980/100 and 980/200 systems are based upon new submicron CMOS semiconductor technology developed at Hewlett-Packard. The Series 980/200 couples two CPUs in a symmetric multiprocessor configuration within a single cabinet. These systems offer outstanding performance, reliability, and functionality for large-scale OLTP and batch applications. They couple mainframe-class throughput and systems management capabilities with the HP 3000's ease of use.

HP 3000 entry and midrange systems

The HP 3000 Series 917LX, 927LX, 937LX, 937, 947LX, 947, 957LX, 957, 967LX, and 967 are the high performance entry to midrange members of the HP 3000 family of business computers. These ten systems take advantage of HP Precision Architecture-RISC (PA-RISC) to deliver a cost effective range of CPU performance, configurability, and user license options. Investments are protected by the ability to increase computing power through simple processor board upgrades, or to increase I/O capacity provided by easy package upgrades.

The entire system including CPU, memory, disk, tape backup device, and operating system come preconfigured from the factory in a compact, integrated package which fits into an office environment with no special requirements. The system, along with external peripherals, can also be rack mounted in a compact 1.1 or 1.6 meter cabinet. External peripherials do not come preconfigured.
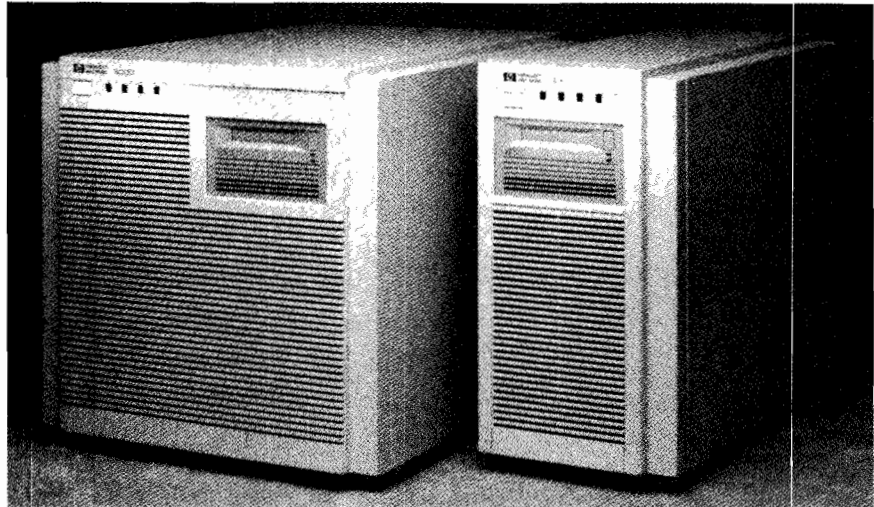
Figure 1-3. HP 3000 Entry and Midrange Packages

Also available as entry and midrange solutions are:
The HP 3000 Series 920, 922, 932, 948, and 958 and Server 920, 922, 932, 948, and 958 systems. These PA-RISC processors provide simple, *board-swap* upgrades that span a performance range of 8.5 times from the Series 920 to the Series 958. They occupy an integrated, compact package the size of a two drawer file cabinet. The entire family, including CPU, memory, disks, Digital Data Storage (DDS) tape backup, and operating system come preconfigured from the factory. These system configurations were designed for office environments and have no special power or environmental requirements.

The server configurations combine the HP 3000's strength in transaction processing with client-server applications, services, and tools for PC users.
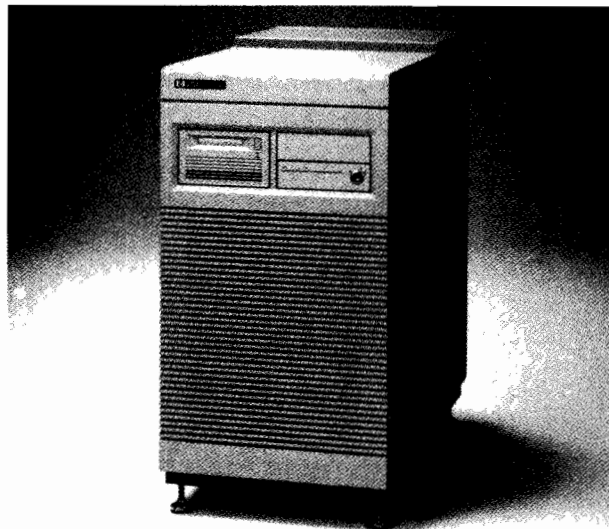
Figure 1-4. HP 3000 Series 948 Platform

HP Precision Architecture

HP Precision Architecture-RISC (PA-RISC), which forms the basis of the HP 3000 900 Series systems, delivers major price and performance advantages over traditional, more complex architectures, and provides the expandability to meet user requirements into the next century. PA-RISC represents a fundamental change in computer design. This new architecture is based on reduced instruction set computing concepts, with significant OLTP extensions for COBOL applications, high-performance I/O, and high availability.

RISC is the result of the discovery that computer performance can be greatly increased by reducing and simplifying the computer's instruction set. This allows computer instructions to be implemented directly in hardware, eliminating the system overhead associated with the microcode of conventional computers. PA-RISC can be implemented in a number of technologies and is ideal for very large scale integration (VLSI) design. By eliminating the chip space required for microcode, highly integrated VLSI designs can be achieved, resulting in single-chip CPUs and single board processors.

Pipelining, which provides higher performance by overlapping the execution of multiple instructions, is enhanced through the uniformity of the PA-RISC instructions, which enables one instruction to be executed every CPU clock cycle.

Improved performance also results from the hierarchical memory design of the PA-RISC architecture and the use of optimizing compilers. Optimizing compilers generate very efficient object code, allocate registers, and schedule instruction sequences to maintain an efficient pipeline operation. Frequently used instructions and data are stored in a large number of CPU registers, thereby minimizing memory accesses. Additionally, a large amount of CPU cache provides high-speed buffering for code and data, further minimizing the time that the processor must wait while memory accesses are performed.

PA-RISC transparently supports a 48- or 64-bit virtual memory address space. The 48-bit space is more than 65,000 times larger than that of a conventional 32-bit system, and the 64-bit space is more than four billion times larger. The large virtual addressing capability of the 900 Series systems allows users to expand their program sizes substantially without being limited by addressing capacity.

PA-RISC has been specifically designed to easily support multiprocessing, and the high-end Series 980/200 system implements two-way symmetric multiprocessing. PA-RISC also provides for a variety of coprocessors to meet specific computing requirements. For example, 900 Series systems use hardware floating-point coprocessors to accelerate the performance of applications that use floating-point data types for scientific, engineering, or statistical applications.

The simplicity of PA-RISC translates into significantly reduced design and development time, reliability, and reduced manufacturing

costs. It allows simplified system designs that require substantially fewer system components than complex instruction set computer architectures. The benefit to you is industry-leading price/performance, minimal environmental requirements, and extremely reliable systems.

PA-RISC is on the leading edge in computer design. It is the *wave of the future* and represents a significant contribution to the computer industry. The HP 3000 900 Series was the first computer in the industry to deliver the benefits of RISC to the commercial marketplace and continues to provide leadership price/performance.

HP 3000 Operating Environment

The HP 3000 supports an open operating environment that provides extensive commercial OLTP functionality together with UNIX application programming interfaces (APIs). operating system manages all system resources and coordinates the execution of all programs, sessions, and jobs running on the system. Starting from the original version of MPE, HP has added new functions and capabilities that extend the HP 3000's performance, superior data integrity, high availability, extensive interoperability with multivendor systems, and networked systems management, all while maintaining upward system compatibility and a consistent user interface.

OLTP systems have very stringent requirements for response times, accuracy of data, and the ability to recover from system and hardware failures while maintaining complete data integrity.

The HP 3000's high OLTP performance is achieved using tight integration of PA-RISC, the operating system, and HP's database management systems. The HP 3000 eliminates the bottlenecks to OLTP performance through an advanced operating system design that not only processes I/O operations very rapidly, but also minimizes the number of physical I/Os that must actually be performed.

Superior data integrity and high availability have long been hallmarks of the HP 3000. Online diagnostics and automatic powerfail recovery are standard features on the HP 3000 900 Series. HP 3000 high availability products limit system downtime due to planned events, such as backup and unplanned events, such as system and hardware failures. HP provides fast, online backup, automatic restart after system failure, disk shadowing, and the ability to switch processing to a secondary processor after primary processor failure. The HP 3000's high availability provides system availability of over 99.9 percent for unplanned downtime, by limiting any failure to 30 minutes or less, allowing virtually 24-hour operation.
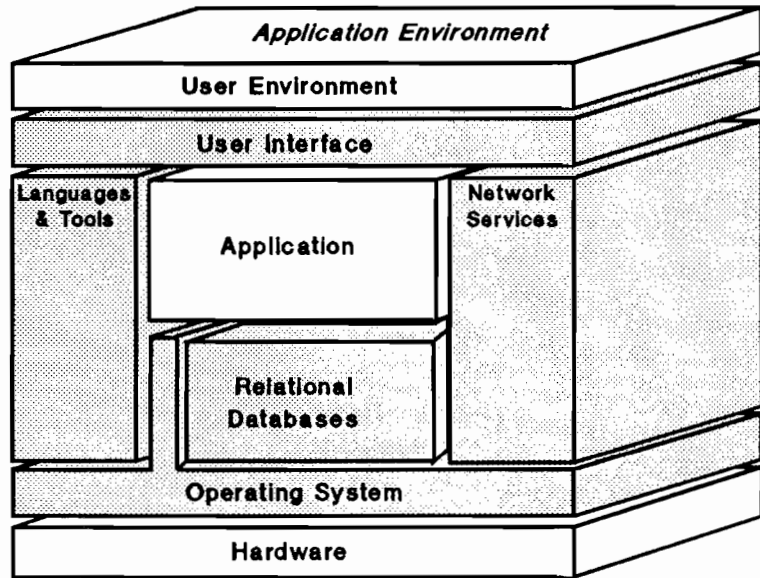
Figure 1-5. HP 3000 Open Systems Environment

Industry-standard APIs allow changes in the underlying technology transparent to the end user. Hence, APIs provide application portability and interoperability with multivendor systems, which facilitates the addition of an even broader range of application solutions on the HP 3000. The HP 3000 open systems environment incorporates industry and de facto standards for:

- Operating system interfaces, for increased application portability
- User interfaces, for consistent application look and feel
- Database management, for common distributed data access
- Networking, for interoperability in multivendor systems environments
- Languages and tools, for ease of application development and portability

The HP 3000 open environment is based on the commercial needs of the marketplace. The HP 3000 is committed to supporting the X/Open interoperability and portability guidelines provided by the POSIX 1003 standards. The HP 3000 already supports IBM SAA interoperability guidelines such as SNA and interoperability with DB2 databases.

The HP 3000 provides mainframe-class networked system management capabilities that lower operating costs and improve staff productivity. HP systems management improves the quality of MIS services with products aimed at increased system availability, error-free operations, and increased flexibility.

Major features

- Multiprogramming: concurrent transaction processing, data communication, online program development, and batch processing
- Symmetric multiprocessing
- Extended large addressing: 48- or 64-bit virtual addressing
- Demand-paged virtual memory transparently manages virtual memory and eliminates the need for program segmentation
- Mapped files: an extension of disk caching without the need for file system buffering; increased system performance for I/O-intensive applications
- File system with file backup, user logging, security, and interprocess communication
- Disk mirroring
- Very fast online, unattended backup
- Comprehensive access security and complete accounting resources
- Concurrent multilingual capability: programming languages, including ANSI-standard versions of COBOL, RPG, FORTRAN, Pascal, C, and BASIC
- Powerful command language including user-defined commands, command files, conditional job control, extensive online HELP facility, and meaningful error messages
- Device and file independence to simplify application development and maintenance
- Native mode spooling of input and output tape label facility
- Systems management capabilities from small workgroup to large, central site systems
- Complete, automatic management for local and remote workstations
- Architected interfaces (AIFs) and a transaction management trusted interface
- Power fail/automatic restart
- System switchover

Investment protection through compatibility is one of the most important elements in the HP 3000 strategy. HP has made a very large investment to ensure that the 900 Series systems are compatible with earlier versions of the HP 3000 family. The result is the smoothest path to next-generation systems ever offered in the industry.

The HP 3000 900 Series has two run-time environments, which are transparent to the user. Native mode delivers the full performance benefits and advanced capabilities of PA-RISC, while providing source-code compatibility with MPE V applications. Compatibility mode provides object-code compatibility with MPE V-based applications. With the flexibility of both native mode and compatibility mode, MPE V applications can be easily moved to 900 Series systems. Your investments in hardware, software, training, and peripherals are protected by the following:

- *Application compatibility.* Applications and their data can be Stored from an MPE V system and Restored on a 900 Series

system and can be run with little or no modifications, which
protects your application investments.

- *Operational compatibility.* The 900 Series supports a functional
superset of MPE V. The two operating environments are
nearly identical in terms of user interface, system management,
accounting, and security. Investments in MPE V training are well
protected.

- *Peripheral compatibility.* Because of common I/O mechanisms,
the 900 Series systems support many of the same peripherals and
workstations as the other HP 3000 systems. This protects your
investment in peripheral devices when you upgrade to the 900
Series systems.

- *Cross-system development.* Compatibility mode allows you to
develop applications on the 900 Series system that will also run on
MPE V-based systems.

Data Management and CASE

The HP 3000 information management strategy offers two of
the most powerful database management systems (DBMSs)
available in the industry today, HP ALLBASE/SQL and HP
TurboIMAGE. ALLBASE/SQL is Hewlett-Packard's relational
database management system (RDBMS), and HP TurboIMAGE
is the most heavily used network model DBMS on the HP
3000. Software developers can choose from major multivendor
computer-aided software engineering (CASE) tools and a rich
selection of ANSI-standard programming languages for efficient
development and maintenance of portable applications. Reporting
and query tools provide access to the stored data without
programming. The HP 3000 also supports major independent
software vendor relational-model databases, which also provide
application portability.

Interoperability

The HP 3000 offers a full complement of distributed and
interoperable database products. HP maximizes investments in
TurboIMAGE applications with ALLBASE/Turbo CONNECT,
which provides SQL read access to TurboIMAGE databases.
ALLBASE/NET provides transparent and secure remote database
access to ALLBASE/SQL data as though it were stored locally.
ALLBASE/DB2 CONNECT provides open interoperability with IBM
DB2 databases by tightly integrating the 900 Series and PC end
users with DB2. As a founding member of the SQL Access Group,
HP is actively promoting the adoption of SQL interoperability
and portability specifications. ALLBASE/SQL will be publicly
demonstrated as a component in an SQL Access Group network
during 1991.

CASE tools   HP ALLBASE/SQL and HP TurboIMAGE support major multivendor CASE tools such as Cognos' PowerHouse, Gateway Systems' Synergist, Infocentre's Speedware, Information Builders' FOCUS, and Ingres' tools. The HP 3000 also supports the Ingres, Oracle, and Sybase RDBMSs. In addition, the HP 3000 supports major Integrated-CASE (I-CASE) tools such as CGI PACLAN, Softlabs' Maestro II, and Cognos' PowerCASE.

PC clients   The HP 3000 supports client-server application development systems with full access to HP ALLBASE/SQL databases. Powersoft's PowerBuilder and Gupta's SQLWindows offer powerful point-and-click graphical application development for PC clients connected to the HP 3000.

HP NewWave Information Access is a PC information management tool that provides authorized users with secured access to departmental and corporate information residing in ALLBASE/SQL, TurboIMAGE, KSAM, IBM DB2, or Oracle DBMSs.

3GL tools   HP also offers a broad range of third-generation languages including, ANSI COBOL, ANSI C, ANSI FORTRAN, ANSI Pascal, BASIC, and RPG, along with other programmer productivity tools such as a symbolic debugger, an editor, and software revision control.

HP's Forms Management Facility includes HP VPLUS, HP VPLUS/Windows, and HP FORMSPEC for the creation of forms and workstation I/O portions of applications.

HP Business Report Writer (HP BRW/XL) for 900 Series systems is a high-performance report-writing system for data processing professionals. And ALLBASE/QUERY enables database administrators and programmers to perform ALLBASE/SQL and TurboIMAGE database queries, to create or modify SQL tables, and to customize reports.

Networking products

HP Networking is a family of hardware and software communication products that enable HP systems to communicate with each other and to interoperate with equipment made by other manufacturers. HP Networking products adhere to industry and de facto standards for data communication. The International Standards Organization (ISO) seven-layer Open Systems Interconnect (OSI) model is the basis for HP Networking product design. HP also offers an array of communication products to effectively integrate with IBM products within the System Network Architecture (SNA) and bisynchronous environments.

HP 3000 networking products provide solutions for both local and wide-area communications needs:

- *Workstation to system communications,* including both terminal-based and PC-based communications facilities, such as NetWare/XL and LAN Manager
- *System-to-system communications,* HP's focus on industry-standard and de facto protocols, such as ARPA and OSI, provide multivendor interoperability
- *HP-to-IBM system communications,* using both SNA and bisync protocols
- *HP network management products,* HP OpenView System Manager encompasses network monitoring and diagnostic capabilities, as well as remote system management
- *Messaging services,* which provide transparent background delivery of messages and files within a network

Office Information

HP's NewWave Office products provide powerful communication, decision support, and information sharing services. NewWave Office provides tremendous flexibility to manage the flow and use of information, and allows for easy information sharing and improved decision making.

Figure 1-6. HP NewWave Office screen

The foundation of NewWave Office is HP NewWave, an easy-to-use PC environment that effectively integrates PC/Mini applications and automates tasks. The NewWave Object Management Facility

(OMF) links data and applications together so that users can move effortlessly among many different PC and HP 3000 applications. This level of integration allows users to create documents using text, spreadsheets, graphics, and image data drawn from different applications. Using the Object Management Facility, changes made in the output of one application are automatically reflected in the output of others.

Customer Support Services

Hewlett-Packard's customer support services are designed to ensure long-term, productive use of HP 3000 systems. Support is available throughout the life of a customer's system to meet the needs of their particular applications and working environment. HP provides a variety of hardware maintenance, software support, and multivendor network support services. HP also provides consulting services on system performance, capacity planning, networking, and information management.
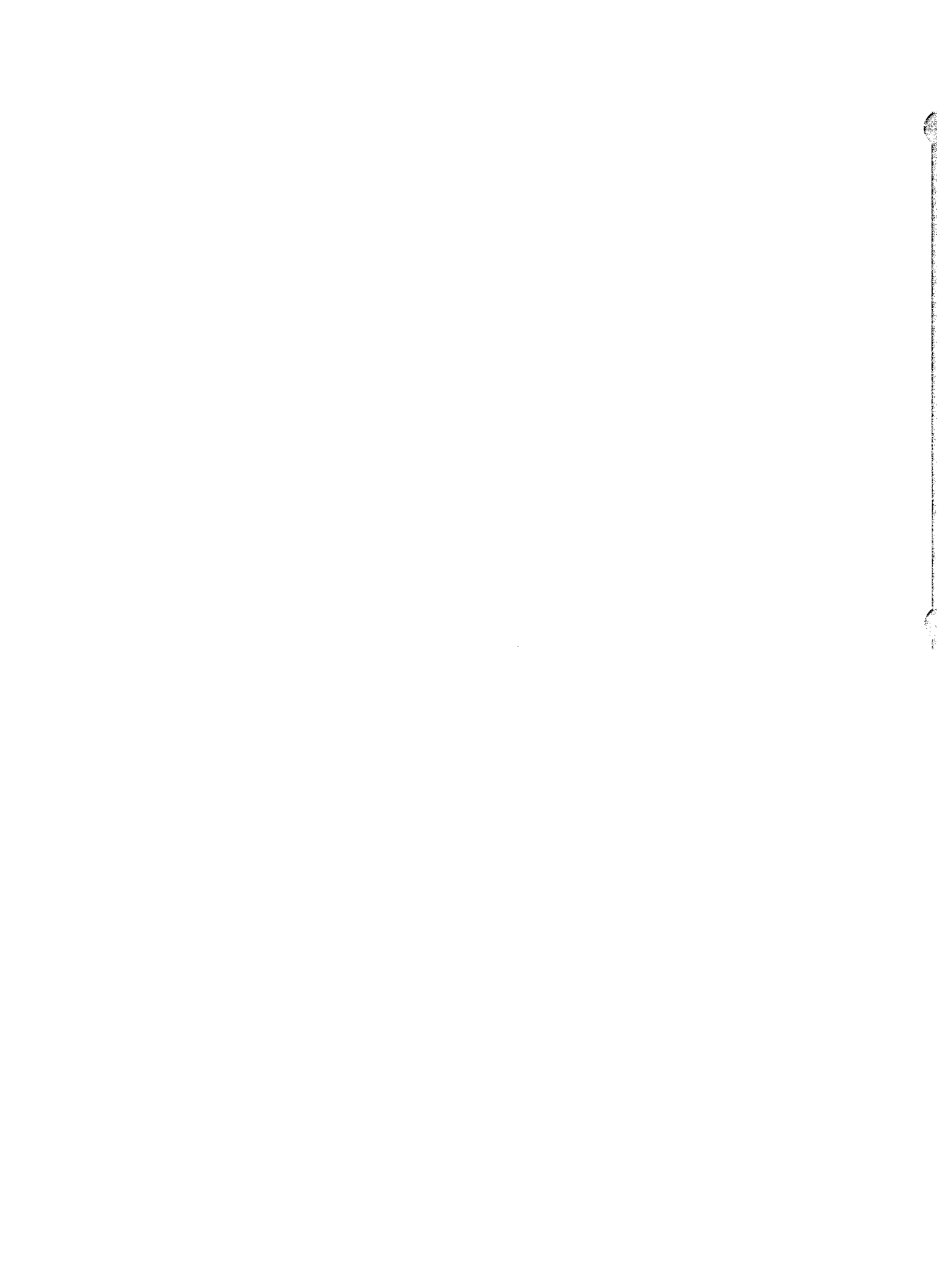
HP 3000 Hardware Overview

Introduction

The HP 3000 family of scalable computers spans a broad range of capabilities and capacities to meet specific application needs, from small workgroup systems to very powerful, central site systems. The HP 3000 900 Series PA-RISC computer family consists of mainframe-class systems which provide large memory, large I/O configurations, and maximum performance—and entry and midrange systems which are low cost and provide the optimum price/performance. The entire HP 3000 family runs the MPE operating system and provides scalable systems for small work groups through mainframe-class applications for hundreds of users.

HP 3000 System Comparison

System	Main memory std/max	CPU cache	Max. work-stations	Max. disk (Gbyte)	Max. tape drives
980/200	256/1024	2x1024	850*	85	8
980/100	192/512	1024	850*	85	8
960	128/256	1024	600	85	8
955	96/256	256	600	85	8
967	64/192	512	600	66	8
967LX	32/192	512	600	24	6
957	64/192	128	600	66	8
957LX	32/192	128	600	24	6
947	64/192	96	600	66	8
947LX	32/192	96	600	24	6
937	32/192	96	600	66	8
917LX,927LX,937LX	24/192	96	600	24	6
958	96/256	1024	600	34.8	5
948	64/256	1024	400	34.8	5
932	32/256	128	250	22	4
922,922RX	32/64	32	152	12	4
922LX	24/64	32	152	12	4
920	24/128	64	48	12	4

* Larger configurations will be supported in the future.

The HP 3000 900 Series computers are available in two business configurations. A *multiuser system* can support many on-line users via workstations and PCs, and a *preconfigured application server* can be utilized for PC-based client-server applications. For detailed information on HP's Precision Architecture-RISC, please see Appendix A.

HP 3000 High-End Systems

Series 955, 960, 980/100, and 980/200

The HP 3000 PA-RISC high-end systems are designed for high-performance online transaction processing (OLTP) and overall system throughput. These systems provide mainframe-class performance, support hundreds of online users, support large memory and large I/O configurations, and use an operating system that has been especially designed for PA-RISC to provide very high performance in OLTP and batch environments, while maintaining the HP 3000's ease of use. The HP 3000 offers powerful systems management and operations capabilities, high availability and backup options, tools for performance measurement and monitoring, and built-in features to ensure the highest degree of data integrity.

The HP 3000 high-end systems take full advantage of advanced technology to provide exceptional performance implemented with single-chip CPUs on single-board processors. The HP 3000 900 Series high-end system family is designed to provide easy board upgrades to more powerful processors with minimal impact on end users and systems operations.
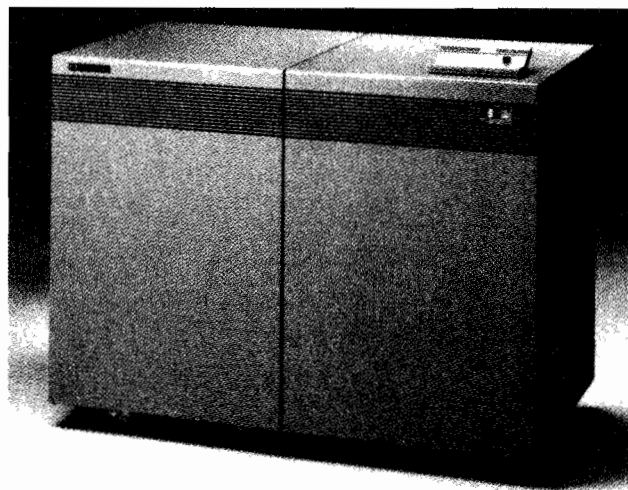
Figure 2-1. HP 3000 Series 955, 960, and 980 System Package

High-performance   All HP 3000 high-end systems run the same, easy-to-use MPE/XL operating system, as do the other members of the broad HP 3000 business computer family. This combination of PA-RISC and MPE/XL makes the HP 3000 900 Series the industry leader in price/performance, as proven by the results of the Transaction Processing Council's TPC-A benchmark. The 900 Series complements high-performance with high availability of the system and its resources, systems management to keep the system running efficiently, networking, and high-end peripherals to meet the demands of high-volume environments.

High availability begins with the high-reliability and reduced complexity Precision Architecture-RISC. Warranty data shows that the HP 3000 900 Series has achieved a greater than 50 percent increase in reliability over the industry-acknowledged, highly reliable HP 3000 Series 70. The 900 Series also provides powerfail recovery and transaction management as standard features. Transaction management automatically recovers system structures, user files, and databases after system failures. The high-end systems offer optional high-speed and online backup solutions, auto-restart after software failure, mirrored disks, and system processing unit (SPU) switchover to a secondary SPU.

The 900 Series supports a complete set of networked systems management solutions, including performance monitoring and analysis, administration and configuration, system security, system availability, operations control, and storage management.

To meet the demands of interoperability, the high-end 900 Series systems support the ISO distributed application service standards, ARPA Telnet, IBM SNA, and IEEE 802.3 and Ethernet LANs.

High-end peripherals on the 900 Series include the HP Rewritable Optical Disk, which stores up to 20 Gbytes, or up to 70 Gbytes with software data compression provided by HP TurboSTORE/XL.

Alternative to traditional mainframes

More and more mainframe application solutions are being ported to the HP 3000 900 Series high-end systems. On top of mainframe performance, powerful functionality, high availability, integrated systems and network management, and high-end peripherals, the 900 Series high-end delivers superior cost-of-ownership. By providing significantly lower hardware, software, and staffing costs compared with typical mainframe systems, HP 3000s are ideal candidates for offloading applications and replacing installed-base (older technology) mainframes.

On the HP 3000 application development and maintenance is simpler and requires reduced programmer support, compared with other systems in its class. With the 900 Series' *extended large addressing*, programmers do not have to segment their programs or use extra data segments, which improves productivity. The HP 3000's

virtual addressing capabilities can meet business application needs throughout the 1990s.

The HP 3000 high-end systems requires only a fraction of the systems and operations staff needed to run and maintain traditional mainframe systems. Powerful systems management capabilities include high-capacity devices and data compression for unattended backup. Automatic, unattended error logging and restart upon software failure ensures maximum user availability and minimize delays for operator identification and response. Integrated network management capabilities for remote console, exception-based alarms, and a graphical network map provide centralized systems management control.

Major features

- Single chip VLSI CPU, single-board processor
- HP PA-RISC
- High-speed CPU cache for data and instructions
- Advanced instruction pipelining
- Floating-point coprocessor standard
- Up to 64-bit virtual addressing: over 4 billion 2-Gbyte spaces
- Translation Lookaside Buffer (TLB) for virtual to physical address translation
- Battery backup, automatic powerfail recovery standard
- Low cooling and power requirements; compact packaging
- High-speed, average 100-Mbyte per second System Memory Bus
- IEEE 802.3 or Ethernet local area network (LAN) terminal connection; HP EtherTwist LAN is also supported
- HP AdvanceNet networking solutions
- MPE/XL operating system

Configuration Maximums

	955	S960	980/100	980/200
Performance x 955	1.0	1.4	2.4	3.7
Memory (Mbytes)	96-256	128-256	192-512	256-1Gb
Users	600	600	850*	850*
Disks	64	64	64	64
Disk storage (Gbytes)	85	85	85	85
Tape drives	8	8	8	8
System printers	12	12	12	12
I/O Channel multiplexer	4	4	4	4
PSI (Bisync and SNA)	8	8	8	8

* Larger configurations will be supported in the future.

System organization   The processor communicates with main memory using the System
Memory Bus (SMB). The SMB is a very high-speed bus that
provides a 64-bit data path and can support an average data transfer
rate of 100 Mbytes per second. The SMB connects to two Central
Buses (CTBs) through separate CTB Adapters. Each CTB supports
two Channel I/O Buses (CIBs) using separate Channel Adapters.
The CIBs support I/O interfaces to peripheral devices and LAN
links.

See figure 2-5 for the HP 3000 Series 980 system structure.

HP 3000 Series 980 Processor

The Series 980 processor, implemented with HP's advanced CMOS
VLSI semiconductor technology, is contained on a single board. The
Series 980/200 contains two of these processor boards. The processor
module includes a single-chip Central Processing Unit (CPU), an
Instruction Cache Comparator and Multiplexer (I-CMUX) chip, two
Data Comparator and Multiplexer (D-CMUX) chips, an SMB to
Processor Interface (SPI) chip, and the Floating-Point Coprocessor
(FPC). The very fast 21 ns CPU instruction cycle time is due to the
advanced implementation of the CPU, which uses submicron CMOS
technology.
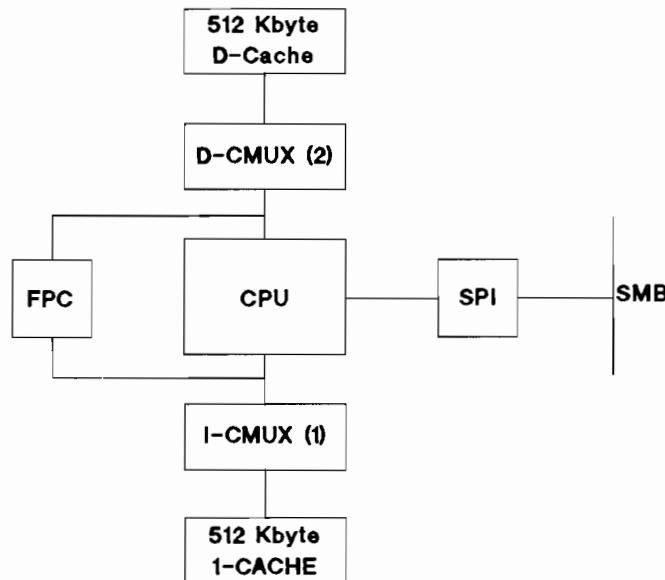
Figure 2-2. HP 3000 Series 980 Processor

HP 3000 Series 955 and 960 processor

The Series 955 and 960 processor module includes a single-chip
CPU, a single-chip TLB Control Unit (TCU), two Cache Control
Units (CCUs), a single-chip System Interface Unit (SIU), and the
Floating-Point Coprocessor.

Features comparison

	955	960	980/100	980/200
Performance x 955	1.0	1.4	2.4	3.7
Virtual addressing	48 bit	48 bit	64 bit	64 bit
CPU cycle time	37 ns	37 ns	21 ns	21 ns
CPU data cache	128 Kbyte	512 Kbyte	512 Kbyte	2x512 Kbyte
CPU instruction cache	128 Kbyte	512 Kbyte	512 Kbyte	2x512 Kbyte
Total cache	256 Kbyte	1 Mbyte	1 Mbyte	2x1 Mbyte
Pipelining	5 stage	5 stage	5 stage	5 stage
TLB on CPU chip	—	—	128	2x128
External TLB entry	16 K	16 K	8 K	2x8 K

Cache

The CPU cache is a high-speed buffer that significantly increases
system performance by minimizing accesses to main memory. Cache
access can provide up to an order of magnitude faster access than
main memory.

Based on a *locality algorithm*, the system automatically moves into
cache the code and data that are most likely to be required. As a
result, the required code and data are found in cache almost all
the time. Data in the cache is only written to memory when the
processor requires more data to be read into cache, when a direct
memory access operation is performed, or upon power failure.

By providing a large amount of CPU cache, the high-end systems
maximize the cache benefits. The larger the CPU cache, the more
likely it is that the required data and code will be in cache.

Instruction pipelining

Instruction pipelining maximizes the use of processor resources by
operating on multiple instructions simultaneously, which allows
the execution of one instruction each CPU clock cycle. Separate
Instruction and Execution Units facilitate instruction pipelining and
provide efficient, parallel use of processor resources.

The Instruction Unit controls instruction sequencing. It fetches
instructions from the Instruction Cache and stores them in the
Instruction Register. The Instruction Unit executes branch
instructions, maintains processor status, and handles traps and
interrupts.

The Execution Unit executes all instructions requiring data
manipulation. It contains the Arithmetic Logic Unit (ALU) and
barrel shifter, which together perform arithmetic, logical, shift,
extract, and deposit instructions. The Execution Unit contains 32
general-purpose registers, which store the results of these operations.

The Series 955, 960, and 980 all employ a five-stage instruction pipeline. While one instruction is being executed, others are being fetched, and the results of still others are being stored. During the first stage, the instruction is fetched from cache. The instruction is decoded during the second stage, and the resulting CPU internal calculation or function is performed during the third stage. The fourth stage is used to generate the condition code for the corresponding result. Finally, in the fifth stage, a general purpose register is set within the corresponding cache or internal result. The net effect is that except for penalties such as cache misses, one instruction exits the pipeline (completes) every CPU cycle.

Instruction 1	Fetch	Decode	Execute	Condition	Store			
Instruction 2		Fetch	Decode	Execute	Condition	Store		
Instruction 3			Fetch	Decode	Execute	Condition	Store	
Instruction 4				Fetch	Decode	Execute	Condition	Store
Instruction 5					Fetch	Decode	Execute	Condition	Store

Time
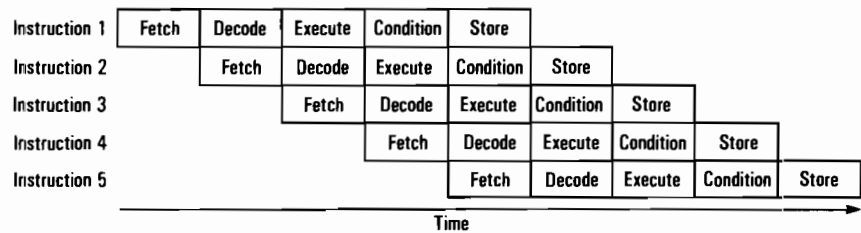
Figure 2-3. Instruction Pipelining

Floating-point coprocessor

For scientific, engineering, and statistical applications that require high performance in floating-point calculations, a floating-point coprocessor is standard on Series 955, 960, and 980 systems.

The Floating-Point Coprocessor supports single- (32-bit) and double- (64-bit) precision floating-point operands of the ANSI/IEEE 754-1985 standard. The Floating-Point Coprocessor and the CPU operate in parallel, with the CPU performing integer calculations and other functions while the coprocessor performs floating-point calculations. This parallel operation provides a high level of performance for applications that use floating-point calculations.

The Floating-Point Coprocessor consists of twelve 64-bit-wide registers for operands and is implemented on two high-speed ECL chips on the Series 955, 960, and 980. The Series 980 provides higher floating-point performance than the Series 955 and 960. In all cases, the Floating-Point Coprocessor is attached to the CPU's cache bus.

Virtual memory management

The HP 3000 900 Series supports one of the largest address spaces in the industry, which provides tremendous expandability for large applications and data structures. Virtual memory management automatically maps all program and data files into virtual memory, which is many times greater than physical memory.

Virtual addresses on the HP 3000 Series 955 and 960 are 48 bits long and are divided into 65,536 spaces, each space being 2 Gbytes. The Series 980 supports 64-bit virtual addresses or over four billion spaces. Each space is further divided into fixed-length, 2-Kbyte pages, which hold data or code. A single data structure can be up to

1 Gbyte or 2 Gbytes in length (compiler-dependent), and program code can span multiple spaces.
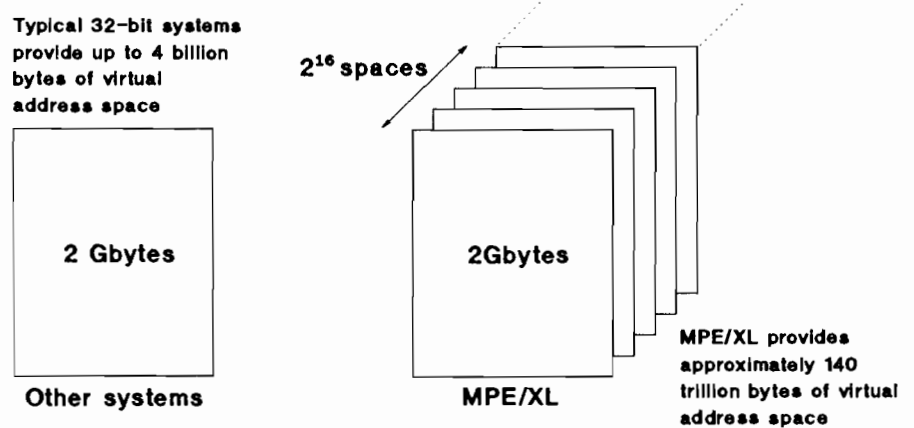
Figure 2-4. Virtual Memory Organization

Virtual address translation
Because virtual addresses are much larger than physical addresses, virtual-to-physical address translation is required. A high-speed RAM buffer called the Translation Lookaside Buffer (TLB) optimizes this task. The TLB can be considered to be a table that holds the most recently referenced virtual addresses and their corresponding physical addresses.

When a virtual-to-physical address translation occurs, the TLB checks to ensure that the executing process has sufficient authorization to perform the requested read, write, or execute access.

Over 99 percent of the time, the needed address is found in the TLB. If the address is not in the TLB, a software hashing scheme is used to find the address of the required code or data in main memory. If the instruction or data is on a page that is not in main memory, a page fault occurs, and the required page is copied from disk. Together, the TLB and hashing scheme provide a very fast and efficient means for retrieving code and data from main memory and disk.

Memory subsystem
Main memory capacities of the Series 955, 960, and 980 systems are given in the table below. The 16-Mbyte memory array board uses 1-Mbit, fast-page mode dynamic RAMs. The 64-Mbyte board uses 4-Mbit, fast-page mode dynamic RAMs.

System	Standard memory (Mbytes)	Maximum memory (Mbytes)	Expansion increments (Mbytes)
955	96	256	16
960	128	256	16
980/100	192	512	16 and 64
980/200	256	1024	16 and 64

Main memory has battery backup to ensure that information is maintained for a minimum of 15 minutes in the event of an interruption in AC power. Automatic powerfail allows the operating system to be automatically restarted and processing to continue without data loss upon resumption of power.

Error correcting code (ECC) memory is standard on all HP 3000 900 Series systems. The internal memory word size is 72 bits with 64 bits of two 32-bit words and 8 bits for error detection and correction. Single-bit errors are automatically detected and corrected to ensure data integrity. Multibit errors are automatically detected, and a high-priority interrupt is sent to the system software for appropriate action.

Memory interleaving
The Series 980/200 uses the memory subsystem to implement cache-line interleaving, which improves performance by increasing aggregate bandwidth for usable memory. Two memory controllers are standard on the Series 980. Consecutive cache-lines are fetched from alternate memory modules to improve the effective data return rate, while allowing parallel access to cache-lines on the same page from different processors.

Subsystems

Buses
The wide data paths and fast, synchronous clocking of the high-end system buses provide high-performance I/O throughput. I/O performance is further enhanced because there are multiple paths to I/O devices through up to four adapters and low-level buses.
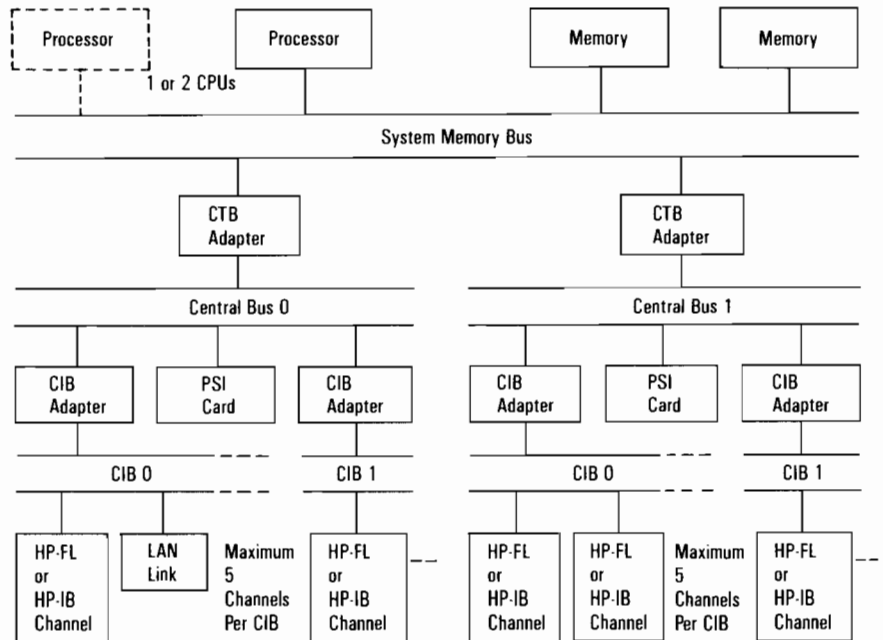
Figure 2-5. HP 3000 Series 980 System Structure

System memory bus

The System Memory Bus (SMB) is the communication path between the CPU, the main memory, and the CTB Adapters. The SMB provides a 64-bit-wide data path and runs synchronously with a 27.5-MHz clock. It supports an average data transfer rate of 100 Mbytes per second.

Central bus adapters

The central bus adapters provide the interface between the SMB and the CTB. The CTB Adapters act as transfer agents for direct memory access (DMA) transfers and direct I/O transfers between the channel adapters and the CPU and main memory. The high-end systems come standard with two CTB Adapters.

Central bus

The central bus (CTB) is the communication path between the CTB adapters and the channel adapters. The CTB provides a 32-bit data path and runs synchronously with a 9.2 MHz clock. It supports sustained data transfer rates of 20 Mbytes per second.

In addition, the CTB directly supports a Programmable Serial Interface (PSI) card to provide point-to-point communication between HP 3000 computers and from the HP 3000 to IBM systems using Bisync and SNA.

Channel I/O bus adapters

The Channel I/O Bus Adapters, or Channel Adapters, for short, provide the interface between the CTB and the CIBs. Each Channel Adapter serves as a high-performance channel multiplexer providing full DMA for all HP-IB, HP-FL, and LAN I/O Channels and

synchronizing the different speeds and bandwidths of the CTB and the CIBs. DMA allows large blocks of data to be transferred to and from main memory with minimum CPU intervention, thereby reducing CPU overhead. The high-end systems include two Channel Adapters; a third and fourth Channel Adapter may optionally be added as an option.

Channel I/O buses

The high-end systems support up to four Channel I/O Buses (CIBs), each supporting up to seven cards for interfacing peripheral devices and providing data communication functions. Each CIB provides a 16-bit-wide, bidirectional data path that runs synchronously with a 4-MHz clock.

A significant benefit of having multiple CIBs and Channel Adapters is that this approach provides multiple concurrent paths to I/O devices.

Memory-mapped I/O

I/O operations are initiated and controlled using a memory-mapped I/O scheme, such that the processor only needs to access reserved virtual or physical memory locations to control I/O operations. Memory-mapped I/O allows for streamlined I/O operations and thus increases system performance in I/O-intensive applications.

Peripheral connections

Disks are connected using HP Fiber-Optic Link interfaces (HP-FL), each supporting up to 8 disks. Each HP-FL can support a data transfer rate of up to 5 Mbytes per second. Fiber-optics offer exceptional immunity to noise, and HP-FL allows disks to be located up to 500 meters from the SPU. Tapes and printers (as well as disks) are connected using the 8-bit wide, IEEE-488 standard Hewlett-Packard Interface Bus (HP-IB). HP-FL and dual fiber-optic disk drives are required for support of HP Mirrored Disk/XL, a disk shadowing capability, and HP SPU Switchover/XL, an SPU recovery capability.
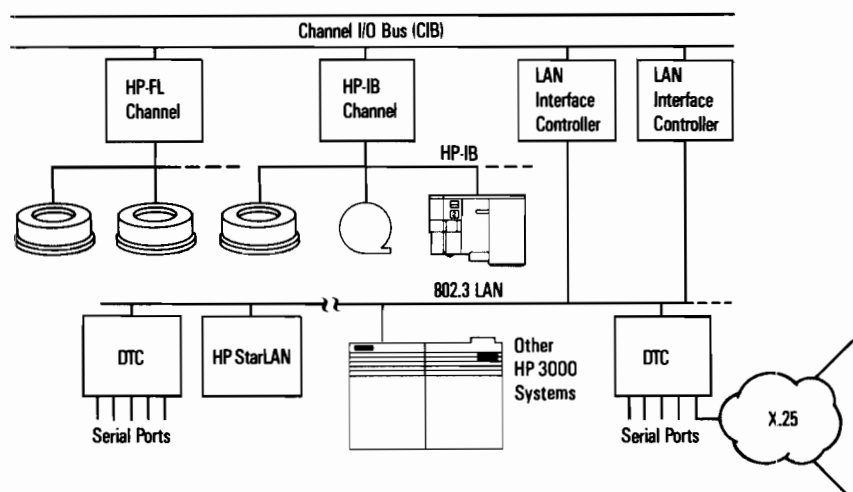
Figure 2-6. HP 3000 S955, S960, and S980 I/O Attachments

Workstation and serial connections

Connections for workstations, serial printers, and other serial devices are provided using Datacommunications and Terminal Controllers (DTCs), which are distributed over an IEEE 802.3 LAN. This flexible connection scheme allows DTCs to be situated in the departments they serve, saving the cost and effort of running cables from each workstation back to the processor. The DTC48 supports up to 48 direct-connect ports, 36 modem ports, or a combination of the two. The DTC16 supports up to 16 direct-connect ports, 12 modem ports, or a combination of the two.

PCs can also be connected to the HP 3000 through HP LAN Manager and Novell NetWare LANs. Physical connections are made using HP EtherTwist, a LAN scheme that uses unshielded twisted pair (or phonewire).

Terminal connections are not supported on the standard servers. Instead, all PC workstations are connected to the server using a LAN. Terminal connections can be added to the server by purchasing an additional terminal connection software product.

System-to-system data communication

HP Network Services provides virtual terminal, network file transfer, remote file and TurboIMAGE database access, network interprocess communication, and remote process management between HP 3000s on an IEEE 802.3 or Ethernet LAN using HP LAN Link/XL, or over wide areas using the HP DTC X.25 Network Link or the HP NS Point-to-Point Link.

For system-to-system, point-to-point communication to other HP 3000s and connection to IBM systems using SNA and Bisync, the Programmable Serial Interface (PSI) card is connected directly to the CTB.

In multivendor inter-operational environments, the HP 3000 supports ARPA Telnet and File Transfer Protocol (FTP), and OSI X.400 messaging services and File Transfer Access Method (FTAM).

HP SNA Link/XL and HP BSC Link/XL are provided for HP-to-IBM system communication in SNA and Bisync environments respectively. Network services over these links include HP SNA IMF/XL for SNA 3270 emulation; HP SNA NRJE/XL for SNA remote job entry; HP LU6.2 API, an LU6.2 program-to-program application interface; HP SNA Distributed Host Command Facility/XL (HP SNA DHCF/XL) for IBM 3270/PC access to the HP 3000; and BSC RJE/XL for Bisync remote job entry.

For detailed network information, please refer to Chapter 5,"Networks".

Environmental Specifications

AC input voltage (nominal)	208 VAC, three phase @ 60 Hz 380 VAC, three phase @ 50 Hz 415 VAC, three phase @ 50 Hz
Input voltage tolerance	± 10% from nominal
Input current	8.0 amps @ 208 VAC 60 Hz 4.4 amps @ 380 VAC 50 Hz 4.0 amps @ 415 VAC 50 Hz
Heat dissipation, maximum	7900 BTU/hr
Physical dimensions	Height: 991 mm (39 in.) Width: 1296 mm (51 in.) Depth: 711 mm (28 in.) Weight: 400 Kg (880 lb)
Operating temperature, system	20° to 25.5° C (68° to 78° F)
Relative humidity, system (operating)	40 to 60% (noncondensing)
Altitude (operating)	Up to 4572 m (15,000 ft)
Battery backup time, minimum	15 minutes
Acoustics	7.3 Bels sound power (A)

HP Entry and Midrange Systems

HP 3000 Series 917LX, 927LX, 937LX, 937, 947LX, 947, 957LX, 957, 967LX, and 967

The HP 3000 Series 917LX through Series 967 are high-performance entry to midrange members of the HP 3000 family of business computers. These ten systems take advantage of HP Precision Architecture-RISC (PA-RISC) to deliver low cost solutions with outstanding price/performance. Offering a range of CPU performance, packaging, and user license options, these systems allow you to purchase for your needs today yet grow easily. Your investment is further protected by the ability to increase computing power through simple processor board upgrades, or to increase your I/O capacity using easy package upgrades. Because these systems are compatible with other HP 3000 systems, a multitude of business solutions are available making them ideal computing systems for small to medium sized businesses, departments and remote office locations.

The entire system including CPU, memory, disk, tape backup, and operating system come preconfigured from the factory in a compact, integrated package that fits into an office environment with no special requirements. The system, along with external peripherals, can also be rack mounted in a compact 1.1-meter or 1.6-meter cabinet.

By using state of the art technologies, these systems provide a low cost of ownership. A high-speed, high-capacity integrated tape drive provides the performance of half-inch magnetic tape backup at a much lower cost. The Digital Data Storage (DDS) backup unit allows many system configurations to be backed up on a single cassette, eliminating the need for an operator to be present during backup operations. The ten systems also support from 1.3 Gbytes to 4.0 Gbytes of next generation, high-capacity disk drives inside the system package.
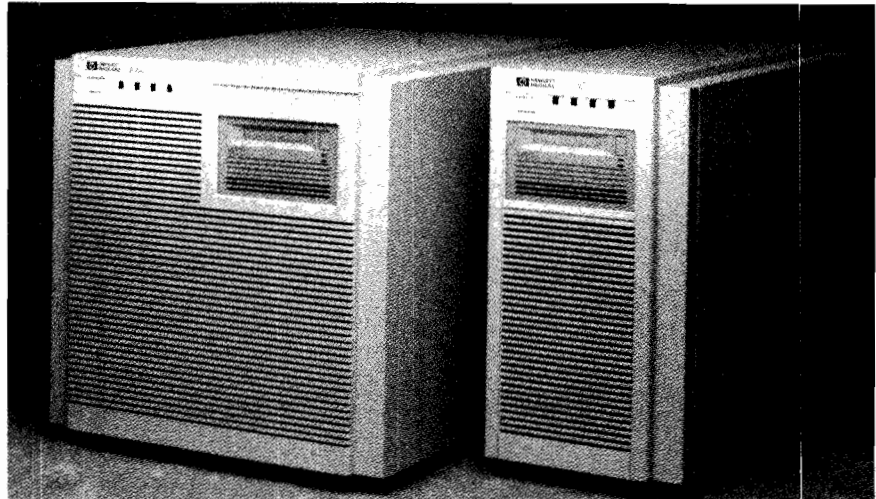
Figure 2-7. HP 3000 900 Series Entry and Midrange Packages

Server versions of these systems combine the HP 3000's strength in transaction processing with client-server applications, services and tools for PC users. The Server versions run all current HP 3000 applications. They offer tools to enhance existing VPLUS applications with NewWave and Microsoft Windows PC graphical user interfaces. In addition, the Servers provide the capabilities to configure and administer PCs, to backup PCs, and to allow PC users to share files and peripherals.

Major features

- Single-chip, submicron CMOS CPU single-board processor
- ECC memory expandable to 192 Mbytes
- Up to 66 Gbytes of mass storage with external disk drives
- Integrated Digital Data Storage tape backup unit with 1.3 Gbytes per cassette
- Battery backup, automatic power fail recovery
- Standard office power and cooling requirements
- HP Easytime User Interface pre-loaded on LX versions
- MPE/XL Operating System and HP subsystem software pre-loaded

System organization

The processor communicates with I/O using the 32-bit HP Precision Bus. The Precision Bus supports Programmable Serial Interface (PSI) cards allowing 900 Series HP 3000 systems to be linked to other computers in a distributed data processing environment. The Precision Bus also supports I/O interfaces to peripheral devices and local area network links.
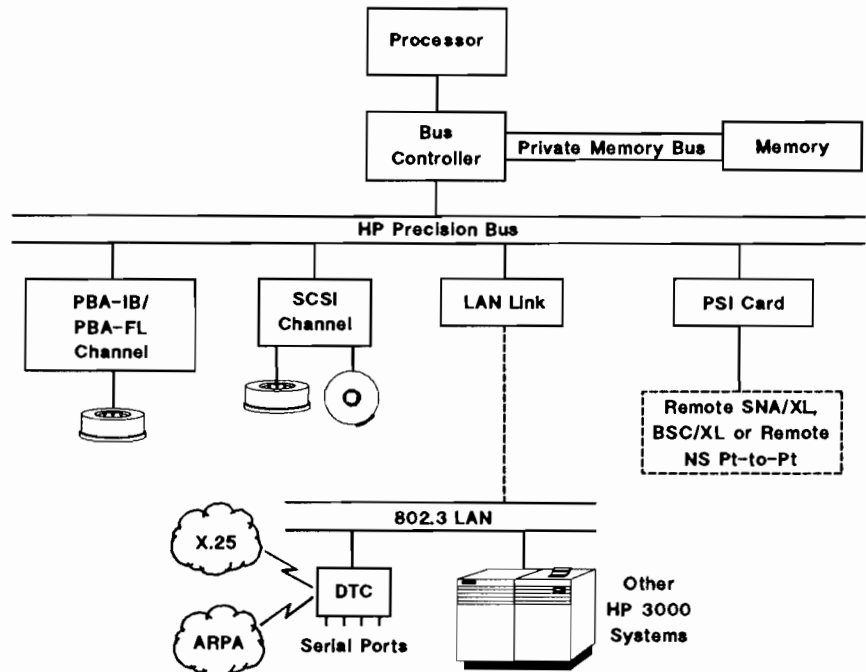
Figure 2-8. Series 9x7 System Structure

Configuration Maximums

	917LX	927LX	937LX	937	947LX	947	957LX	957	967LX	967
Performance x 917	1.0	1.0	1.0	1.0	1.0	1.0	1.6	1.6	2.3	2.3
Memory (Mbytes)	192	192	192	192	192	192	192	192	192	192
User license	8	20	32	32	32	64/100/ UL*	64/100/ UL*	64/100/ UL*	100/160/ UL*	100/160/ UL*
Disks	18	18	18	49	18	49	18	49	18	49
Integrated disk storage (Gbytes)	1.3	1.3	1.3	4.0	1.3	4.0	1.3	4.0	1.3	4.0
Disk storage (Gbytes)	24	24	24	66	24	66	24	66	24	66
Tape drives	6	6	6	8	6	8	6	8	6	8
System printers	6	6	6	8	6	8	6	8	6	8

* UL = unlimited user license

System processors

The system processors use a one-board set implemented with VLSI logic functions. With hardwired control, the systems are capable of executing one instruction with every clock cycle. Separate instruction and execution units facilitate pipelining and allow for efficient, parallel use of processor resources.

Cache

The cache is a high-speed buffer for the CPU that minimizes the number of relatively slow transactions with main memory. These systems use two high-speed CPU caches, one for data and one for instructions. The two caches use a direct mapped scheme. Data

modified in the cache is written to main memory only when the processor requires other data to be in that cache location, or when a direct memory access (DMA) operation is performed within that data area, or upon a powerfail.
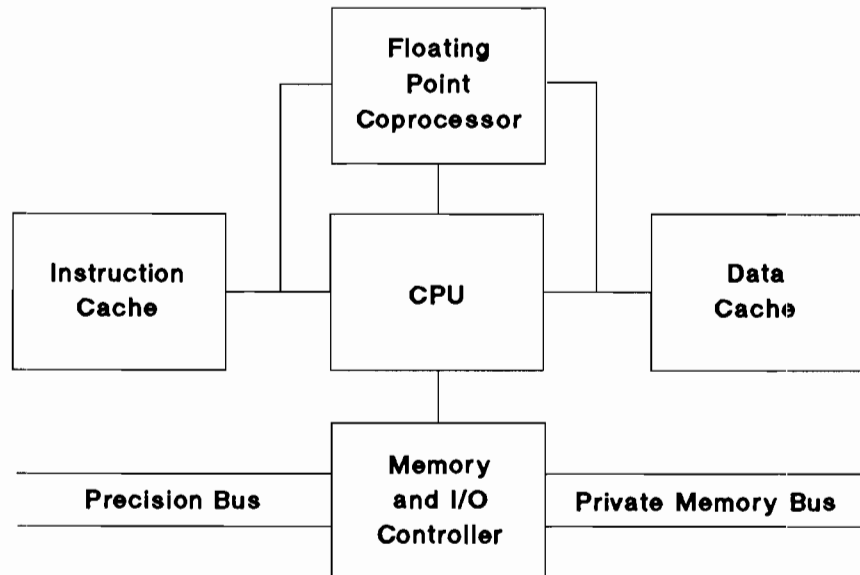
Figure 2-9. HP 3000 Series 9x7 and 9x7LX Processor

Instruction pipelining
Instruction level pipelining allows multiple instructions to be executed simultaneously, such that five instructions can be operated on simultaneously. The instruction pipeline consists of five stages. During the first stage, the instruction is fetched from the I-Cache. The instruction is decoded and General Registers are read in the second stage. The specified function or calculation is performed during the third stage, and in the fourth stage the result of the calculation is saved to a CPU general purpose register. Excluding penalties for cache misses, and branch instructions, the net effect is that one instruction is completed with every clock cycle.

Floating-point coprocessor
A floating-point coprocessor is available as an option to the Series 957LX, 957, 967LX, and 967 systems. By operating in parallel with the CPU, the coprocessor increases performance in applications that utilize floating point. Floating-point calculations on the Series 917LX, 927LX, 937LX, 937, 947LX, and 947 are performed by software routines.

Virtual memory management
Virtual addresses are 48 bits in length, ensuring sufficient expandability to meet evolving software needs. Virtual memory is divided into a set of 4.3 Gbyte spaces, with each space being 2 Gbytes in length. Spaces are further divided into fixed-length, 2-Kbyte pages, with a given page holding either data or code. A

single data structure can be up to 1 Gbyte or 2 GBytes in length
(compiler dependent), and code can span multiple spaces.

Memory subsystem

The memory subsystem uses 1 Mbit or 4 Mbit, fast-page mode
dynamic RAMs and is expandable in 8-, 16-, or 32-Mbyte increments.
Main memory has battery backup to ensure that information
is maintained for a minimum of 15 minutes in the event of an
interruption in AC power. The system state (including all jobs and
sessions) is saved, and processing continues without data loss upon
resumption of power. The internal memory word size is 72 bits, with
64 data bits plus 8 bits for error detection and correction. Single-bit
memory errors are automatically corrected, with automatic detection
of all double-bit errors.

Digital data storage

The digital data storage tape backup unit integrated with each
system stores 1.3 Gbytes of data on a standard audio DAT cassette,
measuring only 73 by 54 by 10.5 mm. With TurboSTORE/XL data
compression, up to 5 Gbytes can be stored on a single cassette. This
large capacity storage on a single DAT cassette eliminates the need
for operator intervention during backup and offers a convenient and
compact storage medium. High data reliability is achieved through
read-after-write, additional third-level error detection and correction
circuitry. The DDS tape drive offers these features:

- 1.3 Gbyte capacity on a 120-minute (60m) tape
- Typical transfer rate of 11 Mbytes/minute
- A large 512 Kbyte data buffer to maintain host transfer rate
- Automatic error detection and correction
- Three levels of error correcting code (ECC)
- Standard 5.25-inch form factor

Figure 2-10. DDS Tape allows Unattended Backup

Disk Storage

The systems take advantage of the state-of-the-art disk storage devices by integrating from one to three 5.25-inch disk drive units into the system and supporting up to 66 Gbytes with external disk storage devices. The storage devices offer reliable, high capacity, high performance, random access mass storage. This is accomplished by the use of advanced electronics and by embedding the servo and data information on the same track, thereby reducing component count and improving reliability. Key features of the integrated disk drives include:

- High reliability (MTBF over 100,000 hours)
- 673 or 1355 Mbyte formatted disk
- Extensive use of HP's state-of-the-art VLSI processes

System Packaging

The systems are available in one of two compact, attractive cabinets. Series 917LX through 967LX systems use a small cabinet measuring 0.4 meters high and 0.2 meters wide. The cabinet has been uniquely designed to hold an entire modular system in the space of a desktop personal computer maximizing the efficiency of office or computer room space. It is capable of holding the SPU, a digital data storage device, and one disk drive.

Series 937, 947, 957, and 967 systems use a larger package offering more room for expansion as well as more integrated peripherals. This package measures 0.4 meters high and 0.4 meters wide. It is capable of holding the SPU, a digital data storage device, and up to three disk drives in a space smaller than a two drawer filing cabinet.

Also available are larger 1.1 and 1.6 meter racks in which the system, additional external disk storage, and a Datacommunications and Terminal Controller (DTC) may be mounted to house an entire system configuration.

I/O subsystem
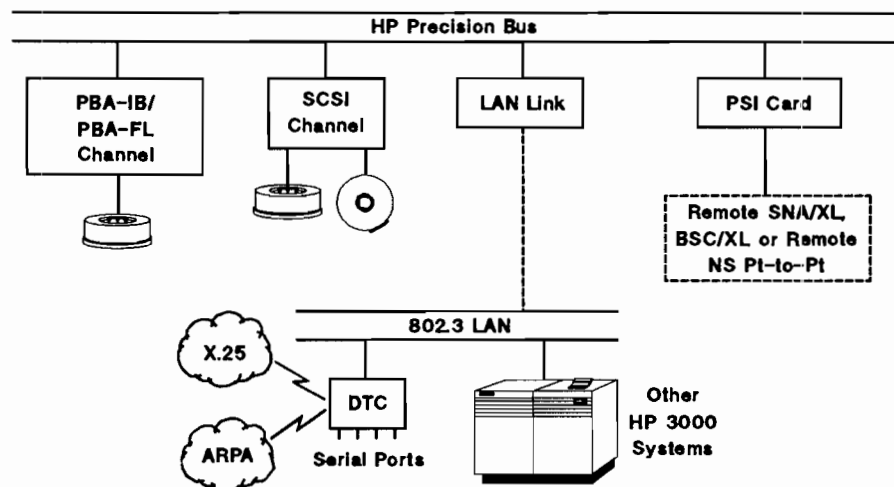
Figure 2-11. System Configuration

I/O buses

The HP Precision Bus supports I/O expansion cards for interfacing to peripheral devices and providing data communications functions. The Precision Bus runs synchronously with an 8-MHz clock, and can support data transfer rates of up to 20 Mbytes/second.

Memory-mapped I/O

Input/Output operations are initiated and controlled via a memory-mapped I/O scheme, such that the processor only needs to access reserved virtual or physical memory locations to control I/O operations. Memory-mapped I/O allows for streamlined I/O operations and thus increases system performance in I/O intensive applications.

Peripheral connections

Disks, tapes, and system printers are connected either using an industry standard Small Computer Systems Interconnect (SCSI) channel card or a Hewlett-Packard Interface Bus channel card, which supports the 8 bit wide, IEEE-488 standard Hewlett-Packard Interface Bus (HP-IB). One SCSI adapter is integrated into the system to provide for peripheral connections. Each additional SCSI channel card supports up to seven peripheral devices, while HP-IB channel cards support up to six peripheral devices.

External disks can also be connected using HP Fiber Optic Link interfaces (HP-FL). HP-FL interfaces support up to eight external disks and are supported on Series 937, 947, 957, and 967 systems.

Workstation and serial printer connection

Connections for workstations, serial printers, and other serial devices are provided via Datacommunications and Terminal Controllers (DTCs) that are distributed over an IEEE 802.3 standard Local Area Network (LAN). This flexible connection scheme allows DTCs to be situated in the department that they service, saving the cost and effort of running cables from each workstation back to the system processing unit. The DTC48 can support up to 48 directly connected ports, or 36 modem ports, or a combination of the two. The DTC16 supports 16 directly connected ports, or 12 modem ports, or a combination of the two.

PCs can also be connected to the HP 3000 through HP LAN Manager and Novell NetWare LANs. Physical connections can be HP EtherTwist, which is a local area networking scheme using unshielded twisted pair (or phonewire).

Both workstations that are connected using a DTC, and PCs that are connected using a LAN, can communicate with HP 3000 systems and servers connected over the same LAN.

Terminal connections are not supported on the standard Server versions. Instead all PC workstations are connected to the server using a LAN. Terminal connections can be added to the Servers by purchasing an additional terminal connection software product.

HP EasyTime/XL

HP EasyTime/XL is an easy-to-use interface to commonly-performed system management functions on entry-level HP 3000 900 Series systems. HP EasyTime is supplied standard on 9x7LX systems.

Based upon a state-of-the-art interface (UIMS ISA Dialog Manager) and architecture, HP EasyTime/XL provides a simple way to access the most commonly used system management utilities. Context-sensitive online help addresses the needs of novice system managers and end users with limited computer experience. HP EasyTime/XL makes the administration of MPE/XL systems possible without costly training.

HP EasyTime/XL provides access to the HP 3000's rich systems management functionality through a logical, simple-to-use hierarchy of windows.

Key features of HP EasyTime/XL are as follows:

- Print file management: show status of print files, read file, delete print files, put print files on hold, take print files off hold, load/align forms, change number of copies, change print device, print first, reprint
- Printer management: enable printer, disable printer, set outfence
- Backup management: full backup, partial backup, review backup information, schedule full backup, schedule partial backup
- Console management: read requests, reply to requests, read console messages, print messages and requests
- Job management: review job details, start job, schedule job, delete a job, suspend a job, resume a job, set job limit, set jobfence, put on hold, take off hold, run next
- Session management: show sessions, abort sessions, send message, limit number of sessions
- File management: show list of files, read files, delete files, print files, store/restore files, copy files, rename files, release files, secure files, move files
- HP EasyTime/XL customization: end user restrictions, choice of startup screen, whether console elimination is on or off, streaming of jobs before or after a scheduled backup
- General capabilities: on-line help, ability to change presentation of display data, flexible sort criteria, special options for advanced users

Open systems functionality

The HP 3000 900 Series systems provide OLTP performance and functionality while supporting industry and de facto standards. The HP 3000 supports X/Open's open systems definition by providing interoperable networking (ARPA, OSI and IBM SNA services) and application portability through application programming interfaces (APIs). In addition, the HP 3000 supports de facto market standards such as Microsoft's LAN Manager and Novell's NetWare for PC

Integration, as well as SQL Access for interoperable relational databases.

System-to-system data communication

HP NS/XL Network Services provide virtual terminal, network file transfer, remote file and database access, network interprocess communication, and remote process management between HP 3000s on an IEEE 802.3 local area network using HP LAN Link/XL or over wide areas using the HP DTC X.25/XL Network Link or the HP NS Point-to-Point Link.

In multivendor, interoperational environments, the HP 3000 supports ARPA Telnet and FTP, and OSI X.400 messaging services and FTAM.

HP SNA Link/XL and HP BSC Link/XL are provided for HP-to-IBM system communication in SNA and Bisync environments, respectively. Network services over these links include HP SNA IMF/XL for SNA 3270 emulation; HP SNA NRJE/XL for SNA remote job entry; HP LU 6.2 API/XL, an LU 6.2 program-to-program application interface; HP SNA Distributed Host Command Facility/XL (HP SNA DHCF/XL) for IBM 3270/PC access to the HP 3000; and BSC RJE/XL for Bisync remote job entry.

For detailed network information, please refer to Chapter 5 on "Networks".

Learning Products

Series 917LX through Series 967LX systems ship with a streamlined manual set covering installation and basic system operation and management. Series 937 and Series 947 systems are shipped with the System Management Core set of manuals to aid in efficient operation of the system. Series 957 and Series 967 systems come with the System Management Core Plus set of manuals.

Additional manual sets covering more advanced system management and administration tasks, HP 3000 programming environments, as well as other topics are available and must be ordered separately.

Environmental Specifications with Integrated Peripherals

Regulatory compliance	UL-listed, ETL listed, CSA certified, compliant with EN 60950
Electromagnetic interference	Complies with FCC Rules and Regulations, Part 15, Subpart J, as a Class A computing device. Manufacturer's Declaration to German FTZ 1046. VCCI Registered.

Input current

	Nominal	Range	Rated Current
9x7LX	100-120 V, 50/60 Hz	90-132 VAC, 47-63 Hz	6.5 A
	220-240 V, 50/60 Hz	180-264 VAC, 47-63 Hz	3.5 A
9x7	100-120 V, 50/60 Hz	90-132 VAC, 47-63 Hz	12 A
	220-240 V, 50/60 Hz	180-264 VAC, 47-63 Hz	6 A

Power consumption	9x7LX: 1383 BTU/hour 9x7: 2766 BTU/hour

Physical dimensions

	9x7LX	9x7
Height:	430 mm (16.9 in)	430 mm (16.9 in)
Width:	222 mm (8.7 in)	444 mm (17.4 in)
Depth:	533 mm (21 in)	533 mm (21 in)

Weight	9x7LX: 31.8 kg (70 lbs) 9x7: 50 kg (110 lbs)
Temperature	Operating: 5° to 40°C (41° to 104°F) Nonoperating: -40° to 65°C (-40° to 149°F) Nonoperating with tape media: -40° to 45°C (-40° to 113°F)
Relative humidity	Operating: 20 to 80%, noncondensing Nonoperating: 5 to 80%, noncondensing
Altitude (operating)	Up to 3.0 km (10,000 ft)
Battery backup time (minimum)	15 minutes
Acoustics	9x7LX: 5.7 bels (A) sound power below 30°C 9x7: 6.2 bels (A) sound power below 30°C

Series 920, 922RX, 922LX, 922, 932, 948, and 958 Systems

These HP 3000 900 Series systems—including memory, disk storage, and tape backup devices—are each contained in a compact, integrated package about the size of a two-drawer file cabinet, which easily fits into any office environment without special power or environmental requirements. These systems provide attractive upgrades for existing systems. As system demand increases, simple board-swap, field upgrades provide more performance and expanded system configurability.

All the HP 3000 900 Series systems run the MPE/XL operating system. The entry member Series 920 supports up to 20 logged-on users, while the top-of-the line Series 958 provides 8.5 times the performance and supports up to 600 users. Taking advantage of PA-RISC and VLSI technology, each is implemented cost-effectively as a single-chip CPU on a single processor board. These systems offer state-of-the-art technology in reliable, high-performance peripherals including an advanced digital data storage (DDS) tape backup unit, which provides high-speed, cost-effective backup. Each DDS cartridge provides 1.3 Gbytes of data storage, or up to 5 Gbytes on a single 120 minute tape with HP TurboSTORE/XL software data compression. These large storage capacities allow many system configurations to be backed up on a single cartridge, eliminating the need for an operator to be present during backup operations. These HP 3000 900 Series systems support up to 2.7 Gbytes of integrated disk storage through next-generation high-capacity disk technology. With external disks, the Series 958 supports up to 34.8 Gbytes of storage.
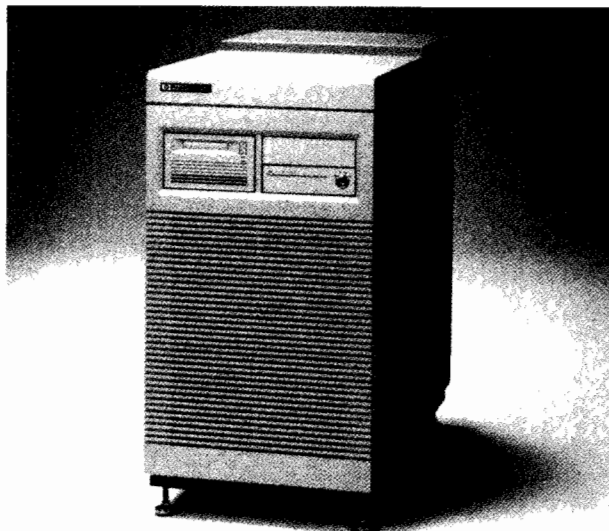
Figure 2-12. HP 3000 Series 948 Package

Configuration Maximums

	920	922LX	922RX	922	932	948	958
Performance x 920	1.0	1.7	1.7	1.7	2.7	6.0	8.5
Memory (Mbytes)	56	128	128	128	128	256	256
User license	20	32	64	UL*	64/UL*	64/UL*	UL*
Workstations connected	48	152	152	152	250	400	600
Disks	10	10	10	10	18	28	28
Integrated disk storage (Gbytes)	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Disk storage (Gbytes)	12	12	12	12	22	34.8	34.8
Tape drives	4	4	4	4	4	5	5
System printers	4	4	4	4	6	8	8
Channel I/O buses	1	1	1	1	1	3	3

* UL = unlimited user license

Major features

- Single chip VLSI CPU; single board processor
- Integrated 670-Mbyte disk drive expandable to 2.7-Gbytes internal storage
- Integrated DDS tape backup unit with 1.3 Gbytes per cartridge—up to 5 Gbytes with HP TurboSTORE/XL software data compression
- 48-bit virtual addressing (Series 920, 922LX, 922RX, 922, 932)
- 64-bit virtual addressing (Series 948 and 958)
- High-performance floating-point coprocessor (in software for Series 920; optional on Series 948 and 958)
- Battery backup, automatic powerfail recovery standard
- Standard office power and cooling requirements; compact packaging
- MPE/XL operating system

System organization

The processor communicates with memory and I/O using the HP Precision Bus. The HP Precision Bus provides a 32-bit data path and can support data transfer rates of 20 Mbytes per second. The Precision Bus supports up to three PSI cards on the Series 920, 922, and 932, allowing HP 3000 900 Series systems to be linked to IBM using Bisync and SNA and to other HP 3000 computers in a point-to-point network. The Series 948 and 958 both support up to five PSI cards. The Precision Bus is interfaced to a separate 16-bit wide channel I/O bus (CIB) using a CIB adapter. The CIB supports I/O interfaces to peripheral devices and data communication links. The following table compares features of the different HP 3000 intermediate processors.

See figure 2-15 for the HP 3000 Series 920 system structure.

Features Comparison

	920	922	932	948	958
Performance x 920	1.0	1.6	2.7	6.0	8.5
Virtual addressing	48 bit	48 bit	48 bit	64 bit	64 bit
CPU cycle time	62.5 ns	80 ns	67 ns	36 ns	20 ns
CPU data cache	64 Kb	32 Kb	128 Kb	512 Kb	512 Kb
CPU instruction cache	64 Kb	32 Kb	128 Kb	512 Kb	512 Kb
Total cache	128 Kb	64 Kb	256 Kb	1024 Kb	1024 Kb
Pipelining	4 stage	3 stage	3 stage	5 stage	5 stage
TLB on chip (CPU)	—	—	—	64	64
External TLB entries	64	4K	4K	8K	8K
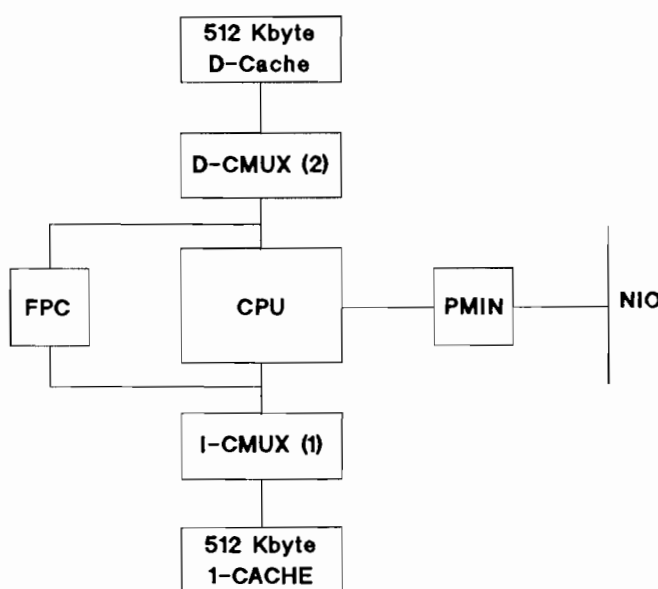
Figure 2-13. HP 3000 Series 948, 958 Processor

Cache

The CPU cache is a high-speed buffer that minimizes the number of relatively slow transactions with main memory. Cache access can provide up to an order of magnitude faster access than main memory. Data modified in the cache is written to memory only when the processor requires more data to be read into cache, when a direct memory access (DMA) operation is performed, or upon a power failure. One of the primary differences between the different members of the HP 3000 intermediate family is the size of their CPU caches.

Instruction pipelining

Instruction pipelining maximizes the use of processor resources by operating on multiple instructions simultaneously, which allows the execution of one instruction each CPU clock cycle. Separate instruction and execution units facilitate instruction pipelining and provide efficient, parallel use of processor resources.

The Series 920 employs a four-stage instruction pipeline that operates on four instructions simultaneously. Each stage takes one CPU cycle and each instruction is processed in four stages: fetch, decode, execute, and store. The net effect is that, except for penalties such as cache misses (which occur infrequently), one instruction completes (exits the pipeline) every CPU cycle.

The Series 922 and 932 use a three-stage instruction pipeline. While one instruction is fetched, another instruction is executed, and the result of a third instruction is stored.

The Series 948 and 958 employ a five-stage instruction pipeline: fetch, decode, execute, set condition codes, and store results.

Floating-point coprocessor

For scientific, engineering, and statistical applications that require high performance in floating-point calculations, the Series 922 and 932 come equipped with a hardware coprocessor that significantly accelerates floating-point calculations. The floating-point coprocessor is optional on the Series 948 and 958. The Series 920 provides floating-point operations in software.

The floating-point coprocessor supports single (32-bit) and double (64-bit) precision floating-point operands of the ANSI/IEEE 754-1985 standard. The floating-point coprocessor and the CPU operate in parallel, with the CPU performing integer calculations and other functions while the coprocessor performs floating-point calculations. This parallel operation helps provides a high level of performance for applications that require floating-point calculations.

Virtual memory management

To ensure sufficient expandability to meet growing software needs, HP PA-RISC virtual addresses on the Series 920, 922, and 932 are 48 bits in length, and on the Series 958 and 948 they are 64 bits. PA-RISC divides virtual memory into 65,536 spaces on the Series 920, 922, and 932 and into over four billion spaces on the Series 948 and 958. A space is 4 Gbytes. Each space is further divided into fixed-length 2-Kbyte pages. A single page can contain either code or data.

Virtual address translation

Because virtual addresses are much larger than physical or real addresses, virtual-to-physical address translation is required. A high-speed RAM buffer called the translation lookaside buffer (TLB) optimizes this task. The TLB can be considered to be a table that holds the most recently referenced virtual addresses and their corresponding physical addresses.

When a virtual-to-physical address translation occurs, the TLB checks to ensure that the currently executing process has sufficient page access authorization to perform the requested read, write, or execute access.

If the address is not in the TLB, a hashing scheme is used to find the required code or data in main memory. If the instruction or data is on a page that is not in main memory, a page fault occurs, and the required page is copied from disk. Together, the TLB and hashing scheme provide a very fast and efficient means for retrieving code and data from main memory and disk.

Memory subsystem

The main memory capacities of these HP 3000 900 Series systems are shown in the table below. Memory is supplied in 8-, 16-, or 32-Mbyte increments. The 8-Mbyte boards use 1-Mbit fast-page dynamic RAMS, while the 16- and 32-Mbyte boards use 4-Mbit fast-page dynamic RAMs. Main memory has battery backup to ensure that information is maintained for a minimum of 15 minutes in the event of an interruption in AC power. Automatic powerfail recovery allows the operating system to be restarted and processing to continue without data loss, upon resumption of power.

Error correcting code (ECC) memory is standard on all 900 Series systems. Single-bit errors are automatically detected and corrected to ensure data integrity. Multibit errors are automatically detected, and a high-priority interrupt is sent to the system software for appropriate action.

System	Standard memory (Mbytes)	Expansion increments (Mbytes)	Maximum Memory (Mbytes)
920	24	8, 16, and 32	56
922LX	24	8, 16, and 32	128
922RX	32	8, 16, and 32	128
922	32	8, 16, and 32	128
932	32	8, 16, and 32	128
948	64	8, 16, and 32	256
958	96	8, 16, and 32	256

Subsystems

Buses

The HP 3000 Series 920 through 958 systems employ a two-level bus hierarchy for high-performance I/O throughput—the precision bus and the channel I/O bus.
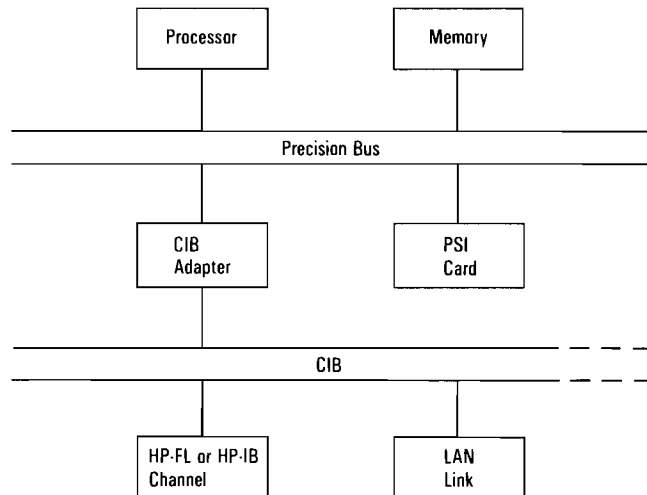
Figure 2-14. HP 3000 Series 920 System Structure

Precision bus

The precision bus is the communication path between the CPU, main memory, and the channel adapters. The precision bus provides a 32-bit data path, runs synchronously with an 8-MHz clock, and supports an average data transfer rate of 20 Mbytes per second.

In addition, the precision bus directly supports a PSI card to provide point-to-point, system-to-system communication between HP 3000 computers and communication to IBM systems using Bisync and SNA.

Channel I/O bus adapters

The channel I/O bus (CIB) adapter, or channel adapter, for short, provides the interface between the precision bus and the CIB. The channel adapter serves as a high-performance channel multiplexer providing full DMA for all HP-FL, HP-IB, and LAN I/O Channels and synchronizing the different speeds and bandwidths of the precision bus and the CIB. DMA allows large blocks of data to be transferred to and from main memory with minimum CPU intervention, thereby reducing CPU overhead.

Channel I/O buses

The HP 3000 intermediate systems include one CIB. The Series 948 and 958 also have one precision bus adapter (PBA) as standard equipment. Each CIB supports up to six cards for interfacing peripheral devices and providing data communication functions. The CIB provides a 16-bit wide, bidirectional data path that runs synchronously with a 4-MHz clock.

Precision bus adapter

The precision bus adapter (PBA) is a single card that combines the functionality of a channel adapter and the channel I/O bus and connects to a single HP-IB or HP-FL card. The PBA was developed to extend the I/O capacity for the Series 948 and 958, because of their greater processor performance. The PBA comes preconfigured with either an HP-IB or an HP-FL card included. The PBA is not supported on the Series 920, 922, and 932.

Memory-mapped I/O

Input/output operations are initiated and controlled using a memory-mapped I/O scheme, such that the processor only needs to access reserved virtual or physical memory locations to control I/O operations. Memory-mapped I/O allows for streamlined I/O operations and increases system performance in I/O intensive applications.

Peripheral connections

Disks, tapes, and printers are connected using an HP-IB channel, which supports the 8-bit wide, IEEE-488 standard HP-IB. Each HP-IB channel supports up to six peripheral devices. In addition, external disks can be connected using HP-FL, a high-speed fiber-optic link with a data transfer rate of up to 5 Mbytes per second and up to a distance of 500 meters. HP-FL and dual fiber-optic disk drives are required for the high-availability products, HP Mirrored Disk/XL and HP SPU Switchover/XL.

Workstation and serial connections

Connections for workstations, serial printers, and other serial devices are provided through DTCs for multiuser systems. DTCs are distributed over an IEEE-802.3 standard LAN. This flexible connection scheme allows DTCs to be situated in the department that they serve, saving the cost and effort of running cables from each workstation back to the processor. The DTC48 can support up to 48 direct-connect ports, or 36 modem ports, or a combination of the two. The DTC16 supports 16 direct-connect ports, or 12 modem ports, or a combination of the two. Both RS-232 and RS-422 interfaces are supported.

PCs can also be connected to the HP 3000 through HP LAN Manager and Novell NetWare LANs. Physical connections are made with HP EtherTwist, a LAN scheme that uses unshielded, twisted pair (or phonewire).

Terminal connections are not supported on the standard servers. Instead all PC workstations are connected to the server using a LAN. Terminal connections can be added to the server by purchasing an additional terminal connection software product.
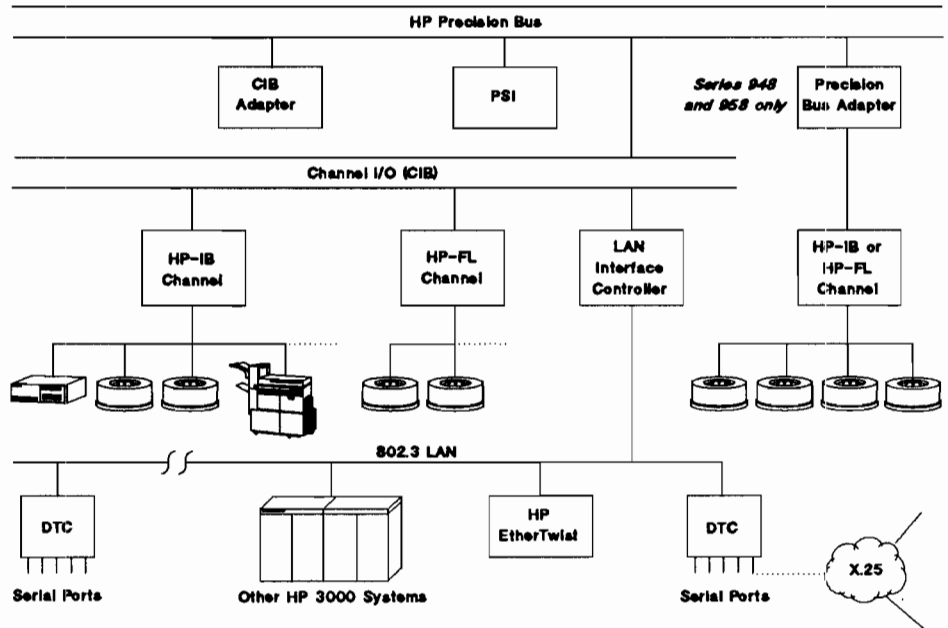
Figure 2-15. HP 3000 Series 948 I/O Attachments

System-to-system data communication

HP NS/XL Network Services provides virtual terminal, network
file transfer, remote file and database access, network interprocess
communication, and remote process management between HP 3000s
on an IEEE 802.3 or Ethernet LAN using HP LAN Link/XL, or over
wide areas using the HP DTC X.25 XL Network Link or the HP
NS/XL Point-to-Point Link.

For system-to-system, point-to-point communication to other
HP 3000s, and connection to IBM systems via SNA and Bisync, the
Programmable Serial PSI card is connected directly to the Precision
Bus.

In multivendor interoperational environments, the HP 3000 supports
ARPA Telnet and FTP, and OSI X.400 messaging services and
FTAM.

HP SNA Link/XL and HP BSC Link/XL are provided
for HP-to-IBM system communication in SNA and Bisync
environments, respectively. Network services over these links
include HP SNA IMF/XL for SNA 3270 emulation; HP SNA
NRJE/XL for SNA remote job entry; HP LU6.2 API, an LU6.2
program-to-program application interface; HP SNA Distributed Host
Command Facility/XL (HP SNA DHCF/XL) for IBM 3270/PC
access to the HP 3000; and BSC RJE/XL for Bisync remote job
entry.

For detailed network information, please refer to Chapter 5 on
"Networks".

System packaging

The HP 3000 900 Series intermediate systems are available in a compact, attractive cabinet measuring 0.7 meter high and 0.375 meter wide, comparable in size to a desk-high, two-drawer file cabinet. The cabinet has been uniquely designed to hold an entire modular system in a small amount of space, maximizing the efficiency of office or computer room space. It is capable of holding the SPU, one digital data storage device, and up to four disk drives. Additional peripherals are supported external to the system cabinet.

Digital data storage

Digital audio tape (DAT), the latest development in the use of helical-scan recording technology, provides digitally encoded, high-quality data storage. The DAT unit stores data on tape using the digital data storage (DDS) format. This format is used by numerous other tape drive manufacturers allowing a fully compatible tape drive technology. The DDS backup unit integrated in the HP 3000 Series 920 through 958 systems store 1.3 Gbytes of data on a standard DAT cassette, which measures only 73 by 54 by 10.5 mm, slightly smaller than an audio cassette tape. Up to 4.7 Gbytes can be stored on a single 120-minute tape using HP TurboSTORE/XL data compression. This large capacity storage on a single DAT cassette eliminates the need for operator intervention during backup and offers a convenient and compact storage medium. High data reliability is achieved through read-after-write and additional three-level error detection and correction circuitry.

Disk storage

These HP 3000 900 Series systems take advantage of state-of-the-art disk storage devices by integrating up to four 5 1/4-inch 670-Mbyte disk drive units into the system, providing 2.7 Gbytes of disk storage. The storage devices offer reliable, high-capacity, high-performance, random-access mass storage. This is accomplished by the use of advanced electronics and by embedding the servo and data information on the same track, thereby reducing component count and improving reliability. Key features of the integrated disk drives include:

- High reliability (mean time between failures of over 100,000 hours)
- Enhanced Small Device Interface
- Extensive use of HP's state-of-the-art VLSI processes

Environmental Specifications with Integrated Peripherals

Regulatory compliance	UL-listed, CSA-certified, compliant with IEC 950
Electromagnetic interference	Complies with FCC Rules and Regulations, Part 15, Subpart J, as a Class A computing device. Manufacturer's Declaration to German FTZ 1046.
Input current	Nominal: 100-120V, 50/60 Hz Range: 90-132 VAC, 47-63 Hz Maximum: 12A, 200-240V, 50/60 Hz
Power consumption	Series 920 – 1900 BTU/hour Series 932 – 1580 BTU/hour Series 958 – 2810 BTU/hour
Physical dimensions	Height: 750 mm (29.5 in.) Width: 375 mm (14.8 in.) Depth: 710 mm (27.9 in.)
Weight	110 kg (244 lb)
Temperature	Operating: 5° to 40°C (41° to 104° F) Nonoperating: -40° to 70°C (-40° to 158°F)
Relative humidity	Operating: 20 to 80%, noncondensing Nonoperating: 5 to 80%, noncondensing
Altitude (operating)	Up to 3.0 km (10,000 ft)
Battery backup time (minimum)	15 minutes
Acoustics	5.8 bels sound power (A) below 30° C
Radiated susceptibility immunity	10 V/m 10 kHz-1 GHz 3 V/m 14kHz-1GHz
Conducted susceptibility	3 volts RMS 30 Hz-50 kHz 1 volt RMS 50 kHz-400 MHz

3

HP 3000 Operating Environment

Introduction

Hewlett-Packard's broad range of compatible HP 3000 business computer systems provides a single operating environment and compatible software, which increases productivity throughout your organization—end users, operators, system administrators, and programmers.

The functional heart of the HP 3000 900 Series is an open operating environment that supports extensive commercial functionality and, shortly, UNIX application programming interfaces (APIs). MPE/XL, MultiProgramming Executive with Extended Large Addressing, is optimized for online transaction processing (OLTP) and business data processing, while supporting all major industry standards for portability and interoperability.

The powerful combination of openness and OLTP performance and functionality makes it an ideal operating environment to drive the wide range of Precision Architecture-RISC-based HP 3000 systems.

Single operating environment

A common operating environment is provided across the entire family of HP 3000 systems. Upward compatibility has long been a hallmark of the HP 3000. When upgrading to larger systems, applications and data are simply stored off the old system and restored on the new system, which protects your investments in applications software and retraining end users, operations staff, and system administrators. The HP 3000 900 Series operating environment also provides application portability and broad multivendor interoperability through industry and de facto standards.

Superior performance

MPE is optimized for high performance in I/O-intensive online transaction processing (OLTP), multibatch, and general purpose business data processing. The HP 3000's high OLTP performance is achieved with tight integration of the operating system, the underlying PA-RISC hardware, and HP's database management systems ALLBASE/SQL and TurboIMAGE/XL. Performance is further streamlined by highly efficient I/O processing and maximum main memory utilization, which results in minimizing the number of physical I/Os that must actually be performed.

Robust functionality
A full range of OLTP functionality is offered on the HP 3000, including built-in capabilities to ensure superior data integrity, system security, easy systems management, and sophisticated performance measurement and analysis tools. The 900 Series offers significant functional extensions: a greatly extended address space for more data and application expandability, an enhanced command interpreter, integrated systems and network management, symmetric multiprocessing, support for the high-performance HP-FL fiber-optic disk interface, and optional configurations supporting very high data availability for mission-critical applications.

Open systems and standards
Open systems means the interoperability of different vendor systems and the support of standard application programming interfaces (APIs) that allow for easy portability of applications between the HP 3000 and systems from different vendors. The HP 3000 supports an open environment that provides a wide variety of de facto and industry standards: operating system, user interfaces, networking, databases, development tools, and programming languages. These standards include X/Open's POSIX operating system interface, MS Windows and OSF/Motif graphical user interfaces, distributed application services based on the International Standards Organization's (ISO) Open Systems Interconnect (OSI) model, ARPA Telnet, IBM's de facto standards SNA network and SAA application interoperability, ANSI standard SQL relational database management system, industry-leading multivendor application development tools, and ANSI standard programming languages.

Systems management
HP 3000 systems management encompasses a broad range of management functions and systems services that includes performance management, administration, system security, system availability, operations, and storage management. Systems management is an important aspect for the standalone system with limited networking, for a distributed node in a network, and for large data centers, which are the hubs of major and minor networks. HP's OpenView provides for the integration of systems and network management in distributed environments.

Ease-of-use
The HP 3000 offers a simple, consistent, and intuitive interface for end users and system administrators; major multivendor CASE tools for application development; and an online Help facility. With these features, the HP 3000 provides simpler system management and administration relative to traditional computers as well as traditional UNIX systems.

Designed for Performance

The HP 3000 is optimized for interactive, I/O-intensive, online transaction processing. It balances interactive and batch processing in a way that guarantees efficient, user-controllable scheduling of processes. A process is a single execution of a program, whether interactive or batch. Virtual memory management, mapped files, and multiprocessing greatly improve performance and data availability.

Virtual memory management

Virtual memory management automatically maps all program and data files into virtual memory, which is many times greater than real memory. By swapping portions of code and data from disk into and out of main memory, virtual memory management allows programmers to create programs and to access data files that are too large to be kept in main memory. This capability makes programming easier, since programmers need not be concerned with segmenting and swapping code and data.

Demand-paged virtual memory
The HP 3000 provides one of the largest address spaces in the industry; this provides the following benefits:

- Applications that are much larger than available main or secondary memory and very large applications can execute concurrently without virtual memory constraints.
- Programmer productivity improves because programmers do not have to segment their programs or use extra data segments.
- System performance is enhanced because the CPU does not have the overhead caused by program or data segmentation.
- The virtual addressing capabilities can meet addressing requirements into the next century.

The term *virtual memory* refers to the fact that the available memory space appears to be many times larger than the actual amount of main or even disk memory. The HP 3000 provides this capability to an extraordinary degree by taking advantage of PA-RISC's extremely large addressing potential.

The HP 3000 900 Series provides virtual addressing that consists of up to 4 billion 2-gigabyte spaces. Most 32-bit architectures in the industry support up to 32-bit virtual addressing, which is equivalent to only one 900 Series space. Far more addressability is provided on PA-RISC systems, with the number of spaces dependent on the processor model. The Series 948, 958, and 980 processors support 64-bit addresses or 4 billion times the addressability of typical 32-bit computers. All the other PA-RISC systems support 48-bit addressing, or over 65,000 2-gigabyte spaces.

All open files on the system are encompassed in virtual address space, which is managed transparently from the programmer's point of view.
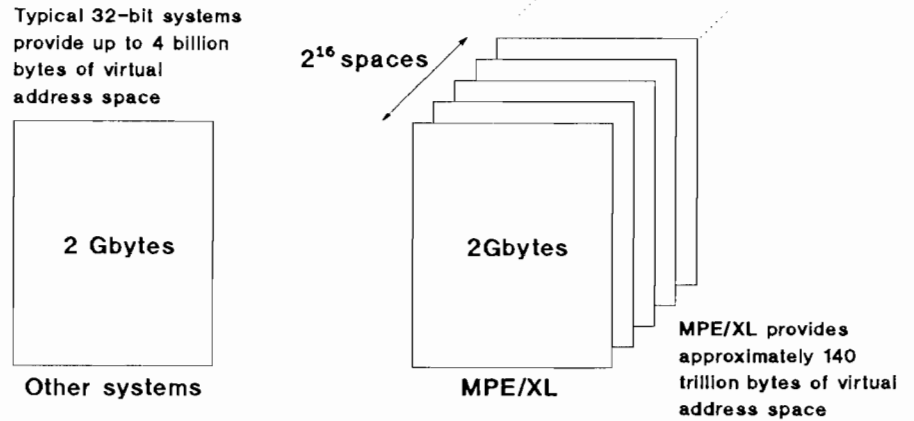
Figure 3-1. The HP 3000's Extremely Large Virtual Address Space

Every virtual space is subdivided into fixed-size blocks called pages. The operating system ensures that a page can hold either code or data, but not a combination of both. Since active code pages are nonmodifiable, multiple users are able to share a single copy of a program's code.

Code and data pages are automatically fetched on demand from disk to main memory as required by the process. While pages needed for one process are being obtained from disk, execution of other processes continues.

The HP 3000 typically fetches pages from disk in groups so that not only the specific page required is obtained, but also those around it. This reduces the number of disk accesses because the processor is most likely to require pages that are located close to one another. Frequently used pages remain in memory for fast access, while rarely used pages remain on disk until needed.

The HP 3000 allows a program's predeclared data structures to be up to 1 gigabyte. Access to multiple 2-gigabyte data areas is provided through mapped files. Very large files can be supported on the HP 3000 without performance overhead.

HP 3000 mapped files
CPU and memory speeds are improving more rapidly than disk access speeds, and memory costs are constantly moving down. Consequently, increasing memory size and using main memory as a buffer for disk is an important way to increase performance for I/O-intensive applications.

The HP 3000 operating system employs a very sophisticated technique for performing file access. This technique, referred to as *mapped files*, is an improved disk caching capability.

The mapped files technique significantly improves I/O performance by reducing the number of physical I/Os without imposing additional CPU overhead or sacrificing data integrity and protection. This

technique also eliminates file system buffering and optimizes global memory management of the system.

Mapped files are based on the operating system's demand-paged virtual memory and are made possible by the extremely large amount of virtual space on the system. When a file is opened, it is logically "mapped" into the virtual space. In other words, all files on the system and their contents are referenced by virtual addresses. Every byte of each opened file has a unique virtual address.

File access performance is improved significantly when the code and data required for processing can be found in memory. File access performance is enhanced because memory access is 10 to 100 times faster than performing physical disk I/O operations. Tradition disk caching reduces costly disk reads by using main memory for code and data. Mapped files and virtual memory management further improve performance by caching writes. Once a virtual page is read into memory, it can be read by multiple users without additional I/O overhead. If it is a data page, it can be read and written to in memory without physically writing it to disk. When the data is already in memory, locking delays are greatly reduced, which increases throughput. Finally, when the memory manager does write a page back to disk, it combines multiple pages into a single write, again reducing multiple physical I/Os.
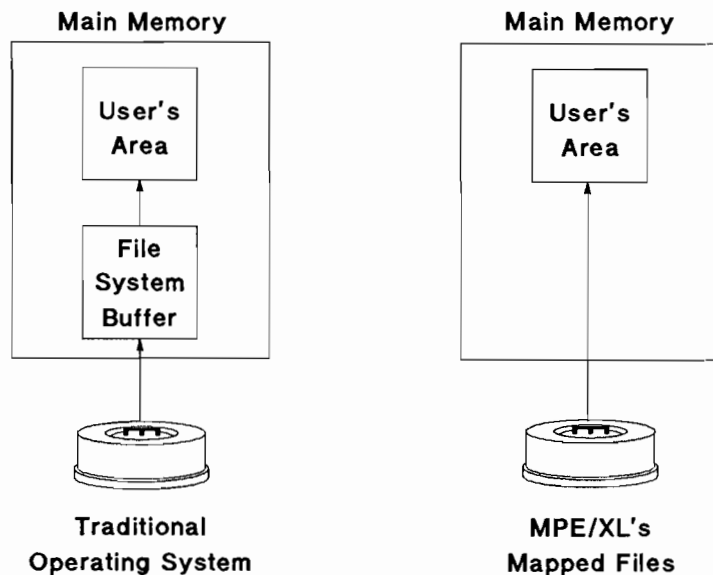
Figure 3-2. The HP 3000's Mapped Files

Traditional disk caching schemes impose a CPU overhead penalty. The HP 3000 operating system takes advantage of the PA-RISC hardware's automatic address translation so that the benefits of increased I/O performance are attained without incurring this penalty.

The virtual-to-physical address translations to locate portions of the mapped-in files are performed by the system hardware, so that operating system overhead is virtually eliminated.

In addition, the mapped file technique eliminates file system buffering. In traditional operating systems, data is copied from disk into a file system buffer in memory; from there the data is moved into the user's area in memory. Since the 900 Series' memory manager fetches data directly into the user's area, the need for file system buffering is eliminated. The benefits of this are two-fold: System performance is increased by the elimination of unnecessary data movement within memory, and the use of memory space is optimized.

Multiprocessing

The HP 3000 900 Series supports fully symmetric multiprocessing (MP). Multiprocessing is where the operating system transparently distributes the system workload over multiple CPUs to process in parallel, thus increasing overall system throughput.

Multiprocessing provides additional capacity for online, mixed online/batch, and multibatch application environments. It is completely transparent to end users, applications, and system administrators.

The HP 3000 operating system has been designed for optimal performance in MP configurations. Since MPE/XL is fully symmetric, virtually any process can be run on any CPU in an MP system. In contrast to other multiprocessor operating systems, which have less flexibility and thus lower performance, some processes can often run only on one designated CPU.

The HP 3000 multiprocessing approach is based on a fine-grained design, optimized for OLTP types of applications. *Fine-grained* refers to the locking scheme necessary to ensure data integrity of shared data structures. Because the CPUs compete for the same data, it is necessary to provide locks on sections of data such that only one CPU at a time is allowed access to a section of data. A fine-grained locking scheme provides many locks on very small sections of data for very short durations of time, thus minimizing the instances where a processor is not performing useful work because it is waiting for access to a data structure.

The HP 3000 multiprocessor systems take advantage of the parallel I/O paths provided in hardware and software, ensuring delivery of maximum performance using system-level parallelism. Other multiprocessor architectures may provide parallelism at the CPU level, but may then bottleneck on a single path through the software I/O system.

Multiprocessing technology also delivers benefits in higher system availability and load balancing. In an MP configuration, if one CPU fails, the operating system notes the failure upon reboot, deconfigures the failed processor, and continues normal boot and operation. Load

balancing among the multiple CPUs is transparently managed by the operating system, ensuring the maximum efficiency of available processing capacity.

High Availability

The HP 3000 is targeted for operationally critical applications where the operation of the business is dependent upon system availability and data integrity—If the system stops, the business stops. The HP 3000 900 Series offers significant enhancements that deliver very high data availability and integrity for critical business applications. High availability begins with high-quality PA-RISC. The HP 3000 900 Series (based on warranty data on the HP 3000 Series 950) has achieved over a 50 percent increase in reliability above the industry-acknowledged highly reliable HP 3000 Series 70.

The high-availability strategy for the HP 3000 provides you with the ability to configure your system with high-availability options to meet the high-availability needs of your environment. Specifically, the HP 3000 provides products that minimize downtime from both unplanned and planned events. Unplanned downtime results from component failures, while planned downtime results from normal system operation events such as data backup. The goal of the HP 3000 high-availability products is to provide system availability of 99.9 percent with respect to unplanned downtime, to limit downtime from any given failure to 30 minutes or less, and to allow 24-hour-a-day operation.

Some high-availability features, such as transaction management, automatic powerfail recovery, user volumes, and online diagnostics, are standard on all HP 3000 900 Series systems. Other solutions, such as HP Mirrored Disk/XL, HP AutoRestart/XL, HP SPU Switchover/XL, HP TurboSTORE/XL, are separate products that can be purchased to tailor your system to the specific requirements of your environment.

Transaction management

Over the last 20 years, computers evolved from batch-oriented systems to online systems that are characterized by a large number of users performing simultaneous updates to common data. OLTP systems have very stringent requirements for response times, accuracy of data, and the ability to recover from system and hardware failures with complete data integrity.

For example, an airline reservation system must maintain data integrity even if several users are performing updates to the same file. It is important that the application ensures that the same seat is not assigned to more than one passenger. This is accomplished by locking common data so that only one user at a time may change it.

In addition, the application must not lose any data in the case of a system failure. Users must be able to recover from both *soft failures*,

which do not cause any data to be altered on disk, and *hard failures*, such as a disk head crash when data is destroyed. Checkpointing and logging provide the ability to recover from both soft and hard failures. *Checkpointing* refers to saving a snapshot of data in a known consistent state. *Logging* is the saving of the actual checkpoint data in a file.

If a transaction is aborted or a soft failure occurs before the transaction is committed to disk, the file can be restored to its original state by copying the before image of the data from the log file back into the data file. This is the same as rollback recovery in HP TurboIMAGE or HP ALLBASE/SQL.

In the case of a hard failure, transactions from the log file can be applied to a backup and a rollforward recovery of the transactions can be performed. This method of recovery just reapplies all the transactions to some checkpoint version of the file.

Transaction manager

The transaction manager has been integrated into the operating system and is standard on every 900 Series system. The transaction manager performs automatic checkpointing and logging activities for critical system data structures such as the file system and HP ALLBASE/SQL and HP TurboIMAGE databases. In the event of a system software failure, the transaction manager provides automatic data integrity recovery of these critical data structures.

In most commercial computing environments, file system, databases, and applications, each manage transactions and recovery differently. The result calls for a complex solution that requires duplication of effort, which incurs high administrative and support overhead costs and compromises overall performance. The HP 3000's transaction manager consolidates all of these functions into a single, efficient, and consistent module that is common across all disk access methods. Performance and efficiency gains are also realized over implementations at higher levels of the system by tight coupling with memory management, I/O, and PA-RISC protection hardware.

Transaction logging

The HP 3000 provides comprehensive logging facilities that are integrated into the operating system and databases.

- *System logging* records the details of system resource requests.
- *Database logging* ensures the logical and physical data integrity of HP ALLBASE/SQL and HP TurboIMAGE data.
- *User logging* allows applications to log events and data to disk or tape files.

The system manager can enable and disable system logging, as well as select which system events to record. System log records are provided for job and session initiation and termination, program

completion, file closing, spooling completion, system shutdown, and I/O device failures.

The database administrator relies on built-in database logging and recovery. The HP ALLBASE/SQL relational database management system logs before and after images for every write transaction. In the event of a system failure or a program abort, the log file is used to automatically roll back any partially completed transactions. In the event of a hardware or software failure, the transactions from the log file can be reapplied to a backup copy of the database to bring it up to the current state.

The HP TurboIMAGE database management system also includes an intrinsic logging facility, Intrinsic Level Recovery (ILR), must recover, and dynamic rollback features. These features ensure the logical and physical integrity of information maintained in TurboIMAGE databases. TurboIMAGE databases can also be rolled forward or rolled back in case of data loss.

The HP 3000 provides user logging using intrinsics, or system procedures, which log application transactions to disk or tape. The application developer has the flexibility to choose whether to wait until the transaction is physically posted to the logging device before continuing to the next transaction, or to continue immediately.

Automatic power failure recovery

Automatic power failure recovery is provided by the operating system in conjunction with the HP 3000 hardware. Should a power failure occur, the system initiates a power failure procedure that preserves the operating environment prior to a complete loss of power. A battery pack, supplied standard with each HP 3000, ensures the validity of main memory for at least 15 minutes. If power is restored within this 15-minute period, the system automatically resumes processing from the point at which the power failure occurred. Jobs and sessions in progress continue where they were interrupted, unaware of the interruption and without loss of data.

HP AutoRestart/XL

Software failures can contribute significantly to extended downtime. HP AutoRestart/XL reduces this downtime by automatically and immediately saving the system state and initiating system restart. No operator intervention or action is necessary. Hence system recovery time is minimized due to a software failure. AutoRestart/XL transfers the system state directly to disk rather than tape, which reduces the time required to save the information by at least 50 percent on high-end HP 3000 systems with larger memory configurations. AutoRestart/XL also performs data compression as it is saving the system state, thus minimizing the amount of disk space required. Once the system error information has been transferred to disk, problem analysis can begin immediately either locally or remotely.

HP Mirrored Disk/XL

Disk failure is one of the major causes of lengthy unplanned downtime. Although HP disk reliability makes these events rare, their occasional occurrence can result in several hours of downtime. To prevent downtime from disk failure, the HP 3000 offers HP Mirrored Disk/XL.

Normal operating mode
- transparent to users/applications
- minimal overhead on disk writes
- higher performance on disk reads
- simple control and operation

When disk fails
- transparent switch on failure
- online replacement of disk

Fiber Link 1   Fiber Link 2

Data duplicated
on mirrored disks

Fiber Link 1   Fiber Link 2

Disk failure

Access to
second disk
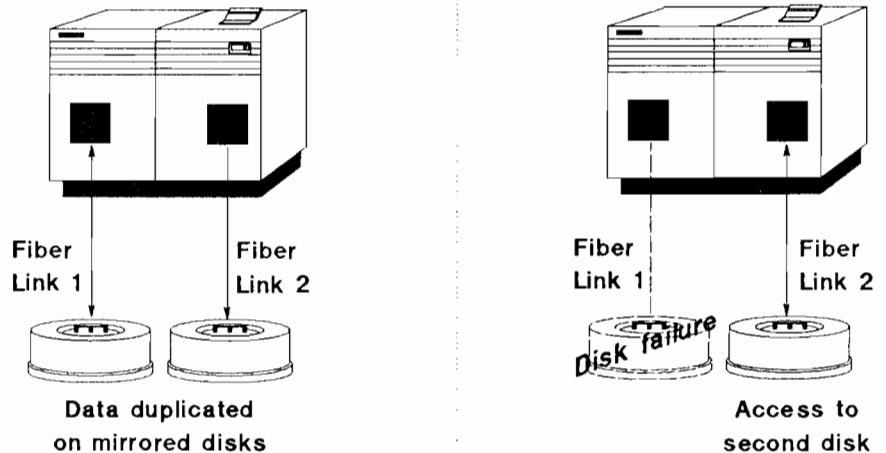
Figure 3-3. HP Mirrored Disk/XL

HP Mirrored Disk/XL provides duplicate disk drives for critical application data. In the event of failure of a disk drive that is mirrored, HP Mirrored Disk/XL automatically and transparently switches all I/O activity for the mirrored pair to the mirrored partner without disruption to the users. Neither existing HP 3000 applications nor new applications require any special coding to take advantage of HP Mirrored Disk/XL. Repair and resynchronization of the failed mirrored disk are also performed transparently to users and applications without loss of data integrity. The figure above illustrates the features and benefits of HP Mirrored Disk/XL.

HP SPU Switchover/XL

HP SPU Switchover/XL automatically detects system failures and allows for switchover between a primary and a secondary 900 Series HP 3000 processor. A single 900 Series can back up multiple 900 Series systems. An important feature of switchover is the full recovery of user data, including flat files, HP TurboIMAGE, HP ALLBASE/SQL, and third-party databases. Switchover can typically be completed in less than 30 minutes, which dramatically increases system uptime. HP SPU Switchover/XL requires that

all systems and DTCs be connected using LAN and all disks be connected using HP-FL.
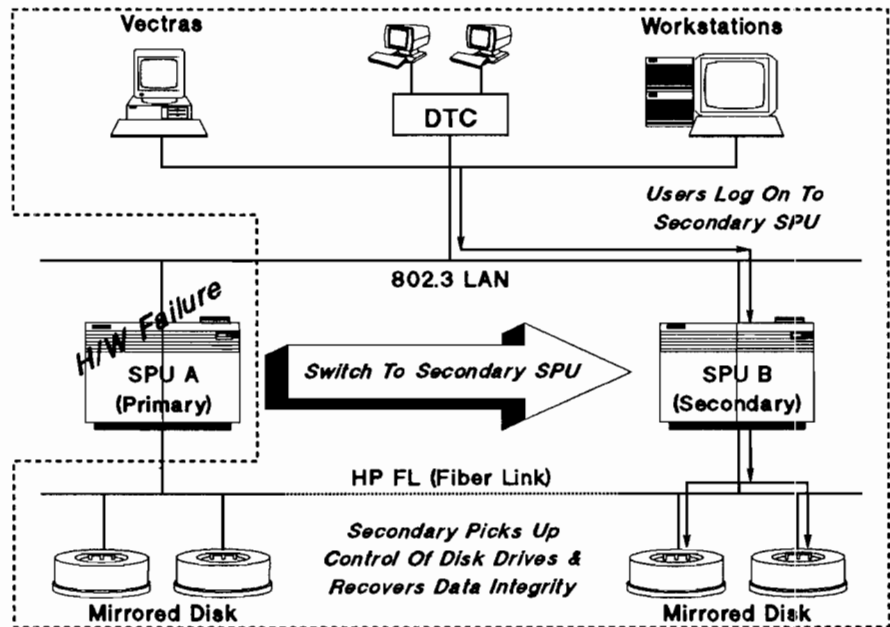
Figure 3-4. SPU Switchover/XL

SPU Switchover/XL imposes no additional system software performance overhead on either processor. Also, the secondary processor does not need to be rebooted, thereby minimizing the switchover impact on the users of the secondary processor. Finally, after the primary processor has been repaired, applications can be returned to the primary processor. This switchback procedure takes about five minutes, as there is no need to perform data recovery.

User volumes   The HP 3000 provides a user disk volume facility that allows the creation and access of files on removable disk volumes. User volumes are removable disk packs that can be accessed through the file system. Disk packs mounted on the drives during a system load are dynamically allocated to the system domain for normal use or to the nonsystem domain for private use. Nonsystem-domain packs can be both physically and logically mounted and dismounted during normal system operation. Thus, system security is improved, since sensitive information can be maintained on a separate disk.

Failure of a user volume or nonsystem volume does not disrupt users and applications on other disks, which results in higher system availability.

Online diagnostics   A comprehensive set of online diagnostics can be used by
HP customer engineers (CEs) to diagnose system hardware
and peripheral problems while the system is in operation.
Hewlett-Packard also provides a system self-test that takes 30
seconds to execute and is highly effective in isolating hardware
failures. The self-test is designed for ease of use so that the customer
can run it prior to requesting service from HP.

All of the diagnostic functions are available remotely. A remote
support modem is included with the system when you purchase a
support contract. By connecting a remote terminal to the system
console by way of a modem, a remote console can operate in parallel
with the system console. This allows HP CEs to diagnose hardware
and run software troubleshooting tools from a remote site. On-line
diagnostics and remote support result in less system downtime and
reduced maintenance costs.

Open Systems and Standards

The HP 3000 open systems environment is based on the needs of
the commercial marketplace. Several standards bodies are striving
to provide environments for portability and interoperability. The
HP 3000's strategy is to encompass the driving forces of X/Open's
interoperability and portability guidelines, de facto market standards,
and IBM's SAA interoperability guidelines. The HP 3000 supports
key industry and de facto standards in the areas of operating
system, user interfaces, database, languages, development tools, and
networking.

This section discusses the operating system interfaces and the user
interfaces supported on the HP 3000. The HP 3000 also supports an
ANSI-compliant and X/Open-compliant ALLBASE/SQL, for optimal
relational database performance and data integrity; and leading
multivendor 4GL tools, for application portability. The HP 3000
also supports popular third-party relational databases. For detailed
information on databases, computer-aided software engineering
(CASE) development tools, and languages, please see Chapter 4. For
open systems networking, the HP AdvanceNet strategy encompasses
a long-term commitment to OSI standards and services such as
ARPA TCP/IP and IBM SNA connectivity on the HP 3000. For
more information on HP 3000 networking, please see Chapter 5.
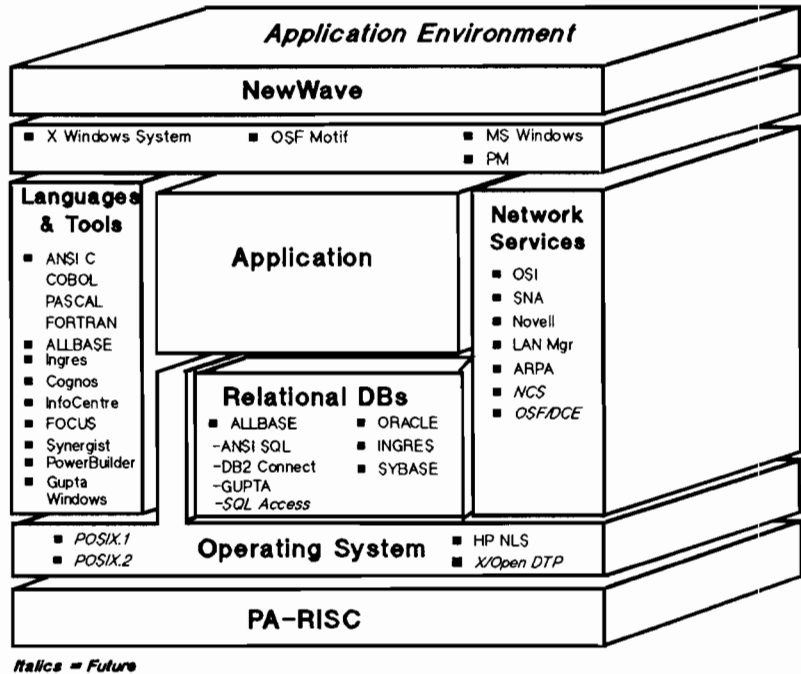
Figure 3-5. The HP 3000 Open Systems Environment

Operating system standards

To support application portability across systems, the IEEE P1003 group, accredited by ANSI, is chartered to standardize UNIX by specifying a portable operating system interface (POSIX) standard for application development. The POSIX group was formed to specify functions and services that an operating system must support and to specify the application programming interfaces (APIs) to these services.

Support of POSIX on the HP 3000 will facilitate the addition of an even broader range of application solutions. The POSIX standard simplifies application portability because software suppliers can expect a well-recognized set of operating system interface services across different vendor platforms. Thus, it provides the ability for users and VABs to develop common applications for the HP 3000 and other POSIX-compliant systems, such as the HP 9000. POSIX also provides a high level of compatibility with applications written for UNIX systems.

POSIX on the HP 3000

The HP 3000 will support POSIX 1003.1, the Core POSIX System Interface in 1991. The HP 3000 will also support the POSIX 1003.2 Shell and Tools specification. As the POSIX committees define specifications for other key operating environment components, such as security, networking, system administration, and transaction processing, Hewlett-Packard will be adopting these standards on the HP 3000, as appropriate.

Because POSIX recognizes that only the API is relevant, and does not specify the internal implementation details, the HP 3000 can take advantage of its high performance OLTP operating environment features, such as high availability and systems management, while providing an industry-standard interface. This allows the POSIX implementation on the HP 3000 to be tightly integrated with its underlying, high-performance OLTP operating system benefits, such as significantly reduced disk I/Os, efficient workload prioritization, and dynamic memory management. The HP 3000 will support the following POSIX 1003.1 API conventions:

- process creation and identification
- normal and abnormal termination of processes
- application and process environment information
- process signal handling
- timer operations
- file/directory management
- backup capabilities
- hierarchical directory
- byte stream file type

The goal of the HP 3000 POSIX environment is to integrate new features as transparently as possible to HP 3000 users, while maintaining the HP 3000's easy to use features. MPE/XL users will be allowed access to most of the new POSIX functionality, such as hierarchical directory management, using intrinsics and commands. Likewise, POSIX extensions will be able to access HP 3000 files and directories. POSIX applications will be able to access files created by MPE/XL and vice versa, providing compatibility between existing HP 3000 data and new POSIX-compliant data. The HP 3000 will provide MPE/XL systems management capabilities for the new environment.

User interface standards

Graphical user interface (GUI) standards have emerged for desktop systems, and the HP 3000 supports industry and de facto standards. The HP 3000 is completely compatible with MS Windows and Presentation Manager running on PCs and also supports HP VPLUS/Windows. In addition, HP has adopted the HP OSF/Motif style guide for the HP 3000 and will support the industry-standard X Windows System. This allows applications to provide the same look and feel regardless of which platform the application is running on: HP 3000, MS-DOS, OS/2, UNIX, or other standards-compliant open systems.

On MS-DOS PCs, HP's NewWave provides an object-oriented application programming environment. NewWave is not a GUI, but it derives its look and feel from the underlying GUI. It is currently supported on top of MS Windows, and Hewlett-Packard plans to support it on PM and OSF/Motif.

VPLUS/Windows is a client-server solution that leverages existing HP 3000 VPLUS forms. VPLUS/Windows delivers a smooth

migration path to a graphical windows-based user interface on PC platforms under MS Windows.

X Window System and OSF/Motif

X Window System has been adopted by X/Open as the industry-standard protocol for implementing a distributed, high-resolution GUI. The GUI built on top of X Window System is OSF/Motif, which HP designed in partnership with OSF. The X Window System allows applications running on different vendor systems in a network to be displayed simultaneously on an X-display device.
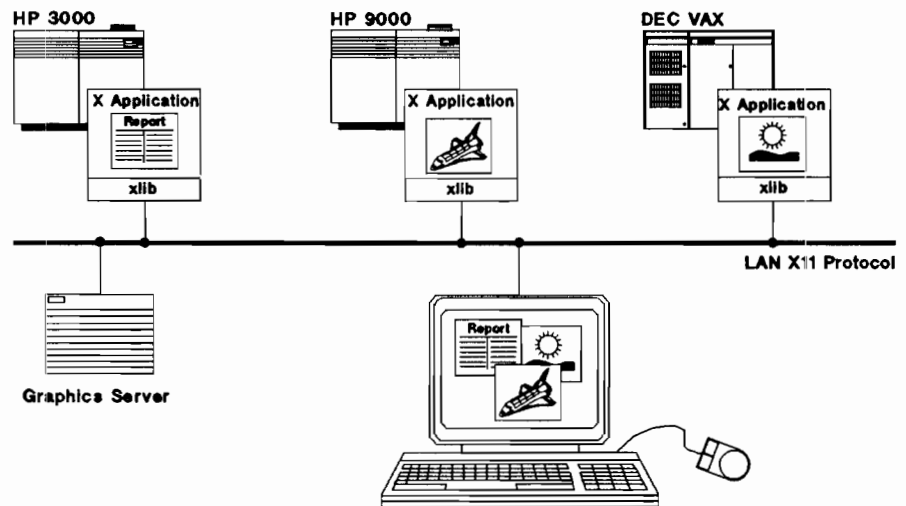
Figure 3-6. The HP 3000 and HP OSF/Motif

HP Motif XL
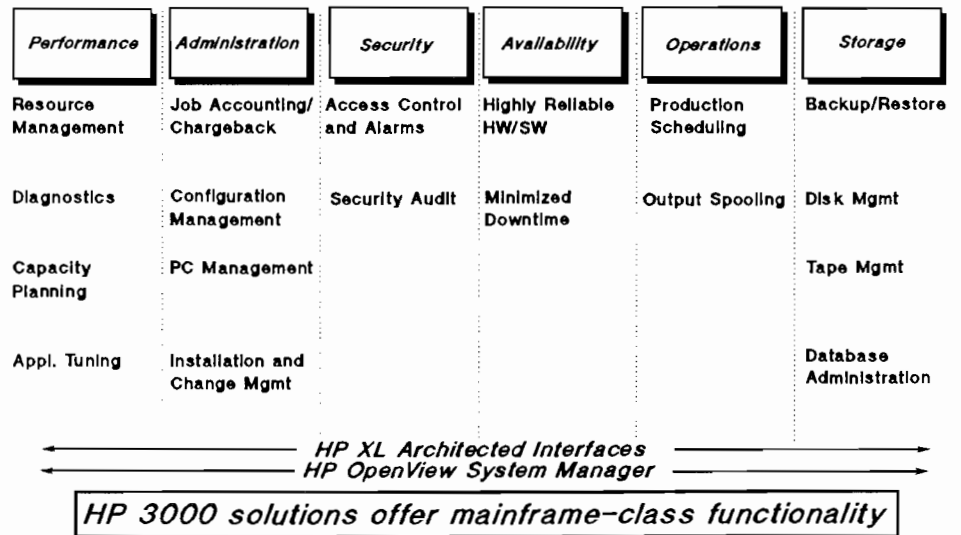
HP Motif XL supports UNIX workstations, X terminal displays (HP 700/X), and PCs equipped with an X Window System card (HP Vectra PC/AXDS). HP Motif XL allows development of new X Windows System-based applications for the HP 3000 and porting of existing applications. HP Motif XL includes the X11 R4 Xlib programming library, Xt intrinsics, OSF/Motif 1.1 widgets and gadgets, and documentation.

Systems Management

Systems management is the process by which data center managers ensure efficient operations of their computer system environments and networks. These environments may include standalone systems, distributed production systems, and central-site data centers. HP 3000's standards-based systems and network management encompasses a broad range of management functions and systems services that include the following:

- performance management
- administration
- system security
- system availability
- operations
- storage management

Performance	Administration	Security	Availability	Operations	Storage
Resource Management	Job Accounting/ Chargeback	Access Control and Alarms	Highly Reliable HW/SW	Production Scheduling	Backup/Restore
Diagnostics	Configuration Management	Security Audit	Minimized Downtime	Output Spooling	Disk Mgmt
Capacity Planning	PC Management				Tape Mgmt
Appl. Tuning	Installation and Change Mgmt				Database Administration

←——————— HP XL Architected Interfaces ———————→
←——————— HP OpenView System Manager ———————→

| HP 3000 solutions offer mainframe-class functionality |

Figure 3-7. Systems Management Services Framework

HP OpenView

Hewlett-Packard's overall strategy to address customers' needs for a flexible, integrated approach to systems and network management is encompassed under HP OpenView. HP OpenView provides a consistent management framework for an organization's entire network of information and computing resources. HP OpenView can reduce costs and improve systems and network availability by providing integrated, centralized management of networked HP 3000s and multivendor networks.

HP OpenView System Manager provides exception-based system management. Operators are notified of system events graphically and automatically by the HP OpenView network map. Operators can define which events to report, providing flexibility and eliminating unwanted notifications. The virtual console provides full system control, including the ability to shut down and restart remote systems from the system manager console. HP OpenView System

Manager also provides the ability to archive events and to generate reports.
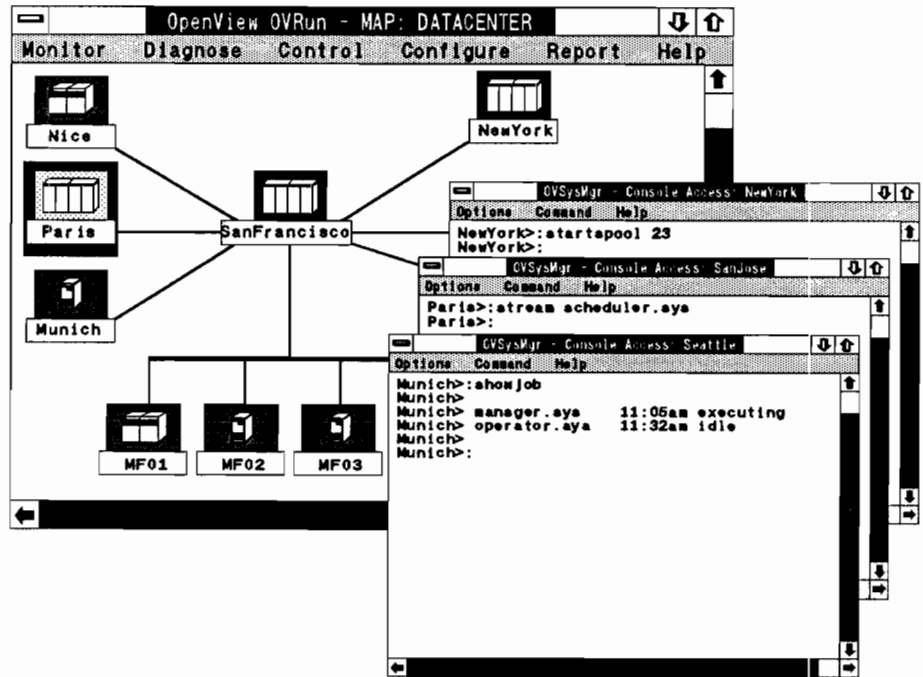
Figure 3-8. HP OpenView System Manager

Performance management

Performance management helps you realize the full potential of HP 3000 systems. The HP 3000 provides a full range of performance management products, which are complemented by comprehensive performance consulting services. The HP 3000 supports resource management (HP LaserRX), diagnostics (HP GlancePlus), capacity planning (HP RXForecast), and application optimization (HP SPT/XL and HP APS/V).

HP LaserRX

HP LaserRX software provides the comprehensive system activity information needed to manage your HP 3000 systems for optimal performance. Within minutes, LaserRX provides data to help you better understand system performance and provide information to your users. As an experienced system manager, you can immediately find the depth and breadth of data necessary to fully analyze your HP 3000 systems.

This performance management software tool helps contain costs, streamlines your internal data processing operation, and efficiently delivers defined levels of service. The software helps you perform actions as varied as scheduling batch jobs, identifying system bottlenecks, and balancing system and data center resources. It can also assist you with equipment purchase planning. Over time, the software pays for itself by enabling you and your organization to maximize the return on your systems and applications investments.

HP LaserRX software and an HP Vectra PC (or IBM PC AT) serve as a central performance management workstation. With it you can display and analyze data collected from one or more HP 3000 systems. Data appears in color graphic format for trend analysis and in tabular format for detailed study. HP LaserRX software continuously collects and reduces data from your HP 3000 systems without incurring significant performance overhead.

HP GlancePlus

HP GlancePlus/XL is a performance monitoring and diagnostic software tool for the HP 3000 900 Series systems. HP GlancePlus provides information on current system resource usage and process activity to help system managers and operators quickly isolate and resolve performance bottlenecks when they occur.

HP GlancePlus is host-based, interactive software that can be accessed from any supported terminal. HP GlancePlus provides real-time system performance information, which is updated at user-defined intervals. The performance information ranges from the global summary of system activity to process-level detail and system resource utilization detail. Users have the flexibility to set thresholds and filters to view only the process information that they specify.

HP GlancePlus displays global summary bar graphs at the top of every screen to provide a quick view of overall system resource utilization. The software also provides detail screens for in-depth examination of individual system resources, such as CPU, disk, or memory, and individual processes. The combination of function keys and an online Help facility make HP GlancePlus easy to use in the day-to-day management of your system.

HP GlancePlus/V will be available for MPE V systems in mid-1991. Customers with software support for HP Glance/V will receive HP GlancePlus/V at no additional cost.

HP RXForecast

HP RXForecast is a forecasting product that allows customers to perform regular system resource forecasting and supports ongoing capacity and budget planning. Forecasts are based on past trends and can incorporate projected future business demands. HP RXForecast integrates into the HP LaserRX user interface and uses HP LaserRX log file information. HP LaserRX is a prerequisite product for the purchase of HP RXForecast.

A business unit is a key indicator of business volumes and has a direct relationship with system utilization levels. For example, the number of sales orders could be a business unit for an order processing system. Sales orders are typically recorded and projected into the future as part of normal business planning. If a correlation between the number of sales orders and system utilization can be confirmed, then a business unit file can be built and used for producing system capacity forecasts.

HP Software Performance Tuner/XL

HP Software Performance Tuner/XL (SPT/XL) provides information needed to increase the performance of native mode 900 Series application programs. With this software, you can evaluate the design and efficiency of application code during development or monitor and improve the performance of production applications. For more information on SPT/XL, please refer to Chapter 4, "Data Management and CASE".

HP Performance Consulting service

HP Performance Consulting service is a flexible, comprehensive service designed to maximize the performance and return on investment of your current systems, and to help you ensure that there are sufficient computer resources available to support your business as it grows and changes to meet new challenges and opportunities.

HP performance consultants can assist you by analyzing your current system performance, identifying existing or potential bottlenecks, providing recommendations to improve system performance, assisting you in defining performance-oriented systems management practices, and helping plan for system and business change and growth.

HP System Utilization—Global service
This service provides you with a presentation quality report that summarizes the current system resource utilization of your system as a whole. The report includes graphical representation of global system utilization with clear interpretation guidelines and an executive summary prepared by an HP performance consultant.

HP System Utilization—Application service
This service provides the information contained in the HP System Utilization—Global service, and, in addition, provides information on system resource usage, transaction rates, and response times for your top five applications.

Administration System administration encompasses job accounting and chargeback, configuration management, PC network management, and software change management. The system management commands and utilities provide simplified system maintenance operations. Compared to other computers of similar power, the HP 3000 requires significantly less time and effort for system administration.

System account structure

The HP 3000 accounting facility provides a flexible and powerful means of coordinating access to the system and to disk file usage. To coordinate system access, system administrators can devise a structure of accounts and users that reflects the functional organization of the people who use the system. The accounting facility maintains running totals on the amount of system resources that each account consumes, including disk space used, cumulative CPU time consumed, and cumulative terminal connect time for sessions. The current totals can be displayed at any time and can be used for billing purposes.

Users are individuals who access the HP 3000. Each user is assigned a unique name and optional password and is assigned to a specific account. Each user may have a specified home group of files and may access any other file groups in the account. A maximum job priority may be assigned to each user.

Groups are used to partition the file domain of an account. Files must be assigned to a group, and each group has a unique name (within the account) and an optional password. Limits may be established on the permanent disk space, CPU time, and connect time used by a group. The operating system maintains running counts of resource usage for each group, and the sum of these group counts equals the total resource usage of the account.

Accounts are collections of users and groups. Each account has a unique name and an optional password assigned to it when the system manager creates the account. Each account also has its own file domain or unique set of files. The system manager may define resource-use limits for an account. The operating system maintains a running count of each resource that the account uses. The operating system also stores a list of user names and group names recognized by the account, the maximum job priority at which jobs may be scheduled, and the limits established for the account's usage of disk file space, CPU time, and connect time.

The account structure provides both control and security over file use. Access to the system is granted only to individuals with a valid log on identification consisting of account, group, and user names, each of which may require a password.

Job accounting and chargeback
A job accounting and chargeback management system tracks computer usage, analyzes usage, and provides comprehensive

chargeback reporting. Comprehensive resource usage tracking and billing is by port (workstation or modem), job or session, department and application, and individual user. Independent software vendors (ISVs) extend the operating environment features to provide job accounting and chargeback solutions on the HP 3000.

Configuration management

Workstation changes represent the majority of the configuration changes on a system. HP OpenView DTC Manager provides easy and dynamic reconfiguration of workstations. HP OpenView DTC Manager provides an intuitive, graphical user interface to configure, monitor, diagnose, control, and update software on DTCs. An operator can centrally and dynamically manage local and remote workstation connections and remote system-to-system communications across multiple DTCs on the LAN. Further, dynamic reconfiguration minimizes system downtime caused by DTC and workstation changes.

PC management

HP is a recognized leader in integrating and managing PCs with HP 3000 systems. PC management includes resource sharing, PC software installation and distribution, PC backup, and so on. With resource sharing products such as HP NewWave System Services, PC users on the network can share high-quality printers and plotters, allowing more users to produce professional output and realize the full value of the peripherals. In addition, PC users can share files transparently and gain the benefits of the HP 3000 system backup.

PC management includes support for various LANs and network operating systems. The 900 Series supports HP NewWave Office, HP LAN Manager clients and Named Pipes, HP NS LAN Gateway for Novell clients, and Novell Portable NetWare. For more information, please refer to Chapter 5, "Networks".

Software change management

Software change management is provided by HP Software Revision Control (HP SRC). HP SRC provides automatic and comprehensive version and release control for installing some software applications. HP SRC tracks historical changes, which is particularly important in systems maintenance. For more information on HP SRC, please refer to Chapter 4, "Data Management and CASE".

System security

Operating system security is an essential component of systems management. To protect your system from unauthorized access and data corruption, the HP 3000 provides robust system security. The operating system is designed so that the user capabilities, the account structure, the file system, and system security are integrated.

The HP 3000 900 Series provides Department of Defense (DoD) C2 functionality when combined with a user interface package. Every file and device can optionally have an access control definition (ACD), which specifies which users have access to that file or device. An

ACD can restrict read, write, and append access, and can restrict printing access to a particular device to a specific user or set of users.
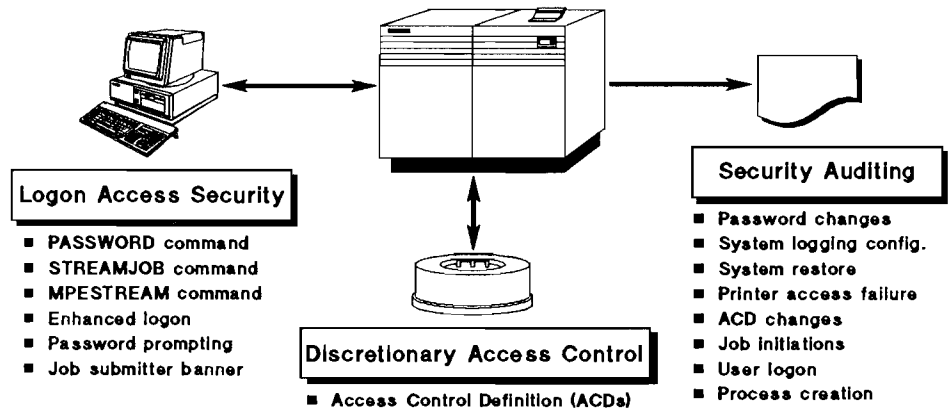

Figure 3-9. HP 3000 System Access Security

Restricting user access
Passwords can be assigned for each account and for each group within an account. Passwords can also be assigned to each user name. Thus, to log on to the system, a user can be required to provide up to three passwords.

To illustrate, suppose you know the password for your user name and account. You would be able to log on to the system and access files in your home group, but you would be unable to access files of other groups in the account whose passwords are unknown to you.

Once users are logged on to the system, their capabilities can be restricted in a number of ways. For example, a user can be restricted from saving files or using nonshareable devices, such as tape drives or line printers. The system manger can limit the amount of CPU time and disk space that a user may consume. Also, the system manager or operator can restrict access to system tables, system resources such as process management and logging, and data communication subsystems. Operators can even restrict users to either interactive or batch access, although normally both are allowed.

File security
File lockwords, similar in effect to passwords, can be assigned to files. When a file is protected by a lockword, the user must supply the lockword in order to access the file.

It may be beneficial to allow users to access given files but control what they may do with the files. On an account, group, and file basis, the system manager can restrict any or all of the following: reading, locking, appending, writing and saving files, and executing program files. In addition, users cannot access files that are not in their own account (except for files in PUB.SYS meant for general usage) unless the file has been released.

System availability

System availability on the HP 3000 begins with the proven, highly reliable PA-RISC hardware. PA-RISC processors have fewer parts and are, therefore, more reliable than traditional architecture processors. Another standard feature of the HP 3000 hardware is the capability to continue processing after temporary power failures, without losing sessions or corrupting data. An integral part of the operating system is the transaction manager, which automatically checkpoints and logs activities for critical system structures, user files, and databases. This facility guarantees data integrity in the event of a system failure. For more information, please refer to the "High Availability" section.

Beyond these standard features, the HP 3000 focuses on maximizing system availability by minimizing the fundamental causes of unplanned and planned downtime. To address unplanned downtime, the 900 Series supports products to manage disk failures (HP Mirrored Disk/XL), processor failures (HP SPU Switchover/XL), and software failures (HP AutoRestart/XL). These products are described in the "High Availability" section. To minimize planned downtime due to system backup, HP TurboStore/XL virtually eliminates unavailability due to backup with its high-performance capabilities. The online backup capacity of TurboStore/XL provides access to user data while it is being archived. HP TurboSTORE/XL is described in the "Storage Management" section.

Operations control

Operations control consists of production scheduling and output spooling. The HP 3000 900 Series provides key production scheduling functionality. The operating system includes job control words (JCW) for programmatic management of job streams. The HP 3000 supports jobfences, which allow execution of high-priority jobs and denial of low priority jobs. Queue management is another important aspect of job scheduling. Queue management provides the ability to balance processing queues between heavy batch jobs and light, interactive sessions. Additionally, queues can be dynamically changed for any process, which is of particular importance for high-end systems that process a large number and variety of jobs.

A complete set of operator commands and utilities simplifies operational tasks such as system configuration, startup, modification, backup, and recovery. Operator commands and utilities also simplify spooling and tape labeling.

System startup
The HP 3000 allows the system manager to specify a series of commands to be executed automatically each time the system is started. These commands eliminate the need for operator intervention when the system is started.

Automatic creation of sessions
Automatic creation of sessions allows terminals to log on automatically into application environments. You can begin working without having to log on to or interact with the operating system.

This feature helps to make the system easy for inexperienced users to use and provides an additional level of security.

Automatic scheduling of jobs
Job scheduling allows you to specify a particular time and date to run your jobs. For instance, if a job will impact system response time, it can be scheduled to run when fewer users are logged on to the system. The job will be executed automatically, without operator intervention. Automatic job scheduling can be used to automate many daily operation routines such as backup.

Self-adjusting system tables
On the HP 3000, most system tables are self-adjusting to the system requirements, thus eliminating the need for a system shutdown to adjust these tables. This feature provides increased system availability as well as simplifying system operations.

Job scheduling
The HP 3000 job and session scheduler schedules jobs and sessions according to their assigned priorities in the queue. The user can specify the priority of a job by assigning it a priority number. System operators can reset the priority of the job and also limit the number of jobs that can be executed at any one time.

In addition, the system operator can set a priority limit such that only jobs with an assigned priority number above the limit, or jobfence, are free to execute. For example, if the jobfence is 8, then jobs with an assigned priority number of 8 and below do not execute until a lower jobfence number is assigned.

Process scheduling
Jobs and sessions are scheduled by means of a master queue that is ordered by priority. This master queue is divided into areas called *priority classes*. Each area is bounded by two priority numbers established by the system manager.

The HP 3000 automatically reassigns priority classes to each process executing on the system. You may, however, specify priority classes by selecting a general category of process dispatching priority for the program. This is done by including the PRI parameter in your JOB or HELLO command. The five process dispatching priority types (queues) are:

- AS - system processing only
- BS - very high priority
- CS - interactive
- DS - batch
- ES - very low priority (background)

The operating system actually translates priority types into numerical ranges that are ordered in a master queue. The numerical range of each priority type can be changed at any time to ensure that an optimal balance of services is maintained among the processes on the system, allowing for a centralized control of the system load. For

example, the desired mix of batch and interactive processes can be set by managing queue priorities.

When the execution of one process is interrupted for any reason, such as I/O, an internal interrupt, or an interrupt from the scheduler itself, control is passed to the process with the next-highest priority that is awaiting CPU resources. When two or more programs have the same priority, the oldest process is selected first.

Process execution

As a process runs, it may require more code or data. If the code or data is not present in main memory, the memory manager is instructed to retrieve it before the process is allowed to continue executing. While the process waits for the needed code or data to be transferred, the HP 3000 transfers control to the next process ready to be executed.

The objective of the process dispatcher and the memory manager is to provide optimal use of system resources while satisfying the requirements of executing processes. This is performed automatically by the HP 3000 operating system without assistance from the system operators.

Job control facilities

The HP 3000 uses job control words (JCWs) and conditional execution functions that permit you to design job streams whose execution can be altered based on the results of previous job steps.

Both system-defined JCWs and user-defined JCWs store job status information and pass the information between programs and between a program and the CI. JCWs are defined and accessed by commands from the CI and by intrinsics from your programs.

JCWs can also be used in conjunction with conditional execution function statements. These statements specify a logical expression (TRUE or FALSE) and are evaluated during program execution. If the value found is TRUE, the remaining statements related to that condition are executed. If the value is FALSE, any existing alternative statements are executed instead.

Spooling facility

The HP 3000 provides a flexible spooling facility for output devices and batch job input. (SPOOL is an acronym for simultaneous peripheral operations online.)

The HP 3000 spooling facility permits the concurrent use of output devices that would otherwise be nonshareable, such as tape drives and line printers. For instance, if several users send output to a line printer at approximately the same time, their output is directed to spool files on disk and printed on a priority basis as the printer becomes available. In this way, each user can immediately proceed with other processing activities without having to wait for the printer. Spool file priorities can be changed by the system operator.

The spooling facility for the 900 Series has been enhanced with additional functionality and capabilities that increase productivity still further. For example, on the 900 Series, spool files can be easily scanned, archived, or routed to other systems in a network for printing. The functions of the CM Spooler and SPOOK utility are fully integrated into the file system and CI. Spool files are permanent, recoverable files managed by the file system. Spoolfiles are accessible through new and extended CI commands, utilities such as STORE/RESTORE, and popular text editors such as HP EDIT. Spoolfiles are contained in the HPSPOOL account in either the IN or OUT group. There are no practical limits to spool file size or the number of spool files.

Minimized operator requirements
Recognizing that smaller enterprises cannot afford a great deal of operator intervention and larger enterprises with smaller replicated sites prefer minimal operator intervention, the HP 3000 is designed to meet minimal operator requirements.

Transparent disk space management
When creating a new account, it is only necessary to specify how much disk space that new account receives. The system operator need not be concerned as to where the system will allocate space for the new user; global disk space is allocated transparently.

Storage management

Storage management encompasses backup and restore, disk management, tape management, and database management.

System backup and restore

Periodically, the operating system and user files must be copied from disk to tape for archival purposes and as protection against hardware failure and accidental or intentional destruction of information.

On the HP 3000, simple backup commands can be executed to initiate system backup. Messages inform the operator of the progress of the backup activities. In some environments, job scheduling may be used with the STORE utility to permit unattended backup.

HP 3000 backup solutions deliver online, unattended backup to high-speed, low-cost devices.

HP TurboSTORE/XL

HP TurboSTORE/XL provides high-performance data backup as well as unattended dedicated data backup and unattended online data backup, thus improving systems availability and reducing operator staffing requirements. With digital data storage (DDS), TurboSTORE/XL provides cost-effective, unattended backup to digital audio tape (DAT). Fast Search provides access time on DAT to 20 seconds on average to a maximum of 20 seconds.

TurboSTORE/XL offers the following purchasable options:

- optical disk autochanger support provides unattended backup for the largest configurations: up to 70 Gbytes per drive
- online data backup (available as an option)
- support for up to eight backup devices running in parallel
- support for IBM-labeled and ANSI-labeled tapes
- tape format and operator interface compatible with HP STORE/XL
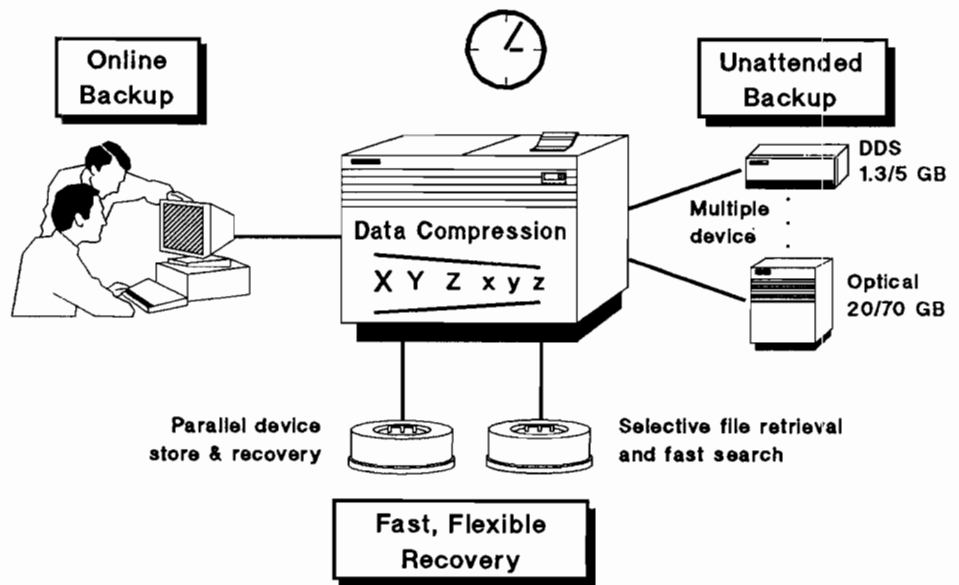- support for dissimilar tape devices such as HP 7980 and HP 7979

Figure 3-10. HP TurboSTORE/XL

HP TurboSTORE/XL provides fast data backup by storing data to multiple backup devices running in parallel, thus eliminating the performance bottleneck experienced by backup methods that use a single tape drive. In addition, TurboStore/XL performs interleaved disk reads to maximize transfer rate from the disk subsystem. TurboSTORE/XL also restores from multiple devices running in parallel.

HP TurboStore/XL increases backup performance through software data compression. For maximum flexibility, two different data compression algorithms are provided. The fast algorithm more than doubles backup device capacity and performance. The high-density algorithm provides almost four times data compression and maximizes backup capacity. The high-density algorithm requires more CPU resources but provides maximum single-device backup for HP 3000 Series 948 through 980 processors.

With the online backup option of HP TurboStore/XL, critical 24-hour-a-day system processing is supported while system backups occur. No modification to applications is required. Though normally a short, five-minute application interruption occurs to ensure complete data integrity, with ALLBASE/SQL applications, there is

no interruption. After online backup has been started, applications can continue processing while the backup runs in the background.

Unattended backup is supported with up to 70 Gbytes when utilizing HP's Rewritable Optical Disk Library System. DDS technology provides cost-effective unattended backup of up to 5 Gbytes on single DAT, or up to 20 Gbytes on multiple DATs.

Disk and tape management

A disk space management system increases productivity by automating the management of a data center's disk space. Further, it reduces the time data center staff must spend managing disk and tape storage. A disk management system automatically determines which files must be saved and which are no longer needed.

A tape management system addresses all aspects of tape usage and control, which also includes labeled tape support. The HP 3000 operating system provides labeled tape processing performance comparable to unlabeled tape processing.

Third-party products augment the HP 3000's strong functionality to provide total control over the content, disposition, movement, and maintenance of all tape volumes by automatically updating the tape library and by selecting the tape number.

Database administration

Database administration (DBA) involves various tools that provide change control, recovery, copy, and restructuring of databases. HP ALLBASE/SQL inherently incorporates these functions, as do most relational database management systems. For HP TurboIMAGE/XL, HP DBChange Plus provides these capabilities. For more information on database management systems and their utilities, please refer to Chapter 5, "Data Management and CASE".

User-Friendliness

User interface The many features and capabilities of the HP 3000 operating system are designed to meet the specific needs of the different users. Each type of user is associated with a particular set of capabilities and responsibilities, and the users access the operating system features that assist with their individual tasks.

There are five categories of users:

- *End users*, who can range from a data entry clerk to a functional manager, use application programs to take advantage of all of the capabilities of the operating system without needing any knowledge of the underlying operating environment, such as the location and format of information.

- *Programmers and systems analysts* create application programs that run on the system. The HP 3000 provides two major areas of system interface for these users: an interactive interface that includes a command language, an online Help facility, and job control facilities; and a programmatic interface that includes programming intrinsics and file system intrinsics.

- *System managers* create accounts (basic structures for user access), define resource-use limits, control scheduling queues, alter the system configuration, and maintain the system library.

- *Account managers* maintain accounts by defining the valid users and file groups for the accounts and specifying resource-use limits for them.

- *System operators* operate the system console and are responsible for responding to all system requests. The HP 3000 provides mainframe class systems and network management capabilities that keep the system operating smoothly and efficiently even while performing day-to-day operations such as job scheduling, output spooling, system backup, maintenance, and recovery.

Command language and interpreter

The HP 3000's command language, which is processed by the command interpreter (CI), contains all necessary commands to direct and control the system. The simplicity of the command language greatly enhances the system's usability.

The more than 175 commands collectively provide a powerful tool for using the system. End users like the ease of use of the command language, while experienced users and programmers appreciate the power the that system commands supply.

Actions that can be performed through system commands include the following:

- initiate and terminate jobs and sessions
- run system programs and utilities
- compile, link, run, and debug programs
- create, maintain, and delete files
- display file information
- display job, session, or device status
- transmit messages
- establish communication with local and remote computers
- control and manage system resources

If the CI detects an error in command syntax during a session, it informs the user with a meaningful error message that specifies the erroneous parameter and prompts for reentering the command correctly. If it detects a command error during a job, it lists the error on the output device and halts the job. However, the user can specify that the CI ignore errors during a job so that the job will be completed.

The command language is used to create batch files (job streams) that contain control statements and variables. Execution of the commands in the file can be altered at execution time through the use of these control statements.

```
:HELLO YOURNAME.YOURACCT ──────────── Initiates the session.

:EDITOR ──── ── ───── ── ───────── Invokes the HP 3000 text editor.

/SET FORMAT=COBOL ───────── Specifies that you will be entering
                                      COBOL source statements.

/ADD ───────────────── Specifies that you wish to enter source code.

    (COBOL source statements)

/KEEP YOURFILE ──────── Saves the text file on disc under the name YOURFILE.

/EXIT ──────────────────────── Terminates the text editor.

:COBOLGO YOURFILE ──── Causes the COBOL source program contained in
                            YOURFILE to be compiled, prepared, and executed.

:BYE ──────────────────────── Terminates the session.
 └──────────────────── Prompt characters issued by MPE and the text editor.
```

Figure 3-11. Sample Session

The example above is simplified as it does not include the various informational messages, compilation output, program output, the text editor, the COBOL compiler, and the program itself. The fact remains, however, that if the source program (entered by way of the editor) contains no errors, the entire session can be performed by entering just eight operating system and text editor commands in addition to the COBOL statements that constitute the program.

The 900 Series system commands include new features that provide greater productivity for all users. The new features include system-created and user-created variables that can be accessed directly with commands and from programs. Over 30 system variables provide information such as the date, time, system serial number, day of week, and so on. Other new features include a significantly enhanced REDO facility, search paths, and built-in calculator.

User-defined commands and command files

The HP 3000 allows users to define their own commands by combining several commands into a command procedure and assigning the procedure a name. The name can then be used as a command. Thus, it is possible to enter a single command name that you have defined and cause several commands to be executed. These user-defined command sets can be created by individual users and can be made available to entire accounts and all accounts systemwide. It is also possible to redefine existing operating system commands and messages to suit your particular situation.

The 900 Series gives you additional flexibility by allowing you to create command files. A command file is simply a list of commands (which can be user-defined commands) and parameters in a file. You use just the name of the file to execute the commands.

Online Help facility

Whenever users need assistance with command syntax, or even the name of a command, they can invoke the online Help facility.

The Help facility provides encyclopedic information on all system commands. There are two ways to use the Help facility. One way is to ask for help regarding a specific command. For instance:

```
:HELP REDO EXAMPLE
```

In response to the above request, the Help subsystem will display an annotated example of the REDO command. Information can be requested on the operation and parameters of each command.

The other way to use the Help facility is to enter the Help subsystem, where information can be accessed by topic areas and tasks. This enables users to learn how to perform specific tasks without prior knowledge of which commands are required.

Interactive processing

HP 3000 systems provide both interactive OLTP and batch processing. In interactive processing, you enter commands and data at a workstation and receive immediate response. This is called a *session*, and is especially useful for data entry, information retrieval, program development, text editing, and any other application in which a direct dialog with the computer is required. Sessions can be used to access the following:

- operating system commands and subsystems
- programming languages and utility programs
- database management systems
- data communication facilities
- application programs
- office system programs

A session begins when you enter the HELLO command from an online workstation and a connection is made to the command interpreter. Then commands can be entered to use language compilers or other subsystems such as the text editor, to run programs, or to modify your files. The session continues until you enter a BYE command or a new HELLO command, or until the system operator intervenes to abort the session.

Batch processing

Batch processing allows the user to submit to the computer, as a single unit, commands that request various operations, such as summarizing database information for reporting, program compilation and execution, file manipulation, or utility functions. Batch processes are called *jobs*. Jobs contain all the necessary instructions and references to programs and data required for execution. Once a job is running, no further information is required.

The HP 3000 does not have a separate job control language for batch jobs. Batch processing is a logical extension of the interactive sessions on the HP 3000. The same commands also can be issued programmatically. Any capability—with the exception of BREAK, suspends processing—that is available in interactive mode is also available in batch mode, and both modes employ the same operating system commands. The only significant difference between a session and a batch job is that during a session you can interactively alter the course of processing, whereas in a job, the command stream is fixed and the job is executed in its entirety, as predefined in the job control statements, unless the system operator intervenes. Languages, utilities, and application development software can be run in either batch or interactive session mode without changes. The standard input and output devices are automatically redefined.

System utilities

MPE includes subsystems and other utilities that are not included with most operating systems. The following subsystems are supplied on the HP 3000:

- HP EDIT/XL, a text editor.
- HP FCOPY, a program for general purpose file copying. FCOPY also allows movement of the files between groups and accounts or from one peripheral type to another.
- HP SORT-MERGE, a utility for sorting records in a file and merging sorted files. This utility can sort any character sequence using any data type.
- HP VPLUS interactive forms management system.
- HP KSAM (keyed sequential access method), a method of organizing records in a file according to the content of key fields within each record

Special-purpose utilities are provided for system administration tasks. For instance, the Tape Labeling Facility allows labels to be placed on magnetic tapes for identification and protection purposes. In addition, utilities are provided to facilitate migration of applications and databases to the 900 Series systems.

HP ALLBASE/SQL and HP TurboIMAGE database management systems, as well as a variety of third-party database management systems, are also supported on the HP 3000 900 Series.

Native language support

The HP 3000 includes utilities and intrinsics that facilitate the development of applications for users in different countries and cultures. Native-language support includes such features as currency symbol handling and character translation.

An application message facility offers programmers fast, efficient access to message catalogs, which can be customized for each country's language. The contents of the catalogs (an application's set of messages to its users) can be changed to fit each country's language without having to recode or recompile the application.

Protecting Your Application Investment

Within the HP 3000 family, simple upgrade paths are provided to higher-performing systems. Simple upgrades and return credits on older systems mean that upgrades are cost-effective. A simple backup and restore procedure with object code compatibility means applications run without changes or recompilation and without disrupting of your business.

Native mode and compatibility mode

Hewlett-Packard ensures compatibility and provides a smooth migration path when moving from MPE V-based HP 3000s to 900 Series PA-RISC systems. MPE/XL is a compatible superset of MPE V.

Native mode
Native mode, the native run-time environment of the 900 Series, offers the highest performance on PA-RISC. In accordance with Hewlett-Packard's design objectives, native mode on a PA-RISC system provides source code compatibility with MPE V-based systems where appropriate. A program written on an MPE V system can simply be recompiled using a 900 Series native mode compiler to take advantage of PA-RISC's performance benefits.

Native mode is the preferred environment because it makes full use of the high performance of the 900 Series systems. Native mode provides all the benefits of MPE/XL described in this chapter, such as demand-paged virtual memory, large address space, and mapped files.

Compatibility mode
Compatibility mode provides object code compatibility between MPE V-based systems and the 900 Series. It does this by emulating in software the MPE V HP 3000 environment on the 900 Series system. Compatibility mode allows current HP 3000 customers to move their applications and data to the 900 Series systems without changes or recompilation.

Compatibility mode provides a working MPE V environment, including MPE V code and stack structures and callable MPE V system intrinsics. As a result, compatibility mode also allows cross-development of MPE V applications on 900 Series systems.

Flexibility and migration

Compatibility mode and HP's assortment of migration utilities provide for smooth, flexible migration to 900 Series systems.

Because of the high degree of object code compatibility, you can simply store an MPE V program, restore it on a 900 Series system, and run it in compatibility mode without modification or recompilation. This applies to applications written in any language supported by MPE V. You can move your databases to the 900 Series in the same way.

For improved compatibility mode performance of MPE V object code, the 900 Series provides an MPE V object code translator that translates MPE V object code into the native instructions of the 900 Series. Translation of the MPE V object code reduces the overhead incurred while running a program in compatibility mode.

To take full advantage of the 900 Series performance and the benefits of the new operating system, applications can be recompiled using native mode compilers. These compilers provide source code compatibility with the rest of the HP 3000 family. Typically, little or no code modification is required.
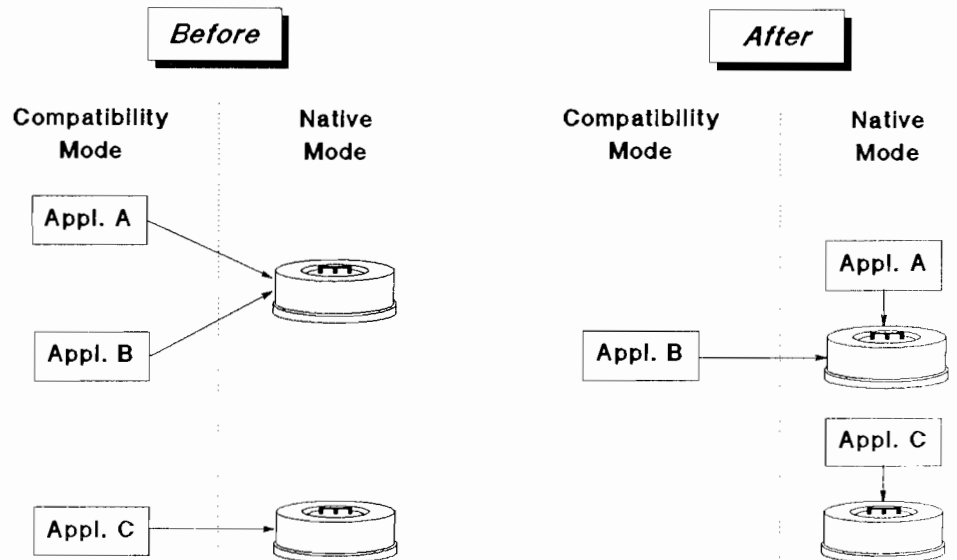
Figure 3-12. Migration Flexibility Example

Applications can run partly in native mode and partly in compatibility mode. The operating system switches between modes transparently. This transparency in operation is made possible by the switch subsystem, which determines whether code is in native mode or compatibility mode and automatically switches between modes as needed while an application is running.

Native mode compilers are available for COBOL II, FORTRAN 77, C, Business BASIC, Pascal, RPG, and Transact.

The figure above illustrates the flexibility of migrating to the 900 Series. You can move some applications to native mode while leaving others in compatibility mode. As illustrated, the same database can be accessed by programs in compatibility mode or native mode.

The total effect is that you can immediately move your applications to compatibility mode and migrate your programs to native mode when and if it fits your schedule.

In addition, if an application written in a high-level language calls SPL/V procedures, it can be recompiled to native mode and call SPL/V procedures in compatibility mode using a user-supplied mode-switching procedure.

Exceptions
Naturally, there are some minor restrictions in migrating MPE V-based applications to the 900 Series. For example, applications that use undocumented intrinsics, execute in privileged mode, or use privileged machine instructions may need to be modified in order to run on a 900 Series system.

For information regarding other, less frequently encountered exceptions, please contact your HP sales representative.

Cross-development (MPE V and MPE/XL)

Applications can be developed on a 900 Series system for use on other HP 3000 systems, allowing a 900 Series system to be used for centralized application development.

The same source code for programs written in HP COBOL II/XL, HP FORTRAN 77/XL, and HP Pascal/XL can be compiled to run in native mode on a 900 Series system and on MPE V-based systems.

The same source code written in COBOL II/V, HP FORTRAN 77/V, Pascal/V, HP FORTRAN 66/V, HP BASIC/V, HP Business BASIC/V, HP RPG/V, and HP SPL/V can be compiled to run in compatibility mode on the 900 Series or on MPE V-based systems. The MPE V segmenter is supplied with the HP 3000 to facilitate cross-family development in these languages.

4

Data Management and CASE

Introduction

Hewlett-Packard provides the industry's most powerful database management systems (DBMSs) to meet your data management needs. The HP 3000 supports a wide variety of application solutions, including manufacturing and distribution, state and local government, finance, human resources, and many more. These solutions are designed to provide superior online transaction processing performance and reliability, low cost of ownership, application portability, PC-integration, and interoperability with other vendors' systems. HP ALLBASE/SQL and HP TurboIMAGE databases provide the foundations for many of these solutions.

The HP 3000 also provides a rich and comprehensive set of CASE tools. CASE, or *computer-aided software engineering*, is both a toolset and a methodology for improving the quality and shortening the process of application planning, development, and maintenance. The HP 3000 supports industry-leading, multivendor CASE toolsets that allow rapid application development, while providing application portability and protection of your application investment.

Data Management

The HP 3000 leads the industry in providing high-performance database management systems to deliver superior business solutions. These DBMSs are tightly integrated with Precision Architecture-RISC and the HP 3000 operating environment to provide the best system price/performance and superior data integrity in the industry.

Hewlett-Packard offers compatible relational and network model databases across the entire HP 3000 900 Series family of business systems:

- HP ALLBASE/SQL is HP's strategic, high-performance relational database management system (RDBMS) based on the ANSI and X/Open industry-standard SQL relational language.
- HP TurboIMAGE is the best-performing network model DBMS on the HP 3000.
- HP ALLBASE/Turbo CONNECT provides ALLBASE/SQL users read access to TurboIMAGE data concurrent with OLTP applications.
- HP ALLBASE/NET delivers transparent and secure remote database access to ALLBASE/SQL data.

- HP ALLBASE/DB2 CONNECT links PC users and database administrators to both ALLBASE/SQL and IBM DB2 data in a client-server configuration.
- HP KSAM is the HP 3000's keyed file management system.
- Popular third-party relational DBMSs are also available.

HP ALLBASE/SQL

HP ALLBASE/SQL is HP's industry-standard RDBMS for application solutions in high performance OLTP environments on HP 3000 900 Series business computers. HP ALLBASE/SQL provides the following features:

- the best relational price/performance on the HP 3000
- open interoperability and portability with multivendor tools and databases
- superior reliability, data integrity, and supportability

Choice of multivendor tools for portability

- Cognos PowerHouse
- Gateway Systems Synergist
- Infocentre Speedware
- Information Builders Inc. FOCUS
- Ingres application development environment

Superior multivendor interoperability

HP ALLBASE/SQL

- Best price/performance
- Open interoperability and portability
- Superior reliability and data integrity

- ALLBASE/NET
- ALLBASE/TurboCONNECT
- ALLBASE DB2 CONNECT
- NewWave Information Access
- SQL Access Group

Figure 4-1. HP ALLBASE/SQL: The Open Choice OLTP RDBMS

Best performance

HP ALLBASE/SQL delivers the best-performing and lowest cost OLTP relational database solutions on the HP 3000 . Hewlett-Packard has achieved superior performance through tight integration with PA-RISC and the 900 Series operating environment and will continue to improve performance with new releases of ALLBASE/SQL and HP 3000 systems. This means that you can achieve your business objectives on a smaller, more cost-effective HP 3000 system than you could from other vendors' larger, more costly systems. HP was the first vendor to publish the Transaction Processing Council's TPC-A industry-standard benchmark and continues to lead the competition in system price/performance. HP also offers performance consulting to design and tune your applications for peak performance.

Open interoperability and portability

HP ALLBASE/SQL delivers interoperability and application portability through adherence to industry standards and support for a variety of industry-leading application development toolsets. Hewlett-Packard is a leading proponent of SQL standards and continues to enhance ALLBASE/SQL in compliance with ANSI and X/Open standards. Moreover, ALLBASE/SQL supports development tools from HP and leading multivendor third-parties, so you can choose the application development solution that best meets your needs. By providing you the choice of third-generation and fourth-generation development environments, ALLBASE/SQL protects and leverages your existing hardware, applications, and development staff investments.

HP ALLBASE/SQL also protects your existing investments through gateway products such as HP ALLBASE/TurboIMAGE and HP ALLBASE/DB2 CONNECT. These products allow your ALLBASE/SQL application to share data with other databases and systems in your business environment. As a founding member of the SQL Access Group, HP is expanding ALLBASE/SQL interoperability to include industry-standard access to Ingres, Oracle, DEC's Rdb, and the many other relational databases whose vendors make up the SQL Access Group.

Superior reliability, data integrity, and supportability

You can entrust your business-critical applications to HP ALLBASE/SQL. ALLBASE/SQL delivers maximum reliability, superior data integrity, and high availability through tight integration with Precision Architecture-RISC and the HP 3000 operating system. PA-RISC is designed with fewer components than traditional computers, which provides higher reliability than traditional computers. The HP 3000 900 Series is designed with OLTP features for reduced I/O requirements, high data concurrency, and high system and database availability. And an ALLBASE/SQL solution means a single point of contact and award-winning HP support for quick resolution of database and system difficulties. For information on ALLBASE/SQL utilities, please see the CASE maintenance section later in this chapter.

Key features of ALLBASE/SQL include the following:

- peak performance through features such as hashing, query optimization, and balanced B-tree indexes
- supports major, industry-leading 4GL tools from Cognos, Gateway Systems, Infocentre, Information Builders, and Ingres
- industry-standard ANSI and X/Open SQL for data definition and data manipulation
- interactive SQL (ISQL) interface for simplified query and update of data without programming
- HP NewWave Access integration for downloading data to the PC environment for decision support applications

- language preprocessors that provide application access and update capabilities for COBOL, C, Pascal, and FORTRAN
- dynamic restructuring allows the database structure, table capacities, and security to be changed without unloading and loading the database
- online backup, referential integrity checks, and rollforward and rollback recovery guarantees logical and physical data integrity in the event of hardware and software failures
- foundation for a growing number of industry-leading application solutions

HP TurboIMAGE

HP TurboIMAGE is one of the most heavily used, high-performance network database management systems for OLTP applications in the industry. HP continues to support and enhance TurboIMAGE as a core product of the HP 3000 computer systems with performance improvements and new functionality. HP TurboIMAGE/XL is the version for the HP 3000 900 Series computers.

HP TurboIMAGE consists of three components: a data definition language, a data manipulation language, and database utilities. TurboIMAGE databases can be accessed programmatically through powerful application interfaces, called *intrinsics*, or interactively from HP NewWave Access and an integrated query tool.

Key features of HP TurboIMAGE are as follows:

- HP TurboIMAGE intrinsics are callable from COBOL, C, FORTRAN, Pascal, RPG, BASIC, Business BASIC, and fourth-generation languages.
- HP NewWave integration for downloading data to popular PC applications for decision support analysis.
- Three logging and recovery methods (intrinsic-level, rollback, and rollforward) ensure logical and physical data integrity in the event of a system failure.
- Remote database access (RDBA) allows transparent access to TurboIMAGE databases across the network.
- Multiple database transactions provide the capability for a transaction to span two or more databases.
- Dynamic rollback recovery on TurboIMAGE/XL provides added flexibility by allowing users to roll back a transaction programmatically.
- Generic key search and generic keyword retrieval will be available in the near future.

HP DBChange Plus is a powerful TurboIMAGE/XL database administration tool that simplifies the tasks of database restructuring, maintenance, and analysis. DBChange Plus provides superior database repair from broken chains down to the bitmap level. For more information, please refer to the CASE maintenance section later in this chapter.

For customers who are interested in using relational technology while preserving their investments in TurboIMAGE, HP ALLBASE/Turbo

CONNECT provides a standards-based, read-access interface to TurboIMAGE data, using the ALLBASE/SQL language or commands.

HP ALLBASE/Turbo CONNECT

HP ALLBASE/Turbo CONNECT provides coexistence between ALLBASE/SQL and TurboIMAGE by allowing ALLBASE/SQL applications to read TurboIMAGE databases. With ALLBASE/Turbo CONNECT, customers can preserve and leverage investments in TurboIMAGE/XL applications while reaping the benefits of relational technology through ALLBASE/SQL. A single, industry-standard SQL interface allows access to both types of data.

Key features of HP ALLBASE/Turbo CONNECT are as follows:

- Flexible access to TurboIMAGE/XL data with SQL syntax
- Concurrent access with existing TurboIMAGE OLTP applications
- HP ALLBASE/NET interoperability, enabling access to TurboIMAGE data across the network
- Automatic data type conversion from TurboIMAGE to ALLBASE/SQL
- Optional translation of TurboIMAGE/XL databases into ALLBASE/SQL databases

Decision Support Applications
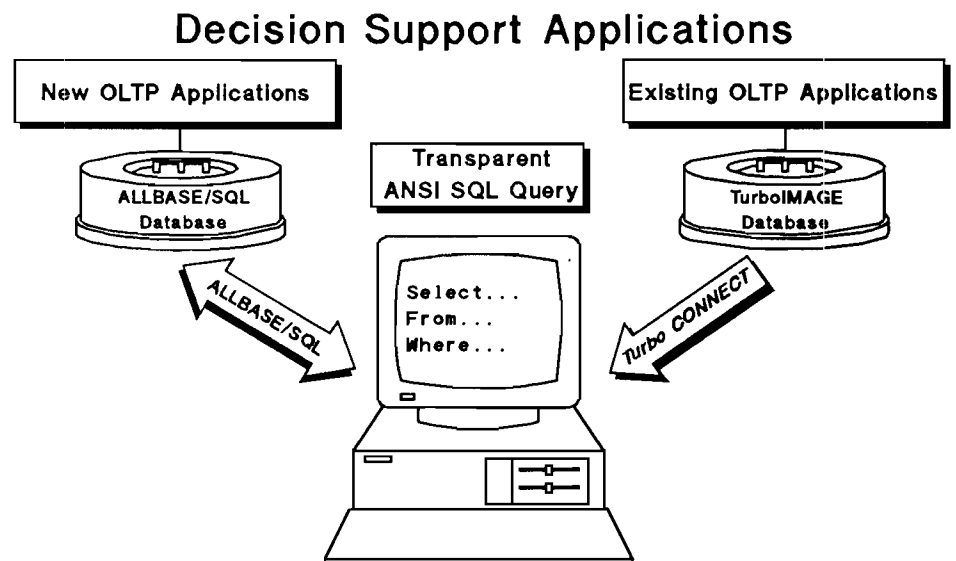
Figure 4-2. HP ALLBASE/Turbo CONNECT

HP ALLBASE/NET

HP ALLBASE/NET provides ALLBASE/SQL users transparent access to remote ALLBASE/SQL data as though it were stored locally. The first step in providing ALLBASE/SQL support for a truly distributed database environment, ALLBASE/NET allows applications running on an HP 3000 or HP 9000 client to transparently read and write to ALLBASE/SQL tables on an HP 3000 server across the network. Since database access is completely transparent to the user and the application, developers

can write code without having to know where the actual database resides.

Key features of HP ALLBASE/NET are listed below:

- Transparent access to remote ALLBASE/SQL tables across a network
- Client-server capability, including HP 9000 HP-UX systems
- Flexibility to move databases across systems without requiring any changes to existing applications
- No special linking required to create applications that access remote data

HP ALLBASE/DB2 CONNECT

HP ALLBASE/DB2 CONNECT extends the open interoperability of ALLBASE/SQL and the HP 3000 to include links to IBM databases. ALLBASE/DB2 CONNECT allows PC end users and database administrators to access both ALLBASE/SQL data and IBM DB2 data at the same time from a single session.

PC end users can use ALLBASE/DB2 CONNECT in conjunction with NewWave Access to download DB2 data to the PC environment, where they can integrate it with powerful PC productivity tools like Lotus 1-2-3, dBASE, and HP Graphics Gallery. Database administrators can use the same HP Interactive SQL (HP ISQL) interface that they use with ALLBASE/SQL to read and update IBM DB2 databases as well.

HP KSAM

HP KSAM (keyed sequential access method) allows the creation and maintenance of disk files whose records are accessed by the value of the key fields within the data records. Each data record contains one primary key field and may include up to 15 alternate key fields. Records are accessed sequentially or randomly by primary or alternate key value, by logical record number, or in chronological (physically sequential) order. Duplicate key values are allowed, and records can be accessed by generic keys (partial key values) or by approximate keys.

ISV databases

The HP 3000 operating environment also supports major multivendor databases, including Ingres, Oracle, and Sybase. These independent software vendor (ISV) products provide a common development environment across a range of platforms.

HP 3000 Open CASE

Computer-aided software engineering, or CASE, has been used by HP 3000 developers for many years to streamline development and maintenance of commercial applications. CASE addresses one of the most critical business needs today—the ability to quickly, and effectively manage a business' information assets. The HP 3000 open CASE program provides developers and value-added software businesses with CASE tools for effectively developing and maintaining applications for HP 3000 systems.

Effective development and maintenance of applications results from viewing the activity as an organized process. The process begins with the planning and analysis of the new system; proceeds through design, implementation, and test; and finally reaches fruition when the system is installed into production and is maintained over the life of the system. These phases are depicted in a lifecycle framework like the one shown in the figure below.
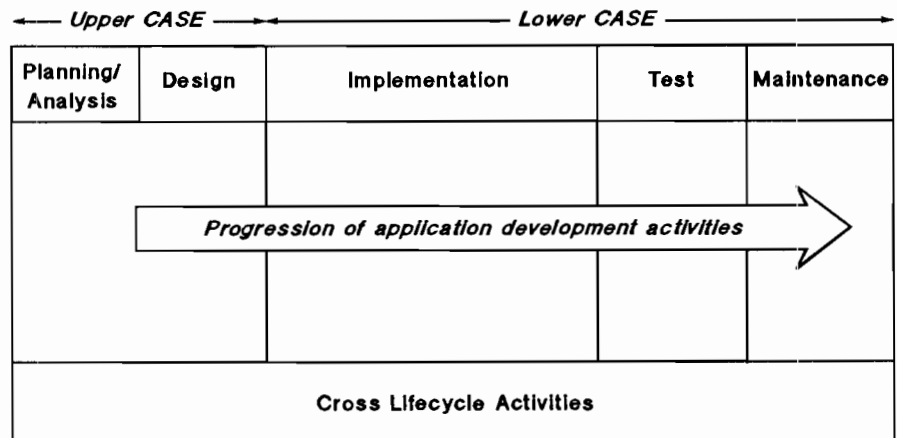
Figure 4-3. Application Development Lifecycle Framework

The objectives of the HP 3000 Open CASE program are to deliver the following:

- the best-in-class CASE tools from leading CASE vendors
- a multivendor CASE solution
- CASE tools ranging from standalone to complete integrated-CASE solutions
- CASE tools for both mainframe class and open systems client/server applications

Within each phase of the lifecyle framework the HP 3000 Open CASE program provides leadership tools for open systems, multiplatform development, client-server applications, and mainframe-class application development. Developers of multiplatform applications require industry-standard compilers, RDBMSs, forms management facilities, and operating system application programming interfaces (APIs). Client-server CASE tools take advantage of the sophisticated graphical user interfaces

(GUIs) of PCs and workstations and their high processing power to offload the host server. HP 3000 servers combine superior open OLTP functionality with support for Novell and LAN Manager PC networks. Mainframe applications are typically large, business-critical systems whose development involves multiperson, multiteam efforts and last for several years. Project management tools are required to control, monitor, and manage these large projects. The CASE tools must be able to develop application solutions that can be deployed on different platforms and to access information across platforms. The HP 3000 provides leading multivendor connectivity and database interoperability.

Application development process

CASE tools are referred to in the context of how they address different phases of the application development lifecycle. Each phase corresponds to a set of activities that are undertaken for applications development. These phases are planning and analysis, design, implementation, test, and production and maintenance. The HP 3000 Open CASE program provides tools for all major phases of the application development lifecycle.

Tools that address the first two phases, planning/analysis and design, are called upper CASE tools, while the last three phases are referred to as lower CASE tools. Upper CASE tools are normally graphical in nature and operate on a windows-based PC or a UNIX workstation. Lower CASE tools can be found on a workstation, a PC, or on the host system. Integrated CASE tools, or I-CASE, are complete application development toolsets consisting of tightly integrated tools that take applications development processes from planning through maintenance.

The HP 3000 currently provides developers with a comprehensive set of high quality CASE and decision support tools that meet the needs of almost all HP 3000 applications. These tools are supplied not only by Hewlett-Packard but also by leading third-party CASE tools vendors. Current CASE tools for developing applications for HP 3000 systems include analysis and design tools, construction tools (industry standard 3GLs, de facto standard 4GLs, report writers, decision support tools, industry standard database management systems, forms management systems), testing tools, and maintenance tools (symbolic debuggers, impact analysis tools, version control tools).

These CASE tools address all the major phases of the application development lifecycle. The figure below shows each of these phases and the activities associated with each phase.

Upper CASE		Lower CASE		
Planning/ Analysis	Design	Implementation	Test	Maintenance
Planning

Requirements Analysis

Application Design | | 3GL Construction

4GL Construction

Database Construction

Screen Construction

Reporting And Decision Support

Edit | Quality Assurance

Performance Tuning

Debug | Version Control

Change Management

Re-- Engineering |

Figure 4-4. HP 3000 CASE Tools

Integrated CASE

Integrated-CASE, or I-CASE, tools consist of sets of individual tools, from single vendors, that aid applications development and support all phases of the application development lifecycle. I-CASE tools provide developers with the capablity to automatically generate 3GL or 4GL applications from high-level designs and to maintain applications at the design level. I-CASE tools are single-vendor solutions built around a repository through which individual tools within the I-CASE toolset can share information about an application. This allows the I-CASE tools to propagate changes through an entire set of programs, databases, and screens from a single change to the application design.

The HP 3000 900 Series supports the following world-class I-CASE toolsets:

- CGI Informatique PACBASE, PACLAN, PACLAN/X
- Cognos PowerCASE
- Oracle CASE
- Softlab Maestro II

Planning and analysis

Planning and analysis occur at the beginning of the application development process. This entails analyzing an enterprise's business goals and then mapping them to its information systems plans. Once the data requirements of the system have been defined and analyzed, the design phase can begin.

Many of the planning and analysis tools run on PCs or UNIX workstations and are target system independent. (A *target system* is the platform where the application will run in production.) The HP 3000 is an ideal target system because of its high transaction performance, data integrity, high availability, and systems management capabilities.

Design   The activities during the design phase translate the information system requirements into high-level data and process models. While in design, the data and process needs for the information system can be evaluated at an abstract level before construction of the application occurs.

Design tools also run on PCs and UNIX workstations. The output of these tools tend to be target system independent and applicable to all target systems, including the HP 3000.

Implementation   The implementation phase revolves around the actual construction of the application. Traditional tools used during construction are 3GL compilers, linkers, database schema processors, screen specification tools, and so on. More recently, fourth-generation languages (4GLs), report writers, and code generators have made their way into the implementation toolset. The lower CASE tools for the implementation, test, and production and maintenance usually run on the target system.

The HP 3000 provides a full complement of application development tools: fourth-generation languages (4GL), third-generation languages (3GL), and forms management.

Fourth-generation languages (4GL)

The HP 3000 supports the major industry-leading 4GL toolsets. These 4GL toolsets provide multivendor application portability and protect application investments. 4GLs integrate application development, testing, and reporting. The HP 3000 900 Series supports, among others, the following 4GL toolsets:

- Cognos PowerHouse
- Gateway Systems Synergist
- Infocentre Speedware
- Information Builders Inc. FOCUS
- Ingres application development environment
- Oracle application development environment
- Protos

Third-generation languages (3GL)

The HP 3000 900 Series family supports a rich set of third-generation programming languages for application development:

- HP COBOL II/XL
- HP C/XL
- HP FORTRAN 77/XL
- HP Pascal/XL
- HP Business BASIC/XL
- HP RPG/XL

The HP 3000 900 Series also supports COBOL II, FORTRAN 77, Pascal, RPG, Business BASIC, BASIC, and SPL in compatibility mode.

This wide selection of programming languages gives customers the freedom to choose the language with which their programmers are most productive. In addition, a program written in one language can call programs and routines written in another HP language. This means that each portion of an application can be written in the language that is best suited to perform the given task.

HP 3000 compiler optimization

The native mode compilers, COBOL II/XL, FORTRAN 77/XL, C/XL, Pascal/XL, RPG/XL, and Business BASIC/XL, are optimizing compilers that maximize a program's run-time performance while minimizing its memory requirements. Hewlett-Packard developed these powerful compilers to take full advantage of the features, simplicity, and uniformity of the machine instruction set of HP Precision Architecture-RISC.

HP's optimizing compilers provide processing efficiency in several ways. For example, they analyze program behavior on a global basis and schedule instructions to fully utilize the advanced pipelining capabilities of the HP 3000 900 Series. They also allocate the processor's registers very efficiently to take full advantage of PA-RISC's LOAD/STORE design.

HP COBOL II

HP COBOL II is a business data processing language that operates on the HP 3000 systems. It takes full advantage of the systems' capabilities and architecture. COBOL II's performance was specially enhanced for packed decimal and display data arithmetic. COBOL II is based on the 1985 ANSI COBOL Standard X3.23-1985. The new features provided by the 1985 standard include many structured programming control structures, such as nested subprograms, nested PERFORMS, NOT phrases, and scope terminators. In addition to being validated as a high-level implementation of ANSI X3.23-1985, COBOL II also compiles programs that conform to the 1974 standard, ANSI X3.23-1974. COBOL II now supports the new, optional Intrinsic Function module of the ANSI COBOL '85 standard, consisting of 42 built-in COBOL functions.

HP COBOL II also conforms to the Federal Information Processing Standard (FIPS) Publication 21-3.

HP has implemented several extensions to the standard in order to increase the capability of COBOL II. The most significant extensions are as follows:

- A preprocessor function that provides statements allowing the programmer to equate a particular macro or sequence of code ($DEFINE) or a file ($INCLUDE) to an identifier, which can be referenced throughout the program and is replaced with the expanded source code it represents at compile time.
- Program debugging aids that increase the productivity of COBOL programming staffs by providing tools that aid in finding problems within a program during the development cycle.

- HP CROSSREF provides a listing of all symbols and tables used in the expanded source file.
- HP VERB MAP provides a listing of COBOL statements and their locations within the object code.
- Ability to call the system intrinsic functions and programs written in other languages.
- Dynamic file assignment support that allows the assignment of logical files to physical files or devices at runtime.
- A special register, called RETURN-CODE, which allows COBOL subprograms to provide a functional return.
- Symbolic debugging support by both Symbolic Debugger/XL and Toolset/XL.
- HP Software Performance Tuner/XL support.

HP C/XL

HP C/XL is Hewlett-Packard's implementation of C for the HP 3000 900 Series that conforms to ANSI standard X3.159-1989. C is a general-purpose programming language that features modern control flow and data structures, a rich set of operators, and economy of expression. It combines the convenience and portability of a high-level language with the flexibility and efficiency of an assembly language. It is widely used for application programming and is an excellent vehicle for porting software applications between different vendors' systems.

Key features of HP C/XL are listed below:

- Function prototypes support type checking of function parameters, providing greater software reliability.
- Functions are recursive and can return scalar, structure, or union values.
- Block-structured scope of variables is provided.
- Public and private functions and data are provided.
- Structured programming statements — *if-else, for, while, switch* — are available.
- Pointers provide flexible manipulation of addresses.
- Multiple-byte character and wide-character support are provided, enabling applications to be localized for national languages.
- Programs are provided to specify optimization options, copyright information, version identification, listing control, and operating system intrinsic access.
- Programs can access the operating environment PARM and INFO values.
- Preprocessor performs conditional inclusion, macro processing, and source file inclusion.
- Programs can be debugged using HP Symbolic Debugger/XL.
- HP Software Performance Tuner/XL support.

HP FORTRAN 77

HP FORTRAN 77 is based on the most recent ANSI FORTRAN standard and incorporates a number of improvements and extensions over previous implementations. Among the more important are an IF-THEN-ELSE control structure, a CHARACTER data type, and generalized I/O facilities. HP FORTRAN 77 is a superset of the ANSI FORTRAN 77 standard. It provides a well-defined language standard for software portability and offers extensions that enhance the flexibility and power of the FORTRAN 77 language.

Key features of HP FORTRAN 77 are as follows:

- Seven data types — integer, double integer (integer*4), logical, real, double precision(real*8), complex, and character.
- Character variables and character arrays.
- Bit extract and deposit capability with partial-word designators.
- Arrays with up to 255 dimensions.
- Named common blocks initialized by block data subprograms.
- Multiple entry points for subprograms.
- Support of user-written error-handling routines that are called under trap conditions.
- ANSI FORTRAN 77(X3.9-1978) full language.
- MIL-STD-1753 language extensions.
- HP language extensions.
- HP 3000 operating system access.
- HP Symbolic Debugger/XL support.
- HP Software Performance Tuner/XL support.

HP Pascal

HP Pascal provides several extensions to the ANSI IEEE standards for Pascal. HP Pascal/XL, the 900 Series version, allows several extensions to the ISO standards for Pascal, including those that provide system programming capabilities. These extensions open many new areas for Pascal usage. Pascal is particularly useful for development of large systems and subsystems, and Pascal/XL is also useful for those applications that require system-level programming.

Pascal offers a very rich and powerful set of data types and control flow structures. Along with control constructs, Pascal's basic building blocks of structure, namely procedures and functions, permit a top-down approach to program development. The modular, self-documenting characteristic of Pascal programs produces code that is easy to maintain and enhance. As a further aid to program development, the language offers strong type-checking and range-checking capabilities. A significant portion of the debugging responsibility now rests with the compiler and the language.

HP Pascal/XL offers system programming extensions to the above features. These extensions have permitted Pascal to be used extensively within Hewlett-Packard for system-level applications.

Key features of HP Pascal are as follows:

- Symbolic debug support for Pascal/XL is provided by HP Symbolic Debugger/XL.
- Conformant array parameter type provides flexibility in parameter passing for HP Pascal/XL.
- Character and string types allow powerful string management operations, when coupled with predefined string handling functions.
- HP Software Performance Tuner/XL support.

HP RPG

HP RPG, or Report Program Generator, is a machine-independent, problem-oriented report-generating language that is easy to learn, to use, and to code. It allows you to specify many important operations with a minimum of effort by making simple entries on specially formatted coding sheets. HP RPG/XL, the 900 Series version, is highly compatible with the RPG II languages offered by other vendors. Minimal effort is required to migrate standard RPG II programs from other vendors' systems to HP. In addition, the HP RPG/XL compiler helps detect errors at the source language level with extensive diagnostic messages.

HP Business BASIC

HP Business BASIC/XL offers a variety of features to ease the programming task. HP Business BASIC supports the commercial applications programmer pursuing serious development as well as the novice programmer involved in ad hoc production of simple programs and tools.

HP Business BASIC not only provides ease of use for the programmer, but also allows the programmer to write applications that are easy to use. Run-time errors and interrupts from the keyboard can be trapped by the program and appropriate action taken automatically. Statements are provided to support applications with softkey-based user interfaces.

Forms management

HP's forms management facilities simplify the creation of screen forms and the development of workstation I/O portions of applications. The forms management facilities make it easy to define and use application screens. The end users are able to see what the application will look like early in the design phase, so they can provide valuable input before application development begins.

HP FORMSPEC

HP FORMSPEC is an easy to use, menu-driven, interactive screen forms design facility for application developers. The forms developed with FORMSPEC can be manipulated by applications using HP VPLUS intrinsics. FORMSPEC provides automatic data checking, editing, formatting, and displays error-dependent, run-time user messages. The separation of the screen interface from the application

allows screen image maintenance without having to change the application.

HP VPLUS

HP VPLUS consists of a set of intrinsics that programmers can use to develop the terminal I/O portions of applications.

Key features of HP VPLUS are listed below:

- Configures the terminal workstation
- Retrieve a form definition from a forms file
- Display a form with application-provided data and window message and enhanced fields
- Return data that is entered into a displayed form along with the value of the last key pressed to the application
- Execute logical groups of system-level workstation management routines with high-level intrinsics
- Perform diagnostic activities during program development and debugging

Client/Server OLTP

Forms management

Database and application processing

Distributes Processing to PCs

No Application Changes
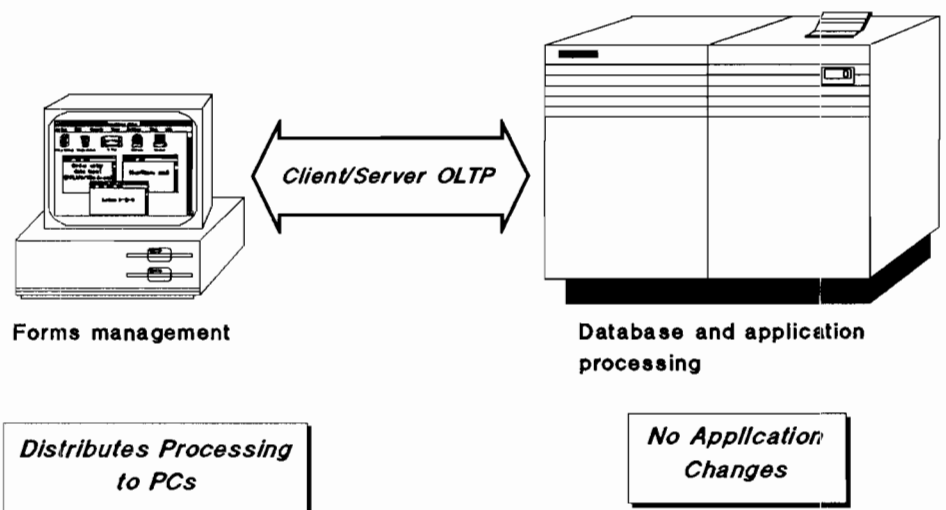
Figure 4-5. HP VPLUS/Windows

HP VPLUS/Windows

HP VPLUS/Windows is part of HP's strategy for optimizing computer resources through a client-server computing environment. VPLUS/Windows allows VPLUS applications running on an HP 3000 computer to be run under MS-Windows on a PC. No changes are required to the VPLUS application programs, which optimizes use of computer resources.

With VPLUS/Windows, users can access multiple VPLUS applications, and move freely between their VPLUS applications and PC-based software such as spreadsheets and word processors. Unlike terminal emulation software, VPLUS/Windows facilitates a bitmapped windowing system and can store part of the application

on the PC. This increases performance and frees applications from the terminal's architecture.

HP Motif XL

HP Motif XL is the GUI that runs on top of the X Windows System on the HP 3000. HP Motif XL provides a sophisticated, consistent user interface for client-server application solutions. For more information on HP Motif XL, please refer to Chapter 3, The HP 3000 Operating Environment.

HP JAM

HP JAM (Jyacc Application Manager) is a user interface management system that allows programmers to design and develop the user interface for applications developed in other third-generation languages for multiple platforms. By eliminating the extensive coding normally required for user interfaces, development is performed quickly, thereby reducing overall time required for application development. With JAM, programmers can easily create and link screens, menus and windows, incorporate color and graphics, and prototype entire applications without writing code.

Additionally, HP JAM allows programmers to build fully functional applications without affecting performance. Because JAM links the user interface with the backend code written in a third generation language, the performance of the application is not compromised.

Software editing and control

HP EDIT/XL

HP EDIT/XL is a full-function, screen-oriented editor designed for application program development. This interactive editor offers a user-configurable editing environment with a rich set of advanced text processing features. Support for standard as well as COBOL line numbering and features such as automatic indentation and line shifting make this an ideal text editor for programmers.

HP EDIT/XL offers many advantages over other editors including full-screen editing with split-screen windowing capabilities, a user configurable interface, the ability to undo unwanted actions, provisions for minimizing loss of data, Asian (16-bit) and European text support and a comprehensive online Help facility. HP EDIT/V is also available for MPE V systems.

HP Software Revision Controller

HP Software Revision Controller (HP SRC) is a sophisticated revision control system designed to manage changes to files in a software development environment. HP SRC provides comprehensive software revision management that alleviates the need for enforcement of strict file access rules or manual logs to track files as they are revised. Instead, HP SRC automates this process by

providing an automated check-in/check-out facility that protects against simultaneous modification to a specific version while providing the flexibility of parallel development on different versions of the same file. In addition, it provides an up-to-date audit trail as software modifications are made.

In addition to operating system file and account security, HP SRC uses its own security system to prevent unauthorized access to files. The combination of these protective measures preserves file integrity. HP SRC/V is also available for MPE V systems.

Reporting

The HP 3000 900 Series supports industry leading reporting tools, which transparently integrate information from HP ALLBASE/SQL and HP TurboIMAGE.

HP Business Report Writer

HP Business Report Writer (BRW) is a high-performance business report writing system for information management professionals. Additionally, BRW is an excellent solution for sophisticated report writing for TurboIMAGE and ALLBASE/SQL DBMS. With BRW, comprehensive report development no longer requires numerous lines of program code or complex report syntax. BRW's ease of use significantly reduces the time required for report development. Maintenance of reports is simplified, and report generation can be tuned to optimize and conserve system resources. BRW is a terminal-based, menu-driven application.

HP BRW-Desk is an add-on product that enables you to automatically send BRW reports to the Intray of selected HP DeskManager accounts. Both BRW/V and BRW-Desk/V are available for MPE V systems.

HP ALLBASE/QUERY

HP ALLBASE/QUERY is an easy-to-use, terminal-based data retrieval tool for HP ALLBASE/SQL. The flexible selection of access and reporting modules available in ALLBASE/QUERY enables end users and database administrators to perform queries, to modify data or tables, and to generate reports, without programming. ALLBASE/QUERY also provides powerful facilities for programmers to use in preconfiguring complex tasks or to improve productivity when working with ALLBASE/SQL.

HP Information Access

HP Information Access is a client-server decision support solution that extends the availability of data processing systems by delivering key business data to authorized PC users. Host server data can be downloaded into popular PC spreadsheet, database, and graphics applications. Information Access provides the means to make better decisions based on up-to-the-minute information wherever it resides. Additionally, centralized administration of information access

improves the management of essential data processing systems. For a complete description, please refer to Chapter 6, Office Information.

HP NewWave Access

HP NewWave Access provides an intuitive, graphical user interface that fully utilizes the MS-Windows and HP NewWave environment. PC users can easily create *data view* objects from network information and update or modify the data without having to know the associated connection information or database syntax. For detailed information, please refer to Chapter 6, Office Information.

Testing

Testing is a critical part of the application development process. During this phase, the application is tested for compliance to specifications and is debugged. The testing tools employed are code analyzers, debuggers, and diagnostic tools. Many of the 4GLs provide their own integrated test facilities.

The products supported by the HP 3000 provide sophisticated debugging and diagnostic capabilities that make it easy to isolate and correct problems.

HP Symbolic Debugger/XL

HP Symbolic Debugger/XL is a powerful, full-featured symbolic debugger that helps the user locate and correct errors in programs. The feature set facilitates high programmer productivity and user friendliness. Symbolic Debugger/XL is the interactive source-level debugger for the COBOL II/XL, FORTRAN 77/XL, C/XL, and Pascal/XL languages on the HP 3000 900 Series.

HP Symbolic Debugger/XL allows the user to examine the program state in which an error or some other condition occurs. The user can then take corrective action and resume execution or abort the program.

HP Symbolic Debugger/XL is compatible with HP Symbolic Debugger/HP-UX, allowing you to use the same debugging environment on MPE/XL and HP-UX.

HP Software Performance Tuner/XL

HP Software Performance Tuner/XL (SPT/XL) provides information needed to increase the performance of HP 3000 900 Series application programs. With HP SPT/XL, the programmer can evaluate the design and efficiency of application code during development or monitor and improve the performance of production applications.

During development, HP SPT/XL's unique compare feature helps build efficiency into applications by assisting programmers in analyzing the performance impact of program logic and critical algorithms. During production, SPT/XL functions as a diagnostic and monitoring tool to help maintain application performance and meet daily business processing needs. And when business demands

dictate program modifications, SPT/XL can help analyze the performance impact of program enhancements.

HP SPT/XL uses transactions as a reference point for application performance analysis. Transaction-based analysis assists the programmer in focusing the tuning effort where it will most directly improve application performance. The software traces operating system intrinsic calls, samples program statement execution, and reports HP TurboIMAGE database and file activity, thereby allowing the programmer to precisely pinpoint tuning opportunities.

Production and maintenance

This phase begins when the application is deployed into production. Tasks performed during this phase include restructuring database information, performing ad hoc queries, implementing application enhancements, and repairing defects. The tools most used here provide database administration, reverse engineering, and decision support. Another task performed in production is software distribution to remote operations. For centralized MIS departments, the task of ensuring that each remote production system has the latest software revision is often complex, expensive, and prone to error. The complexity increases even more dramatically for client-server applications, as the distribution process is carried forward to each client system.

HP ALLBASE/SQL administration

HP ALLBASE/SQL provides a comprehensive set of standard maintenance utilities to create, query, and restructure ALLBASE/SQL databases. Interactive SQL (ISQL), SQLUtil, and SQLGEN provide the database administrator (DBA) the capabilities to design, modify, and tune databases. Dynamic restructuring allows the users to continue accessing data, except for affected areas, during restructuring.

Key features of HP ALLBASE/SQL administration are as follows:

- Create indexes, statistics, tables, views, and view authorization; load and unload tables
- Dynamic restructuring including expanding table capacities, altering security, designations, adding columns, and adding or deleting indexes, views, and tables
- Display and change startup parameters; move files and logs; purge files, logs, and databases; backup and restore databases
- Non-procedural query: select, update, insert, and delete

HP DBChange Plus

HP DBChange Plus is a powerful TurboIMAGE/XL database administration tool that simplifies the tasks of database restructuring, maintenance, and analysis. It increases database availability, gives database administrators more flexibility, and ensures maximum data integrity.

Key features of HP DBChange Plus are listed below:

- A command-driven interface accepts interactive input from a terminal or batch input from a standard text file
- Users may preview and alter new database attributes before the modifications are actually applied
- A full function restructuring package transforms any TurboIMAGE/XL database into a new format without unloading and reloading the data
- Capacity management allows proactive management of databases as the data sets grow
- Comprehensive diagnostic and repair facilities ensure maximum protection for TurboIMAGE/XL data
- Database statistics help identify database areas that need performance tuning

HP Toolset/XL

Toolset/XL provides a set of tools that work together to maximize the productivity of COBOL II/XL and Pascal/XL programmers in the coding, symbolic debugging, and version management phases of development on the 900 Series systems; and extends symbolic debugging to include support for HP FORTRAN 77/XL. These tools perform many of the fundamental and routine programming tasks and simplify or facilitate others. Toolset/V tools are also available for MPE V systems.

Networks

Overview

HP Networking Strategy

HP Networking is a family of hardware and software communication products that enables HP systems to communicate with each other and to interoperate with equipment made by other vendors. HP Networking products adhere to industry and de facto standards for data communication. The International Standards Organization (ISO) seven-layer Open Systems Interconnect (OSI) model is the basis for HP Networking product design. Hewlett-Packard also offers products for batch and interactive communication to IBM mainframes in System Network Architecture (SNA) and bisynchronous environments.
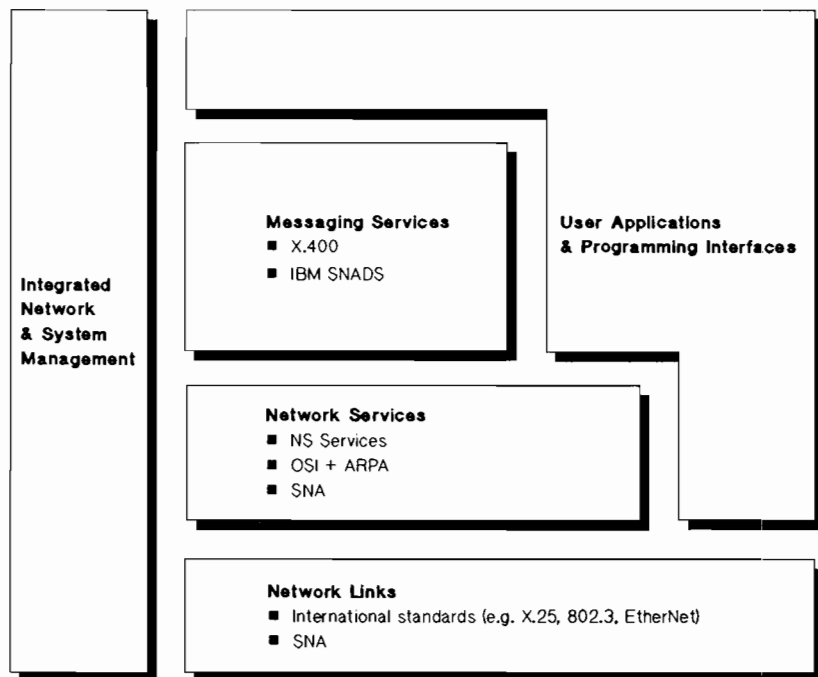
Figure 5-1. HP Networking Strategy

Because HP Networking products are based on industry standards, they provide an open foundation for the development of portable applications that span multivendor platforms.

The HP Networking products provide networking solutions for the primary business areas of manufacturing and service companies, covering both internal automation environments (LAN) and external site communication needs (WAN). These products are grouped in six broad categories:

- Terminal-to-system
- PC integration
- System-to-system
- HP-to-IBM systems
- HP Network Management
- Application integration

Terminal-to-system communication

On HP 3000 900 Series systems, terminal connectivity is provided by the Datacommunications and Terminal Controller (DTC). The word *terminal* is used in reference to the terminals, personal computers (in terminal emulation mode), and serial printers that are connected to an HP 3000 system.

DTC

The datacommunications and terminal controller (DTC) is a modular and flexible LAN-based controller that provides location independent (for example, for both local and remote using X.25) and Telnet protocols for end-user access to HP and non-HP systems. Users connected to the DTC receive all the benefits associated with support of multivendor standards, while at the same time having high-performance access to HP 3000 900 Series systems.

For access to a single HP 3000 900 Series systems, the DTC provides simple and cost-effective connections to one predefined HP 3000 host, that downloads and manages multiple DTCs.

As connectivity needs grow, the DTC can evolve into a powerful multivendor communication server, providing integrated communications for end-user access to multiple systems. Through the use of an HP OpenView PC-based workstation, a single operator can manage these DTC connections, as well as other network and system elements, such as PADs and switches—and soon hubs, bridges, and HP 3000 systems. In addition, the HP OpenView DTC Manager provides an intuitive and easy-to-use graphical interface, leading to reduced cost of operation. For more details on X.25 communications on the DTC, please refer to the "Wide Area Networking" section. For more details on the Telnet access to the 900 Series, please refer to the "Multivendor system access" section.

HP 3000 900 Series system access

Local access

The DTC provides local user access to one or more HP 3000 900 Series systems. The DTC supports data transfer at rates from 3,000 to 19,200 bps, with speed and parity sensing, full-duplex modems, spooled printers, PCs in terminal-emulation mode, powerfail session recovery, type ahead, and multisession capability.

The DTC attaches to the system using an industry-standard IEEE 802.3/Ethernet LAN. The DTC can attach to a ThinLAN, ThickLAN, or EtherTwist cable at speeds of 10 Mbits per second. In addition, the DTC can be distributed throughout an extended LAN made up of LAN repeaters and bridges.

Remote access

The DTC provides the same services to remote users, using the IEEE X.25 protocol or the ARPA Telnet protocol. In X.25 environments, the DTC/XL Network Link provides 900 Series access to remote users connected to an asynchronous Packet Assembler/Disassembler (PAD) device. In ARPA environments, the HP Telnet Express gives remote Telnet users high-performance 900 Series access over an internet IP Network. In addition, an HP ARPA Telnet Access card is available as an add-on for the DTC48.
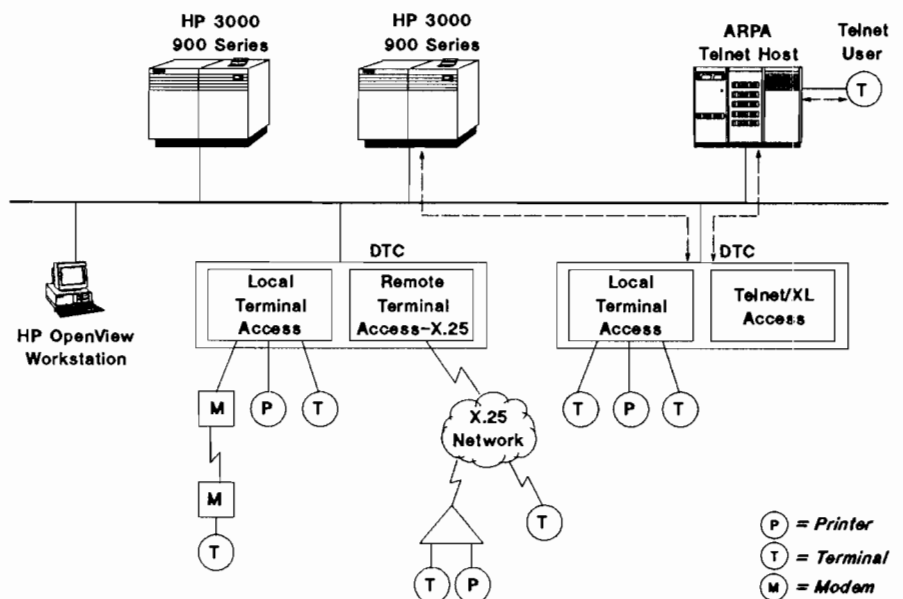
Figure 5-2. Location-Independent End-User Access

Multivendor system access

The DTC simultaneously supports the high-performance 900 Series protocol and the ARPA Telnet protocol. Consequently, local DTC users have consistent access to HP 3000 900 Series systems and ARPA Telnet hosts, that is, HP 9000 and Digital VAX systems with ARPA. In addition, a remote user coming in over X.25 (using PAD) has the same system access capabilities.
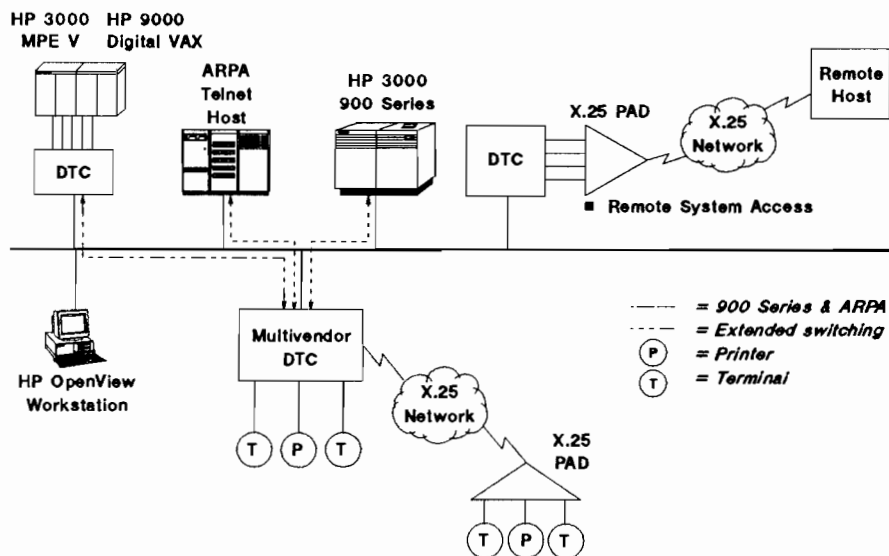
Figure 5-3.
Consistent Access to HP 3000 900 Series,
ARPA Telnet Host and Non-900 Series

Extended switching also allows users connected to a DTC to access systems using asynchronous connections. The other system must be connected using RS-232 connections to a second DTC on the same LAN. A single DTC can also provide extended switching.

The DTC family

There are two DTC models available for maximum flexibility in providing terminal access to systems in a network: the DTC16 and the DTC48. The DTC16 provides a cost-effective solution for entry-level HP 3000 systems, and is well suited for those environments needing a small concentration of ports. The DTC16 provides up to 16 direct-connect ports or up to 12 modem-connect ports. The DTC16 also offers an optional entry-level X.25 solution consisting of one X.25 RS-232 link.

The DTC48 provides a cost-effective solution for those environments needing a larger configurations of ports. The DTC48 provides up to 48 direct-connect ports or up to 36 modem-connect ports. Like the DTC16, the DTC48 supports X.25 connectivity. The DTC48 supports up to three X.25 network access cards providing either RS-232, RS-422, V.35, or V.36 connectivity. In addition, the DTC48 supports one HP ARPA Telnet Access card providing

high-performance Telnet access from an ARPA system to an HP 3000 900 Series.

An X.25 network access card and an ARPA Telnet access card can not reside on the same DTC48. For specific details, please see the HP 3000 Configuration Guide (5091-1731E) or the HP Networking Communications Specification Guide (5091-1303E).

DTC Management

HP offers two management solutions for downloading and managing DTCs:

- Simple management software based on the HP 3000 host for standalone system sites. The PC-based management continues to provide additional benefits in this environment, in terms of ease-of-use for the network operator, thanks to the intuitive and easy-to-use graphical interface leading to reduced cost of operation.
- HP OpenView DTC Manager (PC-based) for multisystem (HP or multivendor) sites with multiple network equipment. HP OpenView PC-based management provides an effective way to control network equipment from one workstation. DTCs, PADs, and switches—and soon hubs, bridges, and HP 3000 systems—can be controlled from a single HP OpenView PC.

PC Integration

With the proliferation of PCs and PC LANs, PC users need greater access to corporate-wide information and computing resources. PCs are becoming critical for corporate information-processing requirements. Increased investment in PCs demands better utilization of these growing computer resources.

Client-server computing brings sophisticated corporate-wide computing services and applications to the desktop. The desktop provides the entry point into the corporate network while retaining the users' independence. Client-server computing provides the best combination of access, performance, control, and investment protection. Hewlett-Packard offers a full, standards-based family of multivendor networking products and a range of computing software for client-server computing.

Terminal emulation

HP AdvanceLink terminal-emulator software provides all the functionality of a terminal plus file transfer capability between the PC and the HP 3000. HP AdvanceLink for Windows provides these capabilities from a Microsoft Windows environment. The windowing environment provides the advantages of ease of use, multitasking, background file transfer, and cut and paste. HP AdvanceLink is also available for the Apple Macintosh.

NewWave Office and LAN Manager

HP NewWave Office on the HP 3000 provides PC users full application and data access as well as resource sharing and program-to-program communication. In addition, HP provides LAN Manager PC integration to the HP 3000 using HP NewWave Office. With HP NewWave Office, users can share resources, manage personal applications, and benefit from easy information access. The HP 3000 LAN Manager offering is further strengthened with support of LAN Manager Named Pipes, the LAN Manager API. Named Pipes allows application programs to communicate with each other and to exchange data. By providing Named Pipes on the HP 3000 , the software developer has the ability to leverage client-server applications across multivendor systems. Please refer to the "NewWave Office" section in "Office Information", Chapter 6.

Novell connectivity

Novell is recognized as a de facto standard for PC networks. To meet the needs of Novell customers, HP provides NetWare on the HP 3000 900 Series systems. HP NetWare/XL, HP's implementation of Portable NetWare, is based on Novell's latest and most powerful product, NetWare 386. NetWare for the HP 3000 supports file and print sharing; server administration and management; and APIs, including the Sequenced Packet Exchange (SPX) protocol for developing client-server applications. HP NetWare/XL protects investment in both the existing PC LAN and the HP 3000 while providing user access to *mission critical* resources.

In addition, HP Network Services, 2.1/MS-DOS for NetWare provides Novell clients concurrent access to HP 3000 applications and to HP network services.

Apple connectivity

For Apple Macintosh connectivity, the HP 3000 provides a number of alternatives. HP NetWare/XL includes NetWare for the Macintosh providing file and print services for standard AppleShare clients. HP AdvanceLink for the Macintosh provides HP terminal emulation with file transfer capability using an 802.3/Ethernet LAN or RS-232C connection.

System-to-System Communication

Users need access to information distributed across a range of computer systems throughout a company. These systems may be geographically dispersed and contain both HP and multivendor equipment. For users to access distributed systems requires interoperability between the systems that includes industry and de facto standards for file transfer and database access, and program-to-program communication.

With HP's networking solution for system-to-system communication, users can access information and applications anywhere on the network as well as utilizing network-wide resources such as printers and plotters.

Hewlett-Packard is committed to supporting de facto and international industry standards such as TCP/IP and OSI to facilitate multivendor interoperability. HP recognizes that the transition to OSI will occur over a significant period of time and that coexistence with de facto standards such as ARPA services and TCP/IP networking will be required. HP also continues to provide leadership IBM communication products for customers requiring connectivity over an SNA network. Refer to the "HP 3000-to-IBM communication" section for more information.

HP Network Services

HP Network Services (NS), which corresponds to OSI layers 5 through 7, provides powerful networking services. It is used in conjunction with the LAN Link, Point-to-Point Link, X.25 Link, and SNA Link (900 Series only) to provide virtual terminal, network file transfer, remote file access, remote database access, network interprocess communication, and remote process management.

The HP Network Services are used for system-to-system communication between HP 3000 computers and the HP 9000 and HP 1000 computers. The network services include the following:

Virtual terminal

Virtual terminal provides interactive access to other HP 3000 systems and PCs on the network. A terminal configured to one system is "virtually" connected to all other systems on the network. Virtual Terminal allows log on to any system on the network as easily as logging on to a local or *home* system.

Network file transfer

Network file transfer is a file copy utility that easily copies files from one HP system to another. The transfer can be interactive or programmatic.

- Virtual terminal
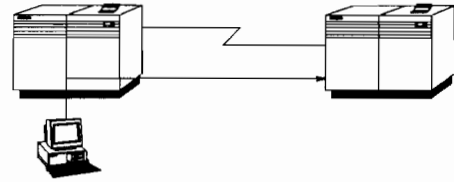
- Network file transfer
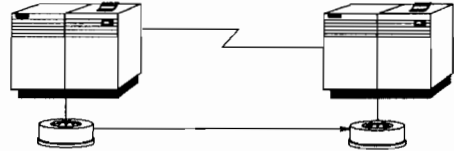
- Remote file access
- Remote database
  access
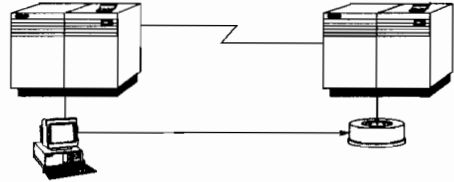
- Remote peripheral
  access
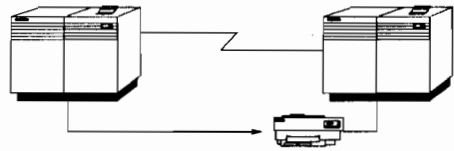
- Network interprocess
  communications
- Remote process
  Management
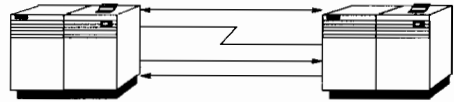
Figure 5-4. Network Services Functionality

Remote file and peripheral access

This service provides access to the files and peripherals of other
HP 3000 systems in the network. Access can be interactive or
programmatic. The HP 3000 operating system contains intrinsics for
file manipulation. Since the HP 3000 treats peripherals similarly to
files, the same intrinsics can be used for peripheral operations. NS
extends this capability throughout the network and allows peripheral
devices, such as printers, to be shared by multiple systems on the
network.

Remote database access

The ALLBASE/NET capability provides remote access to HP
ALLBASE/SQL databases on remote HP 3000s and HP 9000s.
It provides transparent, interactive, and programmatic access to
HP ALLBASE/SQL tables residing anywhere in the network.

Through remote database access (RDA), HP TurboIMAGE databases
can be accessed on different HP 3000 systems in the network.

Access can be interactive, through Query/3000, or from application programs.

RDA provides valuable flexibility for database applications. Data captured by applications on different systems can be consolidated in a centralized database and shared by applications throughout the network. For instance, distributed applications for accounts payable and accounts receivable can access a general ledger database centralized on one system in the network.

Network interprocess communication

Network interprocess communication (NetIPC) is the ideal means for implementing efficient distributed applications.

NetIPC is a set of programmatic calls that facilitate the rapid exchange of data between processes on multiple HP systems. The relation between the processes is peer-to-peer so that any process can initiate communication and any process can send or receive messages. NetIPC applications can also be designed to interoperate with Berkeley Sockets-based applications on other vendors' systems.

Remote process management

Remote process management consists of a set of programmatic calls for initiating and terminating remote processes. These calls will normally be used in conjunction with the NetIPC calls, allowing an entire distributed application to be controlled from a single system.

Security

HP Network Services honors the security provisions of the HP 3000 operating system and the database management systems. Beyond this, Network Services allows the system manager to apply security measures specific to the network. For instance, one-way access can be specified and node passwords can be required.

ARPA services ARPA services are de facto industry standards that are supported by most computer vendors. ARPA services provide the best open systems connectivity for multivendor, multioperating system networks.

HP ARPA Services/XL provide de facto industry-standard multivendor networking on the HP 3000 900 Series over both local and wide area networks. The ARPA/XL FTP service provides an easy method for transferring files with other vendor's system. The ARPA/XL Telnet service facilitates remote logons between the HP 3000, other HP computers, and non-HP computers. Telnet access is provided by the DTC, and allows users on a remote system to log on and run HP VPLUS block mode and character mode applications on the HP 3000 system. Access to applications on the remote system by DTC connected users is also provided. See the

"Terminal-to-System Communication" section for more information on this DTC Telnet implementation.

OSI services

Open Systems Interconnection (OSI) is a networking architecture model and a set of networking protocols developed to provide global, industry-wide standards for multivendor networking.

Probably the most widely implemented OSI networking capability is the X.400 message handling system. It is used for multivendor electronic mail exchange as well as multivendor messaging. The HP 3000 supports a very high-performance implementation of X.400.

HP X.400/3000

HP X.400/3000 provides standards-based multivendor messaging services for HP 3000 systems. HP DeskManager users on HP 3000 systems can transparently exchange electronic mail messages throughout a multivendor environment. Also, they can exchange those mail messages with public messaging services in a local 802.3/Ethernet or remote X.25 environment. HP DeskManager users can send binary files such as spreadsheets, graphics, and word processing files in addition to ASCII text messages.

Users of HP AdvanceMail for the PC can also create X.400 messages. AdvanceMail provides remote user agent capabilities. Users can compose messages on their PCs and later transfer them to HP DeskManager for distribution within the HP DeskManager or X.400 environments.

Hewlett-Packard also supports an API for the X.400 products to allow users to write applications such as electronic data interchange (EDI).

HP X.400 consists of two components: The HP X.400 Server and HP X.400/HP Desk. The HP X.400/HP Desk product runs on HP 3000 systems and connects HP Desk to the X.400 server. The HP X.400 server is a hardware/software bundle providing the connectivity to both LAN and X.25-based X.400 networks.
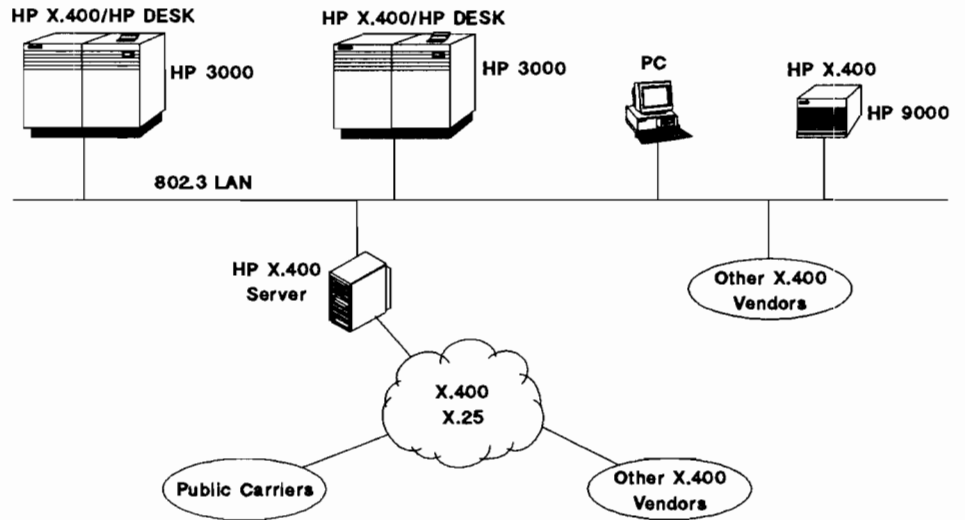
Figure 5-5. HP X.400/3000

In addition to X.400, the 900 Series operating environment also supports OSI File Transfer, Access, and Management (FTAM) standard. HP FTAM/XL provides multivendor file transfer, access, and management services for HP 3000 systems on OSI networks. FTAM/XL allows an HP 3000 900 Series user to transfer or manage any defined data type between a 900 Series system and other vendors' systems, regardless of their hardware platform or operating system. FTAM/XL service runs over the OSI transport mechanisms-HP OTS 3000/XL. Together FTAM/XL, OTS/XL and the HP ThinLan 3000 link or X.25 link provide a full, native, seven-layer implementation of the OSI model.

FTAM/XL is also designed to coexist on existing networks with TCP/IP and NS or ARPA services. This enables the user to take advantage of OSI capabilities while continuing to use existing NS/ARPA services. FTAM/XL can act as a server allowing non-OSI hosts to logon using NS/ARPA services and initiate FTAM connections to any local or remote OSI host.

FTAM/XL and OTS/XL will be available Summer 1991.

Support of these OSI services and link make the HP 3000 900 Series compliant with the Government OSI Profile (GOSIP) version 1.0. If your HP 3000 networking needs include the ability to communicate with another vendor's system, HP has a solution to meet that need.

Local Area Networking

LAN link adapters are essential for communication between computer systems in a local area network. The HP ThinLAN 3000 Link provides the hardware and communication software needed to connect HP 3000 systems to a network for system-to-system communications. It includes a LAN interface controller (LANIC) and transport software that perform the functions specified in layers one to four of the OSI reference model. The ThinLAN 3000 Link is used in conjunction with NS, ARPA, or OSI services (900 Series only). The ThinLAN 3000 link provides transport-level protocols based on the Defense Advanced Research Project Agency and Transmission Control Protocol/Internet Protocol (DARPA TCP/IP), and is supported with data transfer rates up to 10 Mbits per second over either IEEE 802.3 or Ethernet. IEEE 802.5 Token Ring connectivity is currently available with the HP Router.
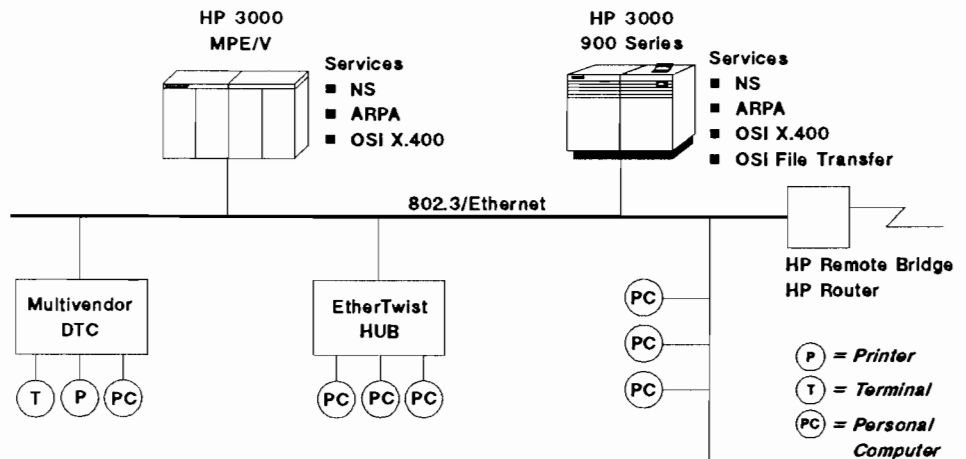
Figure 5-6. Network Services Over a LAN

Extended LAN networking

Recently, the term *extended LAN networking* emerged to represent the technology used for connecting LANs across extended distances. The growth of PC and workstation LANs has been largely responsible for subsequent growth of extended LANs. HP's extended-LAN solution is based on the HP Remote Bridge and HP Routers.

HP Remote Bridge   The HP Remote Bridge combines two geographically dispersed LANs to form one common extended LAN. You can use multiple HP Remote Bridges to link multiple LANs for an enterprise-wide extended LAN. The HP Remote Bridge is a cost-effective and high-performance way to interconnect remote LANs over 56-Kbits/DDS or T1 transmission links. The HP Remote Bridge can also be managed by the HP OpenView Bridge Manager for DOS.

HP Routers   The HP Routers allow you to build extended LANs by connecting multiple LAN subnets. These subnets can be located at single or multiple sites. The HP Router is a multiprotocol router that supports many network-layer protocols, including ARPA IP, Novell IPX, Xerox XNS, and DECnet Phase IV. For those network-layer protocols that the HP Router does not support, datalink layer bridging and spanning tree protocol support are available. In addition, the router supports Simple Network Management Protocol (SNMP) for network management. The high-end HP Router supports up to eight LAN connections and eight WAN connections for a centralized site. It supports WAN connections through the use of public or private X.25 networks and private-leased transmission facilities. The high-end router supports IEEE 802.3/Ethernet connections, 802.5/Token Ring. The low end HP Router ER supports two LAN connections and two WAN connections for connecivity to smaller remote sites. It supports WAN connections through private-leased transmission facilities and IEEE 802.3/Ethernet LAN connections.
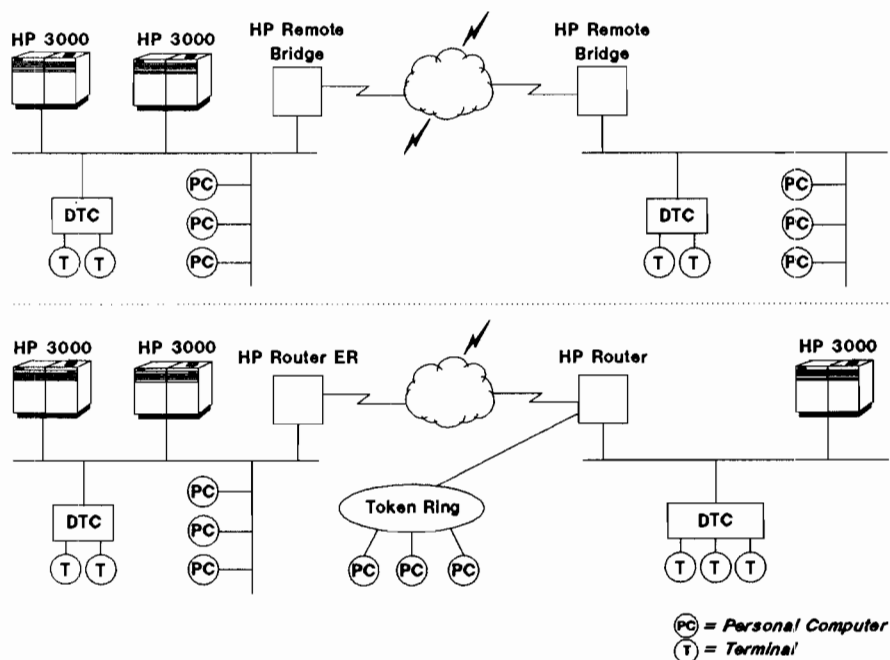
Figure 5-7. Multisite and Multisubnet Connectivity

Wide Area Networking

NS Point-to-Point Link

The NS Point-to-Point Link provides the network connection to allow an HP 3000 system to communicate with another remote HP 3000. It includes a Programmable Serial Interface (PSI) for 900 Series systems as well as transport software that performs the functions specified in layers one to four of the OSI reference model. NS Point-to-Point Link, in conjunction with NS, allows systems to communicate over wide areas using modem connections.
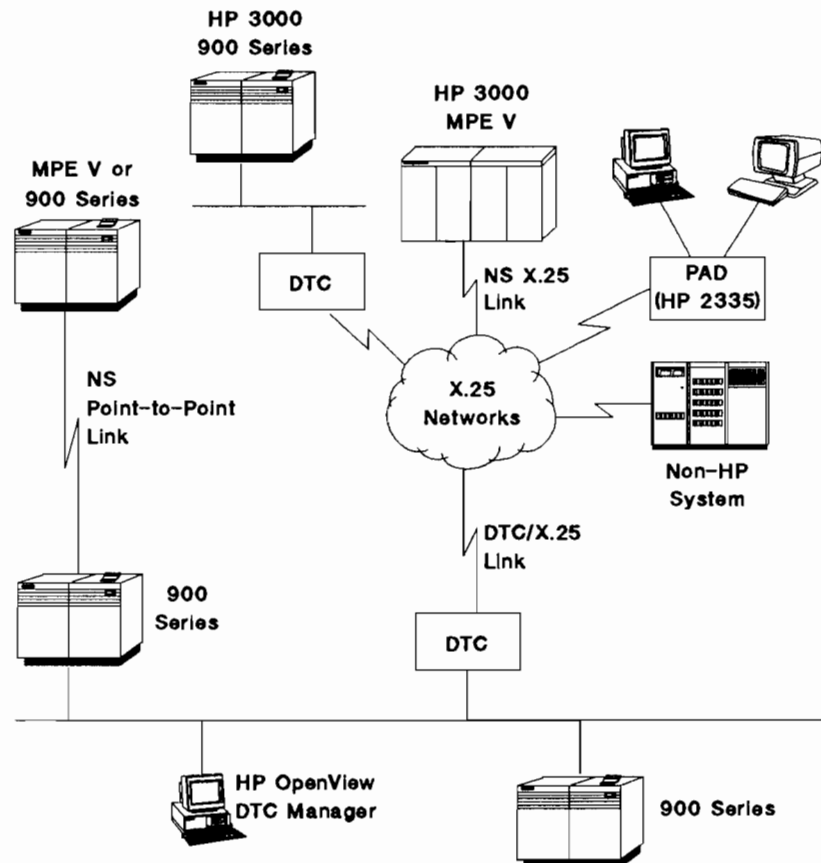
Figure 5-8. Network Services over a WAN

HP DTC X.25 XL Network Link

The HP DTC X.25 Network Link lets systems and remote PAD device users access the HP 3000 900 Series systems using X.25. Because the link is integrated with the DTC, communications overhead is offloaded from the HP 3000, thus increasing overall host availability for other functions. With this hardware and software link, HP 3000s can connect to either public or private X.25 packet switching networks. The HP 3000 can access remote printers and terminals connected to an X.25 PAD.

HP now offers the user two X.25 management solutions, PC-based X.25 management and host-based X.25 management, to choose from to best meet their X.25 needs. The user is provided with an easy growth path between the two solutions, as well as full integration.

PC-based X.25 management is for users with multiple systems on the same LAN and multiple types of devies (that is, DTCs, switches, and PADs—and soon bridges and hubs). For users with this type of environments, the PC-based X.25 management provides a centralized and thus cost-effective solution as the cost of the PC workstation is shared among multiple network management applications.

Host-based X.25 management enables an HP 3000 user to manage an X.25 link from an XL host instead of a PC. Host-based X.25 management is limited to single-system use of the X.25 card. Therefore, host-based X.25 is for users that have one system on a LAN. For users with this type of environment, host-based X.25 management provides a single operator with the capability to configure a system, asynchronous ports, and X.25 links from the operator's console. Host-based X.25 management is scheduled for release on 3.1 (for 9X7 systems only) and for general release in mid-1992.
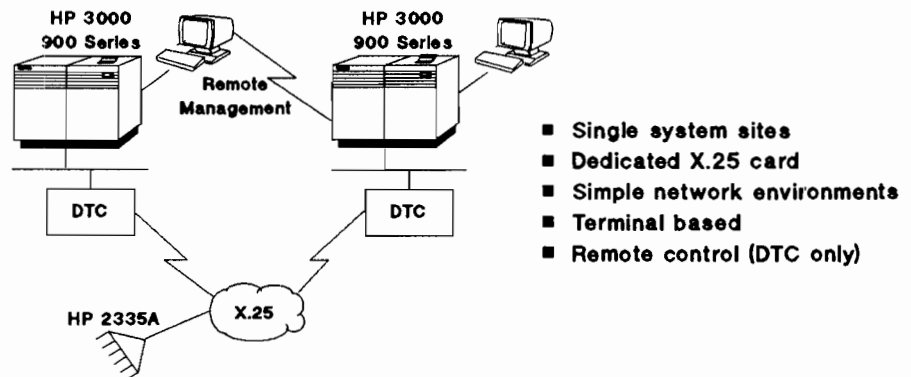
Figure 5-9. Host-Based X.25/XL
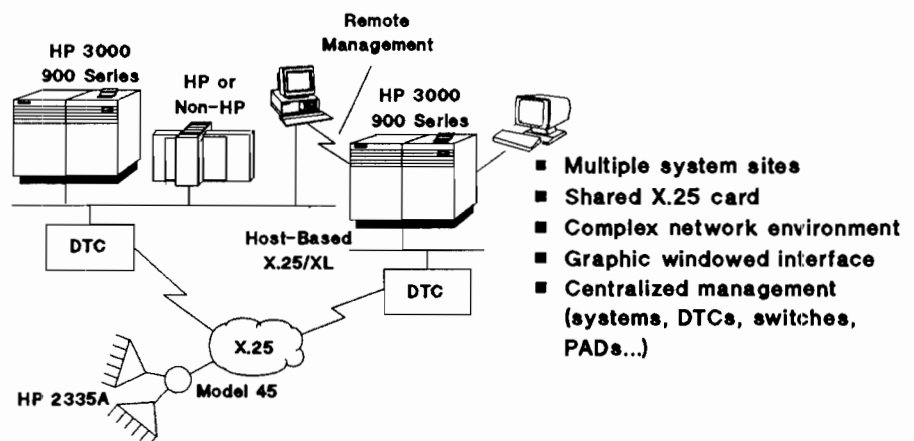
Figure 5-10. HP OpenView PC-Based

Open Wide Area Networking

The Hewlett-Packard open wide area networking solution is the foundation for open system networking. It uses X.25 packet switching technology, one of the most widely and highly developed international technologies. The HP open wide area networking product family includes cost-effective, entry-level products such as the HP2335A asynchronous PAD and the HP Model 45 X.25 switch and multiprotocol PAD. They are typically used to build turn-key solutions for connecting remote terminals and printers to central systems and to concentrate multiple X.25 access lines as well as IBM SNA/SDLC and BSC access lines to one or more systems. Also, multiple Model 45s can be interconnected to build a private X.25 network linking multiple and distributed sites.

The product family also includes the HP OpenView Switch/PAD Manager application to manage HP 2335As and HP Model 45s from an HP OpenView PC. Since this application fully coexists with the OpenView DTC manager on the same platform, it provides a real and integrated system and network management solution under the OpenView umbrella. (Please refer to "HP OpenView Switch/PAD Manager" in the "Integrated Systems and Network Management" section for more information).

The key advantages of using the HP open wide area networking solution include line and equipment cost savings (typically 30 percent to 50 percent) and single point of control for both HP systems and networking equipments through the use of the HP OpenView PC station.
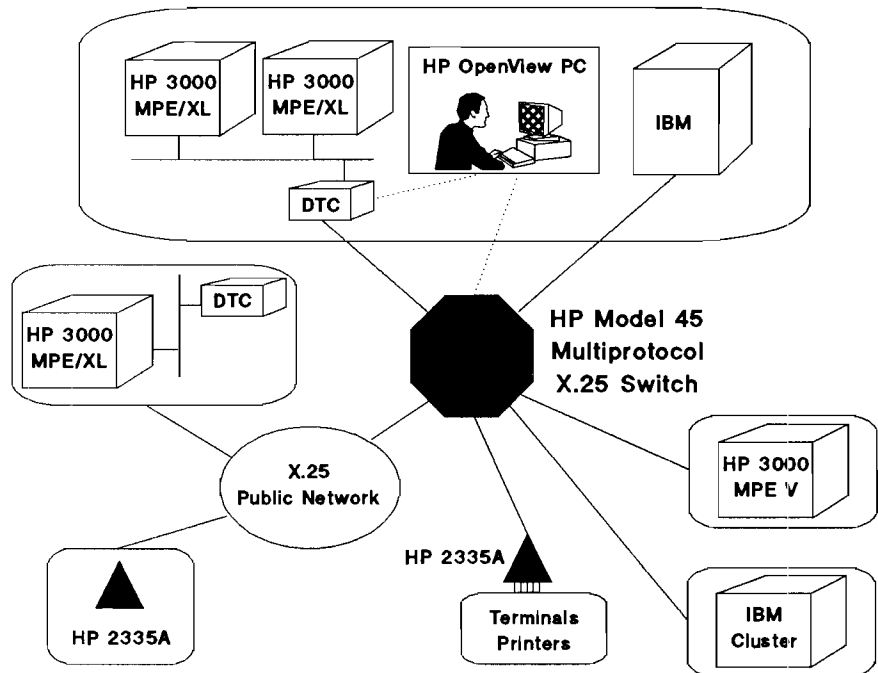
Figure 5-11. Open Wide Area Networking

HP 2335A X.25 Multiplexer

The HP 2335A X.25 Multiplexer is a high-performance standalone device providing connections for up to 16 terminals, printers or PCs in terminal emulation mode to one or more remote HP 3000 using one X.25 link. The HP 2335A operates as an X.25 PAD to connect asynchronous devices over a public or private network to remote systems. Also, it can be used as a statistical multiplexer over a leased line. Finally, the HP 2335A can be connected to various systems including the HP 3000, HP 9000, and HP 1000 systems as well as Digital VAX systems.

HP Model 45 X.25 Switch and IBM PAD

The HP Model 45 is a high-performance, cost-effective X.25 switch providing connections for up to 20 devices. It can operate as an X.25 concentrator for remote X.25 device access (2335A, HP or non-HP systems) to one central system such as an HP 3000 900 Series. Also, it provides one single access point to an X.25 public network for multiple systems, thus reducing the communication bill. More, because the Model 45 supports not only the X.25 standard but also IBM's proprietary SNA/SDLC and BSC's protocols, it is easy to build a real HP/IBM multivendor system and network environment based on Model 45s. Finally, several HP Model 45s can be interconnected to build a cost-effective, private X.25 network linking multiple and distributed sites.

HP 3000-to-IBM Communications

Hewlett-Packard offers a broad range of communications products that connect HP and IBM systems, which provide interactive, batch, and programmatic communications capabilities. Multiple alternatives exist for HP to IBM interoperability, including SNA, binary synchronous communications (BSC), and X.25.

BSC communication

BSC Remote Job Entry

BSC Remote Job Entry (BSC RJE) software emulates IBM 2780 and 3780 workstations on HP 3000 systems. BSC Link manages the data communications protocol and link between the HP 3000 and the IBM-compatible mainframe and communications controller. BSC RJE users can transmit batch jobs and receive output from a host processor supporting standard IBM 2780/3780 devices. Also BSC RJE users can exchange files with another HP 3000 or other processors that emulate standard IBM 2780/3780 devices.

IBM Mainframe

```
┌─────────────────────────────────────┐
│  ┌───────────────────────────────┐   │
│  │      Job Entry Systems         │   │
│  └───────────────────────────────┘   │
└─────────────────────────────────────┘
                    │
            ┌───────────────┐  Front End
            │     NCP        │  Processor
            └───────────────┘
                    │
┌─────────────────────────────────────┐
│              BSC Link                 │
├─────────────────────────────────────┤
│                RJE                    │
├─────────────────────────────────────┤
│      HP 3000 MPE V or MPE/XL          │
└─────────────────────────────────────┘
```
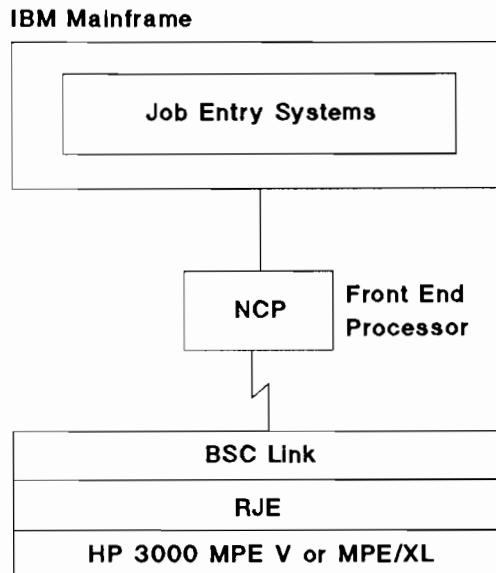
Figure 5-12. BSC Communication

SNA communication

The HP 3000 supports a broad range of SNA services providing interactive, batch, and program-to-program communication. These services work in conjunction with SNA Link, which provides the physical interface and lower layer SNA software for SNA network communication. A single SNA Link can concurrently support all SNA services. Products with an XL suffix are available only on the HP 3000 900 Series.

SNA IMF

SNA Interactive Mainframe Facility (IMF) resides on an HP 3000 and allows access to 3270 applications on the IBM mainframe. In

programmatic mode, application programs on the HP 3000 emulate IBM 3270 terminals and printers, exchanging data with the IBM host using intrinsics (user-callable procedures). In PassThru mode, users of HP terminals and printers can access 3270 applications on the host as if they were using IBM 3270 displays and printers.

SNA NRJE

SNA NRJE allows HP 3000 users to submit batch jobs and transfer files between the IBM mainframe and the HP 3000 system. Additionally, SNA NRJE allows routing of the job output from the IBM host to any standard output device on the HP 3000 , such as tape units, disk files, and printers. SNA NRJE emulates an IBM 8100 DPPX/RJE workstation.

SNA LU6.2 API

SNA Logical Unit 6.2 Application Program Interface (LU6.2 API) gives HP 3000 users program-to-program communication between an HP 3000 and an IBM mainframe in an SNA environment. With SNA LU6.2, HP 3000s and IBM mainframes can automatically prompt each other to start a program or send data. LU6.2 API also allows customers and third-parties to develop HP 3000 applications that use the LU6.2 protocol. Peer-to-peer communications (LU6.2 over PU2.1) will be supported on the HP 3000 900 Series system in 1991.

SNA DHCF/XL

SNA Distributed Host Command Facility/XL (DHCF/XL) allows users with IBM 3270 terminals to access interactively many applications on a 900 Series system through their SNA network. SNA DHCF is supported with both TTY-line-mode and HP VPLUS block-mode applications. SNA DHCF/XL can support up to 120 concurrent sessions.

IBM S/370 Mainframe (MVS, VM, DOS/VSE)

Job Entry Subsystem	LU6.2 Applications	3270 Applications	HCF	DISOSS

VTAM

IBM 3745
Communications
Controller

X.25

DTC

SNA/X.25 Link/XL	SNA/SDLC Link/XL

SNA Transport (included with link)

| SNA DHCF/XL | SNA NRJE/XL | SNA IMF/XL | LU6.2 APPC | NS/SNA |

			LU6.2 API/XL		NS Network Services
MPE/XL			Applications 3270 or LU6.2	SNADS	
					HP DESK
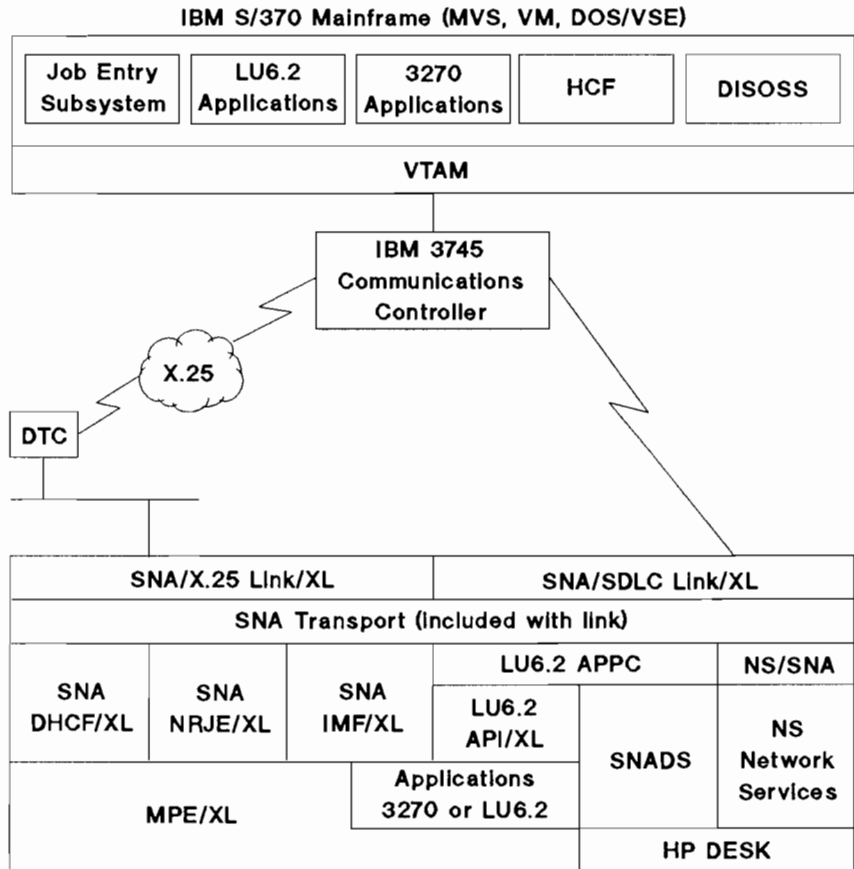
Figure 5-13. SNA Communications

X.25 or SNA backbone

HP SNA/X.25 Link/XL (SNA over an X.25 backbone) and HP NS over SNA/XL (NS over an SNA backbone) provide the choice of supporting and managing only one network backbone for HP-to-HP, IBM-to-IBM, and HP-to-IBM communications. If the environment is primarily IBM, NS over SNA/XL provides an economical way to leverage an existing SNA network. If the environment is multivendor and includes a variety of systems, SNA/X.25 Link/XL provides standardization on an X.25 network, the OSI/ARPA standard.

NS SNA/XL

NS over SNA/XL is a cost-effective way for HP 3000 900 Series users to implement NS services over an existing IBM SNA backbone network. NS over SNA/XL requires NS3000/XL Network Services and SNA/SDLC Link/XL. SNA/SDLC Link/XL manages the physical link to the IBM host and implements the lower three SNA protocol levels. Running both SNA/XL and NS/XL services over the same SNA network connection reduces overall networking costs by using the SNA network for NS backbone traffic. NS can run over SNA/XL simultaneously with other HP SNA service products, such as SNA IMF or SNA DHCF/XL over the same network connection.

HP SNA X.25 Link/XL

HP SNA X.25 Link/XL reduces networking costs by consolidating NS and SNA services on one X.25 link, while allowing access to multiple destination host systems. Fewer communication links are needed, resulting in decreased monthly telecom costs and a simpler, more manageable network. SNA X.25 Link/XL software supports HP SNA Services over an X.25 network. The HP 3000 900 Series systems communicate with the X.25 network using the DTC. The target IBM system can be accessed from either the X.25 network using an HP Model 45 Multiprotocol X.25 Switch or using the IBM X.25 Network Packet Switching Interface (NPSI).

NetView integration

The SNA/SDLC Link/XL product provides link-level alerts to IBM's network management product, NetView. If an HP 3000 900 Series system goes down, the SNA/SDLC Link/XL will send a delayed link-level alert to the NetView console when the link comes back up. This feature also allows an operator on the HP node to send an operator-generated alert to the NetView Console.

Electronic mail integration

HP SNA Distribution Services/XL (HP SNADS/XL) allows users on HP systems to exchange electronic messages between HP DeskManager and IBM Office Vision/MVS (DISOSS). HP SNADS/XL is required on only one HP 3000 Series 900 system in an HP DeskManager network. HP Desk users on the HP 3000 can transparently send messages and documents of PC files to IBM DISOSS users. Messages can also be exchanged with users of other vendor's electronic mail systems who are connected to the corporate IBM host using IBM SNA/DS.

IBM does not support SNA/DS for PROFS on VM mainframes; however, HP Deskmanager can access PROFS through HP X.400. Please refer to the "OSI services" section for more detail on X.400 connectivity.

Computer Museum

Integrated Systems and Network Management

HP OpenView is a broad family of products and services designed to meet the diverse needs of managing multivendor networks. The HP OpenView architecture is the foundation for the open, modular, distributed solutions for today's and tomorrow's multivendor network and system management problems. HP OpenView products and services provide a broad spectrum of network and systems management solutions. HP OpenView can cut costs and improve network uptime by providing integrated, centralized management of multivendor networks and networked HP 3000 systems.

HP 3000, DTC, LAN, and WAN network management products are integrated through the powerful HP OpenView Windows User Interface, which provides a centralized, graphical console.

HP OpenView provides flexible, distributed network management. It is based on industry standards that HP is helping develop as a cofounder of the OSI/Network Management Forum and by participating in the Internet Engineering Task Force on TCP/IP.

HP's network management addresses fault, configuration and change, performance, security, inventory, and accounting management for both systems and networks. These are based on the OSI Management Framework and HP's experience with customers.

HP's full line of network management support services completes the HP OpenView offering assisting organizations at all stages of the network life cycle: planning, implementation, operations, and maintenance. Support services can be tailored to specific customer requirements, helping manage network complexity and operating costs.

HP OpenView development environments

HP OpenView Windows/DOS

HP OpenView Windows/DOS provides presentation services for network management applications in a common view of the network. HP OpenView Windows/DOS displays a network map that shows the status of the network elements. Multiple applications written for different network elements are integrated through the network map. For network managers, HP OpenView Windows/DOS is a central point for executing all network management tasks, regardless of which vendor's equipment is being managed. For network management application developers, HP OpenView Windows creates easy-to-use applications that have a consistent look and feel.

HP OpenView Network Management Server

HP OpenView Network Management (NM) Server is an open, standards-based environment for network management application development. Software developers use this development environment to create comprehensive network management applications. The environment contains a fully documented and supported set of APIs. The use of common APIs protects these applications as emerging technologies and standards are incorporated within this development environment.

Network and systems management

HP OpenView System Manager

HP OpenView System Manager allows operators to monitor and control multiple networked HP 3000s from a central console. As networks of systems grow increasingly large and complex, the number of technical people needed to manage those systems also grows. In order to control costs and simplify operations, businesses are making efforts to centralize management of their networked systems. By consolidating operations control and expertise, HP OpenView System

Manager allows businesses to increase operator efficiency while reducing operations cost.

Managing systems in both local and wide area networks, HP OpenView System Manager provides the key to efficient operations: management by exception. Management by exception frees operators from the burden of monitoring every system console message. Instead, operators are notified only when a problem that they are truly interested in occurs. By allowing operations departments to define which problems to track, HP OpenView System Manager eliminates unnecessary notification, allowing fewer operators to manage more systems.

When problems are detected that require action, HP OpenView System Manager provides operators with full console access to one or more of their distributed HP 3000s from a central console. Operators can execute any console command and receive console messages just as if they were sitting in front of the local system console. Using the console control capability, operators can control system shutdown (Control-A), system restart (Control-B), MPE command execution (for example, restarting network), and applications.

HP OpenView Network Node Manager

The HP OpenView Network Node Manager is an end-user solution for the network and systems management of multivendor TCP/IP networks on a site or campus using the Simple Network Management Protocol (SNMP). Using OpenView Network Node Manager, network administrators can understand the health of their network at a glance. With innovative capabilities, including Discovery, Single-View Management, and the Application Builder, OpenView Network Node Manager greatly reduces the time and effort users must spend managing their networks. These automated and dynamic network management features solve the critical problems customers face deploying networks today. The HP 3000 900 Series will support SNMP during 1991.

HP OpenView DTC Manager

HP OpenView DTC Manager, running on HP OpenView Windows/DOS, is the network management product used for managing local and remote DTCs. From a central management station, the network administrator can configure, control, monitor, and diagnose DTCs, as well as update DTC software. This product also increases the productivity of the network administrator, thanks to the remote management functionality and the easy-to-use graphical interface based on HP OpenView Windows.

HP OpenView PC-based management is targeted at multisystem multivendor sites where there is a need to control network equipment from one workstation. HP OpenView PC can now control DTCs and switches—and soon bridges and hubs. This is a very cost-effective solution as the cost of the PC workstation is shared among multiple

network management applications and the X.25 link is shared among multiple systems.

NetCI

NetCI, the NS remote command interpreter, allows a single operator to execute commands on any remote system without having to manually establish a remote session. Remote command execution can be interactive or contained in script files. The output from the command execution may be stored in log files for later analysis. NetCI reduces troubleshooting time, minimizes the effort needed to interact with networked HP 3000s, and reduces the need for remote operators.

NMMGR

The NMS configuration manager (NMMGR) is a menu-driven configuration utility that is used to create and enter information into a configuration file. The information in the configuration file is then used by the datacommunication products on the network to determine their operating characteristics.

Local Area Network management

HP OpenView Bridge Manager for DOS

HP OpenView Bridge Manager centrally monitors and controls HP local and remote bridges. Capabilities include automatic discovery of the network configuration; collection, logging, and graphing of network performance data; selective address filtering for enhanced network security; and control of IEEE spanning tree parameters to explicitly assign primary and backup bridges. Bridge Manager runs on an HP OpenView Windows/DOS workstation.

HP OpenView Hub Manager for DOS

HP OpenView Hub Manager provides central management of the EtherTwist Hub Plus in a local or extended IEEE 802.3 or Ethernet environment. HP OpenView Hub Manager automatically discovers and displays the network configuration, monitors, and graphs network traffic conditions, helps identify and diagnose network problems, enhances network security, and increases network reliability by controlling hubs and individual links. Hub Manager runs on the HP OpenView Windows/DOS workstation.

LAN Probe

LAN Probe distributed analysis system lets network managers monitor all critical aspects of a remote or local network from one central vantage point. LAN Probe tracks Ethernet LAN problems including those related to the cable, communications software, traffic load, equipment malfunction, and even user error. As an integral and natural part of the network, the LAN Probe system provides a

comprehensive and informative view that is key to confident network management.

LANDIAG

The LAN Node Diagnostic (LANDIAG) is an online diagnostic tool that verifies the LANIC components by running the LANIC self-test, as well as a series of diagnostics, as far into the LAN as possible. LANDIAG testing includes a remote node test that sends and receives test frames between nodes.

Wide Area Network management

HP OpenView Switch/PAD Manager

The HP OpenView Switch/PAD Manager is a network management application to remotely configure, monitor and control an X.25 network based on HP 2334As, HP 2335As and HP Model 45s. It runs on the OpenView Windows/DOS workstation and fully coexists on the same platforms with other HP OpenView applications such as the HP OpenView DTC Manager. Therefore, from a single and central point, both systems and X.25 networking equipments can be monitored and controlled.

HP OpenView Data Line Monitor

HP OpenView Data Line Monitor automatically monitors leased point-to-point analog lines while they are in service. It also detects lines that are performing outside preset alarm limits. Lines on the HP OpenView network map change color to indicate line status. If an alarm is detected, a message containing the line descriptions and line transmission limits is displayed. HP OpenView Data Line Monitor runs on an HP OpenView Windows/DOS workstation.

Performance management

HP LaserRX and HP Glance Plus provide detailed information about network node activity—the system and application processes that generate load on the network. These tools, which provide important insights for network performance management are described in detail in Chapter 3, "HP 3000 Operating Environment".

Application integration

HP Software Integration Sockets

HP Sockets is a software tool that enables the seamless integration of applications at the data level. With this tool, integration can be achieved with little-to-no modification of the applications. Thus, it is especially useful in existing environments wishing to reap the benefits of seamless integration that they have been otherwise not able to achieve. HP Sockets is also useful when a new application is brought into an existing environment that may or not be integrated. Because of the non-intrusive nature of this tool, integration is possible in about half the time, with half the coding and half the skill set that would be otherwise needed.

Conceptual View
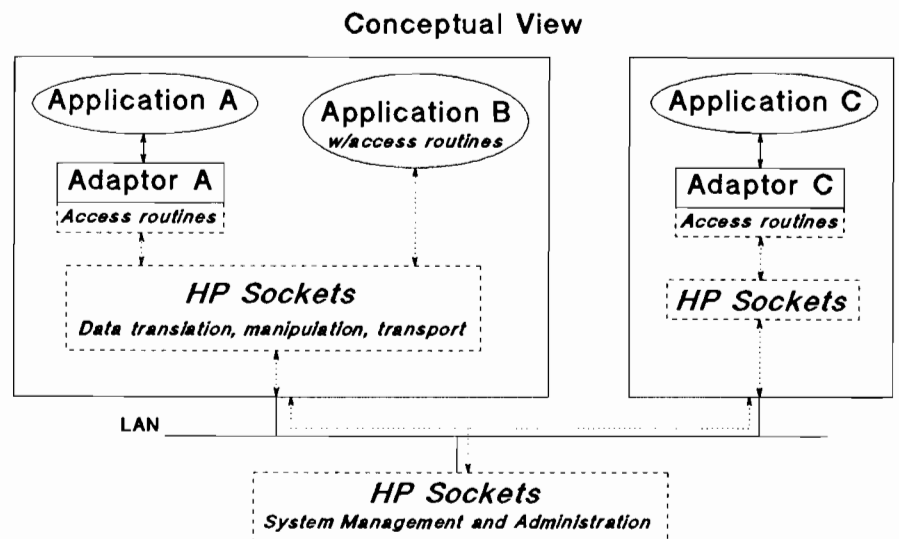
Figure 5-14. HP Software Integration Sockets

There are three obstacles to be overcome in order to achieve seamless integration: data access, data transportation, and data compatibility. HP Sockets resolves the data transport and compatibility obstacles and helps resolve the data accessibility obstacle.

Key features of HP Sockets are as follows:

- Comprehensive program-to-program communication—all the functionality required to move and guarantee delivery of both messages and files among applications is included.
- High performance data manipulation, translation, and record reformatting—differences in data caused by database incompatibilities, file structure incompatibilities, languages, data types, processors, and the applications themselves are resolved in realtime.
- Adaptor-based data access—adaptors, programs written to access application data and pass it to HP Sockets using 12 HP Sockets

access routines, allow data access with little-to-no modification to the application and insulate the developer from the specifics of network.

- System management and administration—the part of HP Sockets that runs in a background mode on existing supported equipment and allows system managers full control of their integrated environment.
- Command processor and data/error logging—tools to assist in the development and debugging of integrated environment.

HP Sockets runs on the HP 3000 900 Series and HP 9000 family. An IBM/MVS gateway product is also available. Adaptors may be written in Cobol, C, Fortran, and Pascal. It requires Network Services and a C compiler on at least one of each processor type in the HP Sockets environment.

As a NewWave Computing technology, HP Sockets is complementary to other products such as NewWave Office, NCS, and so forth. It is the integrating technology that supports industry marketing architectures like OpenCIM, OpenStore, and State and Local Government.

6
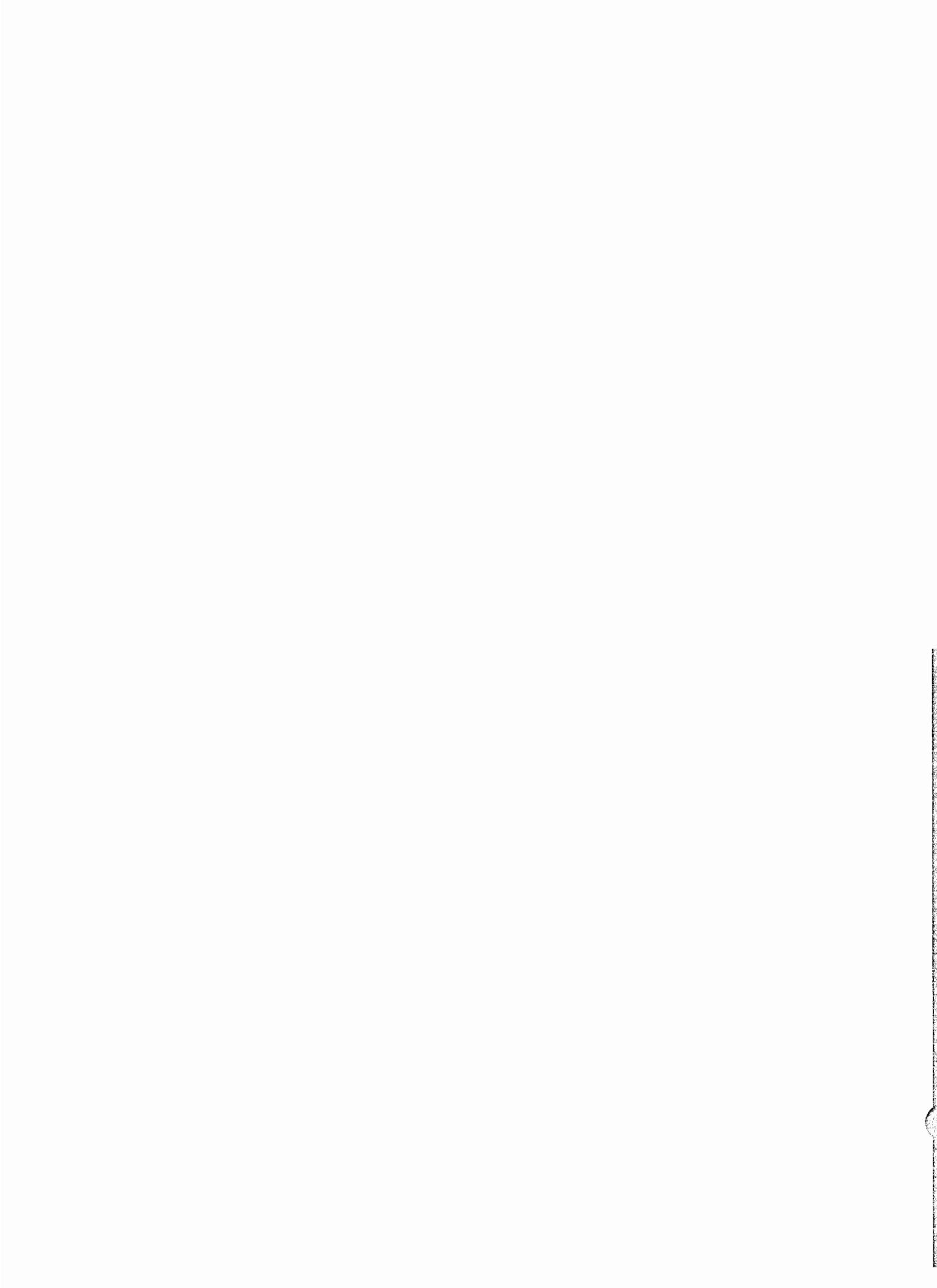
Office Information
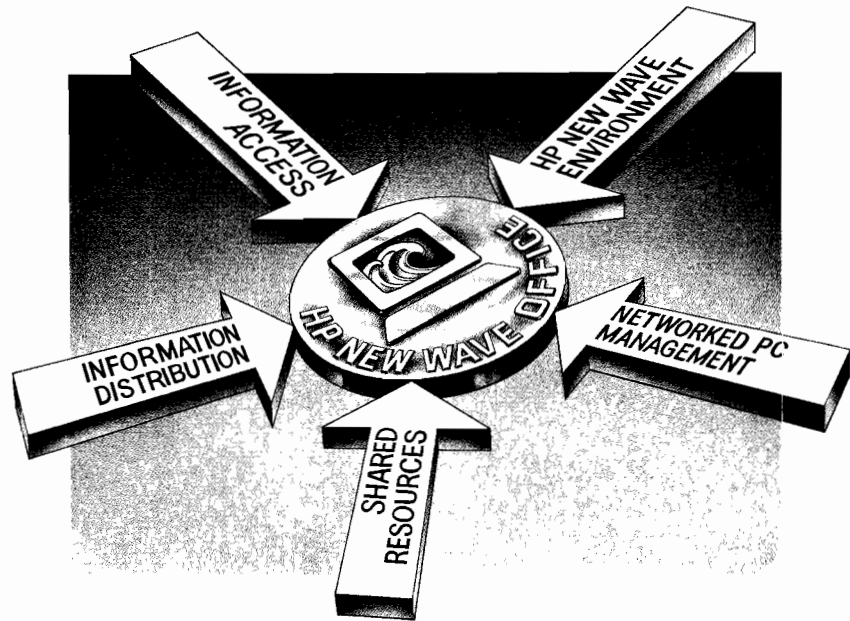
HP NewWave Office

Figure 6-1. HP's Office Framework

HP NewWave Office delivers an industry-leading, open systems solution with powerful communication, decision support, and information sharing services on multiple platforms. Building on standards, HP NewWave Office delivers solutions that allow customers to manage the flow and use of information using their choice of applications. More than office software, HP NewWave Office solutions enable organizations to build powerful workgroup applications that meet the business intelligence document management and process automation needs.

A key component of the HP NewWave computing strategy, HP NewWave Office breaks down technology barriers, allowing organizations to use information to their fullest advantage.

- Endusers can create flexible, open information systems that bridge islands of corporate information from PCs to mainframe systems.
- HP NewWave Office extends HP's leadership in PC integration. Users can integrate the PC software of their choice from Hewlett-Packard and other vendors. They can establish meaningful links between their favorite PC applications that were not originally designed to work together.
- The HP NewWave Agent capability provides a means to easily automate tasks across applications. Agent tasks can be rapidly

built for individual solutions or workgroup applications that span networks of PC users, integrating the user's choice of application software in the process.

- PCs are linked into networks that offer consistent capabilities across a full range of server (MPE, HP-UX, SCO UNIX, OS/2) and network (LAN Manager, NetWare, MS-NET) platforms.
- HP NewWave Office automates the management and control of PC applications with centralized software distribution and update, and simplified installation processes that help administrators maintain license control of their organizations' PC software. Administrative agent tasks can be created to help system and network administrators manage corporate-wide information systems.

HP NewWave Office offers a single integrated family of products that deliver a complete cooperative computing software solution. NewWave Office is a flexible solution that allows users to choose the combination of services that their organization needs today and that gives them the ability to add services incrementally as needs grow. HP NewWave Office 3.0 functionality can be divided into two areas:

Enhancement of Core Services

- HP NewWave environment
- Information Access Services
- Information Distribution Services
- Shared Resources
- Networked PC Software Management
- Electronic Image Management

Integration of leading applications from ISVs Wave Group Developers with HP NewWave Office core services to provide complete business solutions for three Office Information Systems (OIS) applications:

- Business Intelligence
- Document Management
- Process Automation

HP NewWave Office supports industry-standard PCs and UNIX and Apple Macintosh workstations. Users can choose from a variety of local area networking options or asynchronous connections. In all, Hewlett-Packard's NewWave Office provides the flexibility to build an organizational information system that is tailored to meet the needs of individual users.

HP NewWave   HP NewWave is an easy-to-use PC environment for integrating applications and automating tasks. The breakthrough behind HP NewWave is the object management facility (OMF), which links data and applications together so that users can move effortlessly among many different kinds of software. This high level of integration allows users to create documents using text, spreadsheets, graphics, and image data drawn from different applications. Equally important, changes made in the output of one application are automatically reflected in the output of others.

Beyond all this, HP NewWave offers computer-based training, an online Help facility, and a consistent and predictable graphical user interface for ease of learning, ease of use, and ease of access to the full range of HP NewWave Office services.

HP NewWave offers flexibility and choice in a PC environment. Using an industry-standard PC, popular MS-DOS and MS-Windows applications are easily integrated into the HP NewWave environment. Future applications can be added without worrying about compatibility.
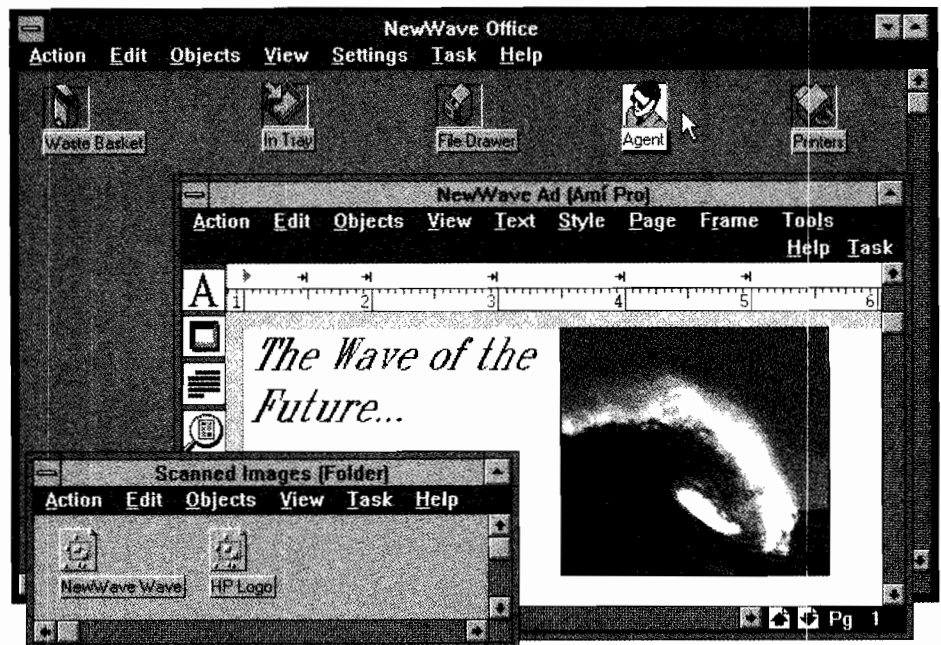
Figure 6-2. HP NewWave screen

Key capabilities

The first thing that a user sees when starting HP NewWave is the Office window. It is modeled after real office functions for ease-of-use and is the starting point from which the user creates, files, copies, deletes, and renames objects.

In HP NewWave, an *Agent* automates tasks. An Agent is analogous to a spreadsheet macro, only it does much, much more. An Agent can record sequences of tasks in one or more applications for later playback. Playback can be triggered manually or can be scheduled to happen at any time on any day. Agent tasks can also be edited. MIS departments can use this sophisticated Agent facility and task language to create advanced Agent tasks that can be given to users to run on individual personal computers. For example, an Agent task can start the HP NewWave Information Access application, download information from a remote source into a spreadsheet, generate a graph of the data, incorporate the graph into a document, and then mail the document through HP NewWave Mail.

Information Access services

HP NewWave Office's Information Access services allow users to select a broad range of data sources on the HP 3000 or PC and to output the data to PC applications of their choice. HP's NewWave Office Information Access services consist of an easy-to-use client interface on the user's PC and a data server on the HP 3000. With Information Access, decision makers spend less time gathering and reentering data and more time analyzing and solving business problems.

On the PC, there are two interactive interfaces available that allow users to join, select, sort, summarize, and convert data and then to incorporate the results into spreadsheets, graphics, and word processing applications.

For HP NewWave users, the HP NewWave Access PC component provides an intuitive, graphical interface to database information that fully utilizes the ease of use and power of HP's NewWave environment. Using the intuitive graphical interface of HP NewWave Access, users create "data view" objects that can easily be modified or updated. Leveraging HP NewWave agents and data links, users can automate and schedule routine data retrieval tasks and have the resulting data inserted into PC applications. HP NewWave Access also provides an SQL window, graphical join editor, and agent task language to help MIS professionals build customized information systems.

The Information Access PC client is a softkey, character-based interface supported in the MS-DOS environment or encapsulated within the HP NewWave environment. The built-in report writer can be used to generate professional looking reports without involvement from the database administrator. A batch processing feature is also available, allowing repetitive tasks (such as generating routine reports or queries) to be fully automated. Within the HP NewWave

environment, these tasks can be scheduled and executed by the HP NewWave agent.

On the HP 3000, administrative functions are provided to control access to the data sources. For non-relational data (TurboIMAGE databases, KSAM, SD, and MPE files), a softkey-driven utility is included with the HP 3000 server allowing the database administrator to specify which new data tables and combination of existing data tables PC users can access. Relational databases (HP ALLBASE/SQL and ORACLE) provide these same administration functions as an integral part of the database management system. In either case, database administrators can satisfy user needs for accessing data while maintaining central security and control of the data sources.

Information distribution services

HP DeskManager

HP DeskManager provides the information distribution and messaging services of HP NewWave Office on the HP 3000. HP DeskManager provides an organization with a cost-effective communications server. Users can distribute any information, whether it is a simple message, a file created on a personal computer, or data processing information.

In addition to distributing information and messaging services, there are a number of features to optimize user productivity. Electronic filing provides users with easy access to information, and time management facilities enable users to organize their time in the most efficient way. Customization options allow individual users to decide how they would like to have their electronic office work, and the Suspend and Resume feature enables users to manage the interruptions of normal office work. At all times, HP DeskManager provides these capabilities while maintaining system security and ensuring confidentiality of information when required.

HP DeskManager integrates with a range of complementary applications that add to its benefits. HP AdvanceMail and HP NewWave Mail integrate the personal computer user with HP DeskManager. They provide users with the ability to work in the familiar PC environment and to communicate to the rest of the HP DeskManager network and beyond. These applications are key components of Hewlett-Packard's leadership in PC integration.

PC Mailing with HP NewWave Mail and HP AdvanceMail

HP NewWave Mail is a fully integrated NewWave application that provides mail services. HP AdvanceMail is the information distribution service for DOS PC users.

Both applications provide electronic mail (E-Mail) facilities while integrating with popular PC applications and delivering consistent PC performance. In addition, they provide the PC user with a

transparent link to other users on a network-wide basis through Hewlett-Packard's electronic mail servers—HP DeskManager and HP OpenMail.

The close integration of the PC with the mail server gives users the best of both worlds. They can use the power and ease of the PC in combination with the communication and distribution capacity of the HP 3000 and HP DeskManager.

HP NewWave Mail and HP AdvanceMail have a rich set of PC mail functions, including forward and reply capabilities, priority mailing, and new mail notification. In addition to sending and receiving any object by any user, the software allows automatic, background message transfer; full distribution list checking; automatic file conversion; and the ability to filter mail on predefined criteria.

HP NewWave Mail and HP AdvanceMail minimize the use of host resources by allowing the user to perform many functions, such as creating, reading, printing, and editing messages, without ever making a connection to the server. The only time a server connection is needed is to send or receive mail.

PC investments are protected and enhanced through the support of a wide range of file types, which allows the user to send, receive, and even convert files from existing PC applications. These file types include binary, text, Graphics Gallery, Lotus 1-2-3, NewWave Objects, HP, and other word processor file types. Additionally, HP NewWave Mail and HP AdvanceMail further enhance PC investments by integrating popular word processors with these PC E-Mail products.

HP NewWave Mail, HP DeskManager, and HP AdvanceMail users can all exchange information with each other. They can read, print, and, in many cases, edit the information whether they are using a terminal or a PC. This means that NewWave users can be added to an existing system, protecting the original investment.

HP 3000 connections can be made quickly and easily by means of connection files configured in HP NewWave Mail and HP AdvanceMail. This built-in flexibility is available whether the PC is directly connected to the host computer with a LAN or by X.25 communications. In a LAN environment, Network Services/XL is used on the PC to connect it to the HP 3000.

HP NewWave and DOS PC users can connect to outside users on other systems through the mail server. These connections include communicating to users on IBM systems using SNADS, to multivendor systems using X.400, to telex users using HP Telex, and to fax users via HP OfficeFax.

HP DeskMon

HP's DeskMon is a comprehensive network monitoring system that checks the status of the entire HP DeskManager network from a single location. HP DeskMon checks the HP DeskManager network

as often as is required, automatically initiating the monitoring process at preconfigured times. Additionally, HP DeskMon can be configured to monitor applications external to HP DeskManager.

The administrator can be notified of system exceptions through message output to a specified console (local or remote), a printer, or a designated HP DeskManager user and can take immediate action.

Minimal overhead is required on the host machine to take advantage of these benefits, and no changes are required on the existing HP DeskManager database configuration. HP DeskMon reduces the time an administrator needs to spend monitoring the HP DeskManager system. The administrator's only responsibility is to configure the processes that need to be monitored and then to ensure that reported exceptions are either corrected or noted. This leads to lower administration costs and more efficient use of the HP DeskManager system.

HP DeskManager intrinsics

HP DeskManager intrinsics are a set of tools that facilitate the integration of application data to the HP DeskManager's mailing and diary functions.

HP DeskManager intrinsics add value to HP DeskManager users by delivering exception reports to decision makers. For example, exception reporting through the use of HP DeskManager Intrinsics could trigger an automatic desk message to a purchasing manager when inventory drops below a predetermined level. The purchasing manager could then take immediate corrective action.

HP DeskManager Intrinsics also provide the ability for application data to be transparently connected to the HP DeskManager diary. This allows for the development of an automatic scheduling system, where, for example, an insurance claims processing application could automatically send all of the claims that need to be updated on a particular day to the correct claims administrator. The claims would appear as "To Do" items within that administrator's HP DeskManager calendar area.

HP DeskManager intrinsics are also the recommended method of connecting foreign E-Mail systems to HP DeskManager, providing an open interface to many other vendors' E-Mail systems.

HP OfficeFax

HP OfficeFax provides HP DeskManager with the ability to send faxes to anyone with access to one of the over ten million Group III facsimile machines and compatible devices around the world.

Sending faxes from the HP DeskManager environment is easy, as the software uses the familiar E-Mail interface of either HP DeskManager, or for PC users, HP AdvanceMail or HP NewWave Mail. Text and graphics in the form of Graphics Gallery files can be sent out, and the system will automatically track the information

being sent, so that the sender is notified if, for example, the line is busy and the fax is unable to be transmitted to the requested destination.

Incoming faxes can also be received on the system. The administrator has the option of printing the faxes on an HP LaserJet or HP DeskJet printer and manually distributing the information, routing them to a local facsimile machine, or sending the information to the addressee as a TIFF file using HP DeskManager.

HP Schedule

With HP Schedule, meetings can be organized with other HP DeskManager users, even if they are on different computers, and at the same time, any resources that might be needed—from meeting rooms to corporate jets—can also be scheduled.

To schedule a meeting, HP Schedule examines the relevant electronic calendars and determines a list of potential meeting times within a specified range of dates. The user then selects a time, and HP Schedule sends appointment requests to all those concerned. Features such as reply tracking and automatic conflict reporting mean that the user always knows whether attendees have received the request and is automatically notified if someone schedules a conflicting meeting before all details are finalized.

HP Schedule accommodates noncalendar users, too. In the event that some of the necessary attendees do not use the HP DeskManager Calendar, HP Schedule places the meeting request in their InTray, so that they can either respond personally or reply with an HP DeskManager message.

HP File/Library

HP File/Library provides community filing and archiving for HP DeskManager. HP File/Library electronically indexes documents stored both inside and outside HP DeskManager. This means the entire workgroup can share documents and access the information they need to perform their jobs.

The HP DeskManager Library Area contains one or more shared or individually owned Catalogs, where documents can be indexed by up to eight attributes: Subject, Creator, File Type, Status, Create Date, Keywords, Author Name, and Comments. Keywords and Comments can be added to provide a unique item description for fast document retrieval. For example, the Keyword "Hazardous Chemicals" can be used to describe documents concerned with environmental pollution.

To find a document in the catalog, the user simply specifies as many attributes as are known about the document. Each catalog automatically maintains a keyword dictionary so that users know which keywords have been used. Search specifications can be saved to avoid retyping when requesting a frequently used document.

Connectivity

Hewlett-Packard is committed to providing E-Mail integration in a multivendor environment. This connectivity is provided through integration of the X.400 standard using HP X.400 for multivendor interoperability, or HP SNADS/XL for connections between HP DeskManager and an IBM SNADS network.

These connectivity products give customers more flexibility to choose the solutions that best fit their needs, while protecting their HP 3000 investment.

HP AdvanceLink

The HP AdvanceLink family provides comprehensive data communications, allowing the integration of terminal-based host applications with client/server and personal computer applications. It provides emulation of HP and DEC terminals, enabling access and execution of host software from the PC. Fast, reliable file transfer simplifies exchange of data between the PC and the host. Task automation facilities minimize the amount of work required to complete complex or frequent activities, improving productivity and reducing training needs. HP AdvanceLink is supported on a variety of personal computers and supports serial and LAN connections to the host computer.

The HP AdvanceLink family consists of three products that support four of today's popular personal computer environments:

MS-Windows

The multitasking capability of MS-Windows permits the establishment of multiple simultaneous host connections over serial or LAN links. Microsoft's DDE protocol, combined with HP AdvanceLink's powerful "Termtalk" command language, enables tighter integration of host applications with the PC. Host connections can be achieved using HP or 3COM LAN Manager, Novell NetWare with HP NetWare/XL, the HP NS LAN, or Gateway.

HP NewWave environments

HP NewWave environments offer further benefits beyond MS-Windows, and Hewlett-Packard offers you the choice of installing HP AdvanceLink either as an MS-Windows or a native HP NewWave application from a single set of disks. When you install it in the HP NewWave environment, additional user interface and task automation functions are enabled. AdvanceLink can then recognize and handle HP NewWave data objects, simplifying data transfer. The Termtalk command language has many features in common with the HP NewWave Agent language which are suited to data communications tasks. Using AdvanceLink within the HP NewWave environment provides the benefits of the sophisticated NewWave user interface and the powerful task automation capabilities, achieving a level of integration and interoperability that is impossible in other environments.

Apple Macintosh

HP's AdvanceLink's graphical user interface is common to all of the windowing environments (HP NewWave, MS-Windows, and Apple Macintosh), so you can use the same basic menus, keystrokes, and command language. In addition, HP AdvanceLink provides support for Localtalk to Ethernet gateways, enabling access to host applications from the Apple networking environment.

MS-DOS

The original and best-known member of the HP AdvanceLink family provides monochrome and color graphics terminal emulation in addition to block mode alphanumeric emulation, file transfer, and task automation.

Shared resource services

With shared resource services, available in the LAN environment, workgroups have easy access to HP 3000 peripherals from the PC. Using system shared disks, a workgroup can easily access and work on a common document, making the workgroup more effective. Sharing high-quality printers and plotters enables workgroup members to cost-effectively produce superior documents and presentation materials for a more professional image.

Shared resources services are supported over LAN Manager or NetWare networks.

Networked PC management

HP NewWave Office software management services administration tools provide distribution and management of Hewlett-Packard and other PC applications and files from a server to PC clients in a LAN environment.

An industry-leading approach to software management, networked PC software management services offer automated, centralized PC application installation, automated software updates, and software license tracking.

Software management services can greatly improve productivity by eliminating the manual PC software installation and update process, minimizing software configuration problems and reducing the amount of time required for PC software license auditing.

Application development tools

Hewlett-Packard also offers tools to integrate office functionality into your data processing environment.

LAN Manager/XL Named Pipes APIs for client-server application developers

The Named Pipes Application Program Interface (API) can be used by application developers as a standard communication interface for the development of client-server applications. Named Pipes provides two-way communication between the client, typically on a personal computer, and the server application operating on the

HP 3000. With this implementation of the LAN Manager standard, Hewlett-Packard is the first major systems vendor to offer this functionality across a wide variety of platforms (MPE/XL, HP-UX, OS/2, and SCO UNIX). This broad platform support provides developers with increased functionality and portability. In addition, their investment in development is protected.

Cooperative Services

The Cooperative Services development tool helps software designers create cooperative processing applications between personal computers and the HP 3000. The development tool consists of both an MS-DOS procedure library and an HP 3000 intrinsic server.

Using the PC as the development workstation, software designers can create PC applications that programmatically access and update data that resides on the personal computer or on the HP 3000. Cooperative Services simplifies the development of commercial transaction-processing applications by eliminating the need for PC software designers to access lower-level network intrinsics or provide parallel coding on the HP 3000. HP's Cooperative Services can be used with integrated transaction processing applications.

The Cooperative Services programming environment on the PC is similar to the HP 3000's environment. Developers use the equivalent of HP TurboIMAGE or operating system file intrinsics to access HP 3000 data. Developers may call the *command* intrinsic as well as HP 3000 procedures. The Cooperative Services MS-DOS procedure library provides the programmatic interface between the PC application and the intrinsic server on the HP 3000.

Cooperative Services supports a variety of popular PC development languages and user environments, including MS-Windows. Internal representation differences between the PC languages and the corresponding HP 3000 intrinsic interfaces are handled automatically by Cooperative Services. For conversion to or from common HP TurboIMAGE and character types, the developer may call data type conversion routines provided by Cooperative Services.

Cooperative Services offers designers network flexibility in designing applications. Personal computers may be connected to the HP 3000 with Network Services/XL or with basic serial connections.

NewWave Developer's Kit

The NewWave Developer Kit contains all the HP components needed to write applications for this new environment. It includes the HP NewWave environment software, software development tools, and documentation. Inside the kit are development versions of the environment, services, and software libraries, plus development tools and samples of application source code.

Software documentation in the HP NewWave Developer Kit includes many helpful materials. The *Programmer Orientation Guide* presents

a conceptual overview of the environment and user interface, with emphasis on techniques for writing programs in the HP NewWave environment. It describes the office window, object management facility, the API, computer-based training, and the Help facility.

The *Programmer Reference Manual* is a list of all commands, messages, and so forth, required to create an HP NewWave application in the HP NewWave environment. Appendices include utilities descriptions and a set of data interchange standards, which are specifications describing the storage of various types of data within the HP NewWave environment.

User Interface Guidelines set forth the design rules for the HP NewWave environment external user interface. It defines how software applications should appear to the user.

The *Writer's Style Guide* provides guidelines to documentation writers and helps facilities developers approach the writing tasks. It includes a definition of what is included in each document and how the documents work together. Appropriate writing style and terminology is also provided.

Peripheral Devices

Hewlett-Packard designs and manufactures a very broad range of computer peripherals to meet the needs of all HP computers. HP has long had a reputation in the industry for excellence in computer peripheral products.

Hewlett-Packard is a leader in printers that use laser-scanning technology. These microprocessor-controlled printers provide advanced printing capabilities such as electronic forms, multiple fonts per page, high resolution, and type size variations. A wide range of impact printers are also available.

HP's backup devices, digital data storage (DDS)-format tape drives, the Rewritable Optical Disk Library System, and 1/2-inch magnetic tape are technological leaders offering ideal backup solutions for all sizes of systems. Combined with HP TurboSTORE/XL backup software, HP provides high-performance online and/or unattended backup for all 900 Series systems. In addition to providing secure data storage, these backup devices save valuable floor space and improve operator efficiency.

HP has combined thin-film technology for heads and media with eight generations of disk drive design and manufacturing to produce a series of disk drives with superior performance, very low cost-per-megabyte of storage, and industry-leading reliability. High-density data storage and compact size provide the ideal storage systems for a wide range of multiuser computer systems.

HP's personal computers — the IBM-compatible HP Vectra PC family — provide a broad range of personal computing solutions and extend the power of the HP 3000. HP's terminals combine quality ergonomic design with high-productivity features such as forms caching and block-mode operation.

Peripheral
Connections

HP-FL channels Disk drives are connected using HP Fiber-Optic Link (HP-FL) on HP 3000 900 Series systems. Besides offering a fast, 5-Mbyte per second data transfer rate, HP-FL allows large disk configurations and supports cable lengths of up to 500 meters, allowing greater flexibility in disk placement.

The HP-FL interface is a CPU-resident card that provides an interface between the fiber-optic cable and the backplane on 900 Series systems. The cable between the CPU and disk drive is the fiber-optic portion of the HP-FL architecture. A wire P-Bus cable, which also operates at 5 Mbytes per second, is used to connect up to seven subsequent drives to the fiber-optic cable. A total of up to eight HP-FL disk drives can share one HP-FL interface.

HP-FL is required for HP Mirrored Disk/XL, a duplicate disk capability available on the HP 3000. HP-FL is also required for HP SPU Switchover/XL, which provides the capability to switch processing from a failed SPU to a secondary SPU.

HP-IB channels Tape drives and system printers are connected to the systems on the Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's implementation of the IEEE 488 standard interface.

HP-IB is a cost-effective solution that allows customers to continue using many of the peripheral devices that they already have when upgrading from one HP system to another. Up to six non-disk devices can be connected to a single HP-IB channel. Four disk drives can be connected to each HP-IB channel.

HP-IB is an 8-bit wide, asynchronous bus. HP-IB can support sustained data transfer rates of up to 1 Mbyte per second.

SCSI channels Disk drives and DDS tape drives are supported using the small computer interface (SCSI) on the Series 917LX, 927LX, 937LX, 947LX, 957LX, 967LX, 937, 947, 957, and 967 systems. The HP Rewritable Optical Disk Library System is also connected to the HP 3000 900 Series with the SCSI.

SCSI is a low-cost solution for entry-level and midrange systems. SCSI is an industry-standard local I/O bus that provides computer connections to mass storage devices and other high-throughput peripherals. The 900 Series SCSI implementation adheres to the HP Common SCSI (HPCS) specification, which is a superset of the ANSI SCSI-2 specification.

Workstation connections

On the HP 3000 900 Series, asynchronous terminals and serial printers are connected through datacommunications and terminal controllers (DTCs). For a detailed discussion of each of these products, refer to Chapter 5, "Networks".

System Printers

HP 256xC family

The HP 256xC family of dot matrix line printers is designed for a wide variety of printing applications and offers many special printing capabilities, such as raster graphics, compressed print, double-size and block characters, OCR characters, bar code printing, and math and multinational character sets. Other convenience features include paper-out and paper-jam detection, a 16-channel downloadable vertical forms control, and easy forms alignment. In addition, this family features:

- high reliability
- excellent print quality
- interfacing flexibility
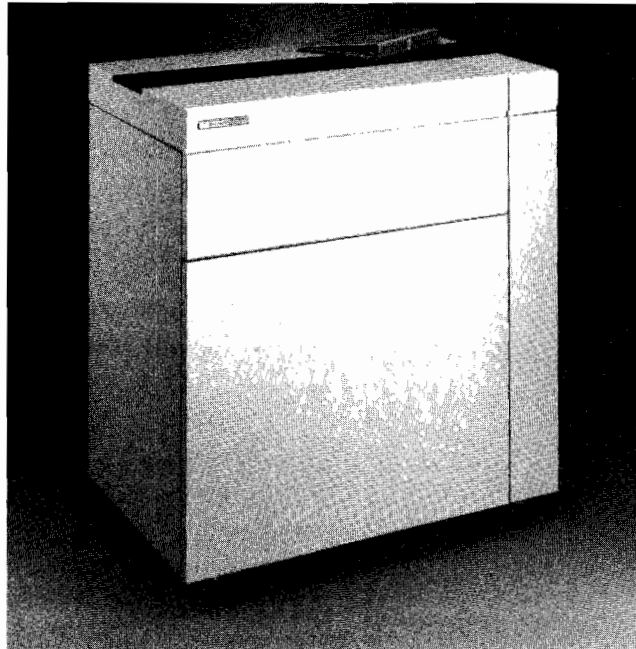
Figure 7-1. The HP 2566C Line Printer

The HP 256x family is composed of the following printers:

- HP 2562C—a 300 line per minute (lpm) industrial printer built to provide fast and reliable performance for high-volume printing.

- HP 2563C—a 420-lpm printer comes standard as a 55-dBA unit with noise-reduced cabinet, sound enclosure, and passive paper stacker. A 65-dBA desktop model is also available without the cabinet, sound enclosure, and passive paper stacker.

- HP 2564C—a 840-lpm printer that comes standard as a 55-dBA unit with noise-reduced cabinet, sound enclosure, and passive paper stacker. A 65-dBA cabinet model is also available without the sound enclosure and passive paper stacker.
- HP 2566C—a 1200-lpm printer
- HP 2567C—a 1600-lpm printer

Also available for each of these printers is the HP Label Card, which adds versatile forms, graphics, and labeling capabilities. This option greatly expands the types, sizes, and shapes of printed characters and also generates forms, lines, and bar codes. It provides the ability to create and print labels, minimizing the need for preprinted labels. The HP Label Card uses the powerful and easy-to-use QMS Magnum programming language.

In addition to being HP-IB devices, members of the 256X family can also be connected serially through an RS-232 or RS-422 interface.

Serial Printers

HP LaserJet Series III and LaserJet IIID

The HP LaserJet Series III and HP LaserJet IIID printers are the third-generation desktop laser printers from Hewlett-Packard. Both printers print 8 pages per minute at up to 300 dpi resolution. The LaserJet IIID provides automatic two-sided (duplex) printing at up to four pages (8 images) per minute.

The LaserJet Series III comes with 6 internal fonts, 23 symbol sets, and an easy-to-use front control panel. The LaserJet IIID comes with 24 fonts, greater paper capacity, and an optional envelope feeder. Both printers are completely compatible with the previous LaserJet generations, so all software, font cartridges, and soft fonts will work with the LaserJet Series III and IIID.

Technical details are as follows:

- 512 Kbytes memory standard, expandable to 4.5 Mbytes in 1-, 2- or 4-Mbyte increments
- RS-232C/RS-422 interface
- toner cartridge with integral print drum prints about 4000 pages of normal text
- 200-sheet input tray (LaserJet Series III), two 200-sheet input trays (LaserJet IIID), 100-sheet correct-order output tray (both models)
- prints on letter, legal, executive, and A-4 single-sheet paper; optional envelope feeder available for the HP LaserJet IIID
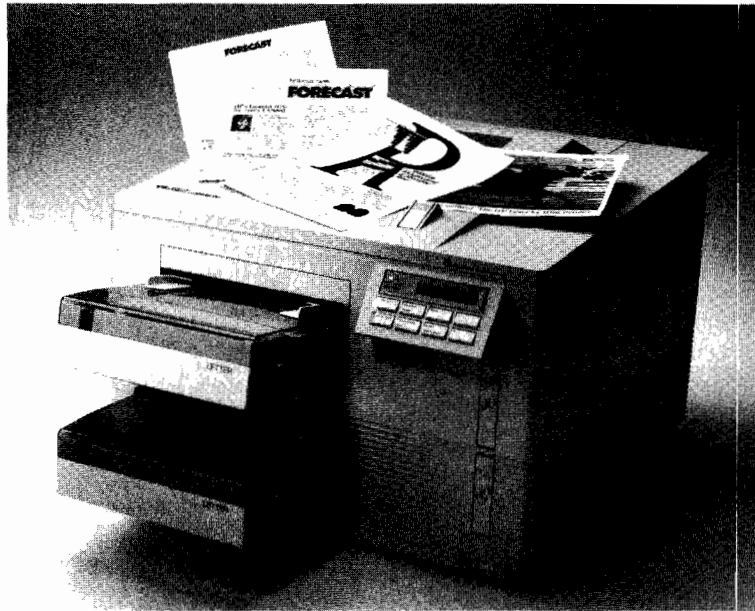
Figure 7-2. The HP LaserJet Series IIISi

HP LaserJet IIISi

The HP LaserJet IIISi laser printer, designed to print up to 50,000 pages per month, is the top of the LaserJet printer line. Designed to meet the high-performance needs of the multiuser PC network and minicomputer environments, the LaserJet IIISi offers many features that make it ideally suited as a departmental printer.

The HP LaserJet IIISi prints up to 17 pages per minute, single-sided, on a wide range of paper sizes. Duplex printing is also available as an option. Two 500-sheet input trays are standard, and a 2000-sheet paper deck can be added. A 50-sheet correct-order output tray is standard.

Technical details are as follows:

- print resolution: 300 by 300 dpi
- full-page 300 dpi 8 1/2- by 11-inch graphics standard
- designed to print up to 50,000 pages per month
- fully compatible with previous generation HP LaserJet Series font cartridges and downloadable soft fonts with automatic font rotation
- HP LaserJet II software compatibility
- 1-Mbyte standard memory expandable to 10 Mbytes total
- integrated Adobe Postscript
- network printer interface supports Novell NetWare and 3COM 3+Open operating systems
- operates in either Ethernet or Token Ring environments

Backup Solutions

The choice of a backup solution is specific to the customer, based on applications, backup requirements, and other MIS strategies. The appropriate solution can depend on many of the following variables: mass storage configurations today and in the future, amount of data interchange with non-HP systems, level of operator intervention or unattended backup, continuous 24-hour processing, CPU utilization and user impact, price/performance of solution, and future applications of backup technology (that is, Rewritable Optical Disk Library System as a future archival solution).

The HP 3000 offers a range of backup solutions from single file storage to online, unattended system backup. HP TurboSTORE/XL II provides high-performance data backup as well as unattended dedicated backup and unattended online data backup. For more information on HP TurboSTORE/XL, please refer to Chapter 3, "HP 3000 Operating Environment".

Digital Data Storage (DDS) drives

HP Series 6400, Models 1300H and 1300D DDS-format tape drive (P/N C1511A HP-IB or P/N C2463 SCSI) advances backup technology by offering very high capacity in a compact and low-cost device. Based on digital audio tape (DAT) technology, DDS format takes the DAT recording format as its base and adds extra layers of error correction and data organization. Three levels of error correction with read-after-write ensure data integrity. Widely accepted by other computer manufacturers, the DDS tape format has become an industry standard for products based on DAT technology.

With the TurboSTORE/XL fast compression algorithm, each DDS cassette records up to 2.7 Gbytes of data on inexpensive, high-quality media. DDS drives are embedded in 900 Series entry-level and midrange systems, providing unattended backup for these systems. With TurboSTORE/XL data compression and four DDS drives, unattended capacities greater than 20 Gbytes can be achieved on Series 947, 957, 967, 960, and 980 systems.

As the amount of data per cassette increases, so does the need to improve the access time to the stored data. TurboSTORE/XL supports Fastsearch, which minimizes the time to locate individual files, resulting in an average 20-second access time per file.

Technical details are as follows:

- digital data storage (DDS) format
- 1.3 Gbytes capacity per cassette
- up to 5 Gbytes with TurboSTORE/XL data compression
- 11-Mbytes-per-minute transfer rate
- large 512-Kbyte data buffer to maintain host transfer rate
- three level error correction code
- SCSI and HP-IB interface
- compact package
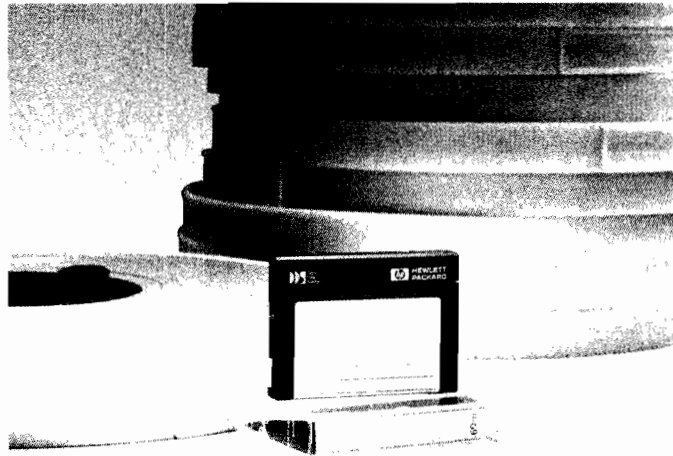
Figure 7-3. DAT Cartridge (supports 1.3 Gbytes of data)

Rewritable Optical Disk Library

HP Series 6300 Model 20GB/A Rewritable Optical Disk Library System combines the latest 5.25-inch rewritable optical technology and an autochanger. It features two rewritable optical disk drives, 32 rewritable optical disk cartridges, a mail slot for loading and removing the media, and an autochanger. Each cartridge provides 650 Mbytes of removeable storage (325 Mbytes per side.) Model 20GB/A with TurboSTORE/XL automates complex backup and recovery procedures, saving valuable operator time. With the high-density data compression algorithm provided by TurboSTORE/XL, the library system can provide up to approximately 70 Gbytes of storage for high-end HP 3000 systems. Up to three Rewritable Optical Disk Library Systems can be configured on an HP 3000 900 Series.

The rewritable optical media, housed in a tough plastic cartridge, will retain data for at least 10 years, without maintenance. Like a magnetic disk, it provides unlimited read-write passes without degradation. The media is more resistant to magnetic interference than other media and can withstand common office mishandling as the data is written and read with a laser that focuses on the inner recording layer of the media.

Technical details are as follows:

- library system (C1700A) capacity: 20.8 Gbytes (uncompressed) for deskside cabinet (option 1AB); 40 Gbytes (uncompressed) for 2 library systems in 1-meter cabinet (option 1AC and 133)
- media capacity: 650 Mbytes (formatted)
- library system holds 32 optical disk cartridges
- approximate transfer rate: 1.4 Gbytes/hour per library system
- SCSI channel connection
- conforms to ANSI and ISO specifications for continuous composite format
- maintenance-free media archive life of at least 10 years

1/2-inch magnetic tape   The HP 7980A and HP 7980XC 1/2-inch magnetic tape drives
are the devices of choice for HP 3000 customers who need data
interchange with non-HP systems. These 1/2-inch magnetic tape
drives offer high-performance attended back-up solutions. The
HP 7980XC tape drive has an advanced algorithm in the electronics
and firmware that compresses the data on tape by a factor of 2 to
5. While most HP 3000 systems with typical loads will experience
satisfactory online backup performance using TurboStore/XL II
software data compression, heavily loaded systems can achieve higher
online backup performance by using the HP 7980XC tape drive's
hardware data compression. The HP 7980XC also offers ANSI
standard PE (1600 bpi) and GCR (6250 bpi) formats.

The HP 7980A operates at both 1600 bpi and 6250 bpi. A data
compression upgrade kit can be added at your site to upgrade an
HP 7980A to an HP 7980XC.
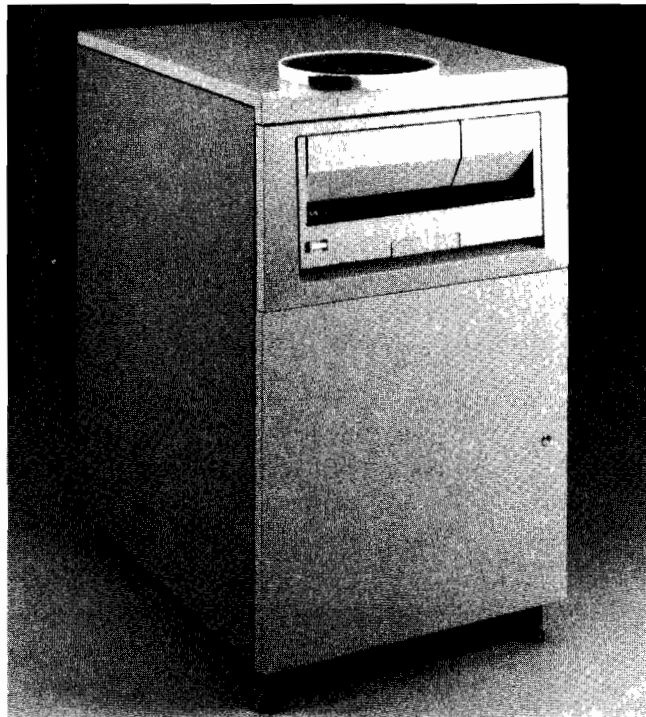
Figure 7-4. The HP 7980XC Magnetic Tape Drive

All drives have the same autoload feature that accepts any standard
reel from 6 to 10-1/2 inches. The operator simply places the reel
in the slot and closes the door. The drive does all the positioning
and threading. A tape speed of 125 inches per second, a 512-Kbyte
buffer, and HP Immediate Response and Read-Ahead software
maximize streaming performance.

Technical details are as follows:

- density: 1600/6250 bpi (HP 7980A/HP 7980XC)
- format: GCR/PE (HP 7980A/7980XC)
- capacity per reel: 700/140/40 Mbyte (7980XC),
  140/40 Mbyte (HP 7980A)
- operating mode: Streaming or start/stop emulation
- tape speed (inches per second): Read/write, 125 ips; rewind, 320 ips average
- burst transfer rate (bytes per second): 781 Kbps (6250 bpi), 200 Kbps (1600 bpi)
- two-track error detection and correction (6250 bpi)

Disk Drives

HP C24xx Series   The HP C2400 family of disk drives are supported with the small computer system interface (SCSI) on the Series 9x7LX and 9x7 systems. These disks combine compact size with high-density data storage to provide an inexpensive storage system for the 900 Series low-end and midrange systems.
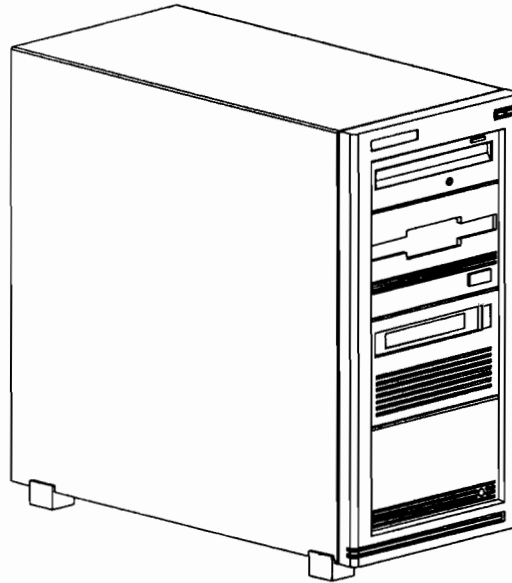
Figure 7-5. The Series 6000 C24xx Floor Model

HP C22xx Series

The HP C2204A provides 1.34 Gbytes of formatted data storage on sixteen 5 1/4-inch platters and is an ideal product for high-end mass storage. HP's complete range of disk drive products offer low-cost-per-megabyte storage for all HP 3000 systems.

It is possible to rackmount HP disk drives. The Series 6000 multi-mechanism package allows up to three C24xx disk drives to be stacked in a single cabinet. The C2204A disk drive can also be stacked in a standalone cabinet. Modular design offers great flexibility in rackmount and cabinet configurations to help you optimize the use of floor space. Low power consumption and a wide tolerance for ambient conditions make the disk drives suitable for installation in a variety of environments, including the factory floor, the data center, and the typical business environment.

A sophisticated dual servo system in each drive provides fast head positioning with the precise accuracy required by high track densities. Variable-length frequency modulation is used to take full advantage of the high bit density available with HP-designed and HP-manufactured thin-film media.
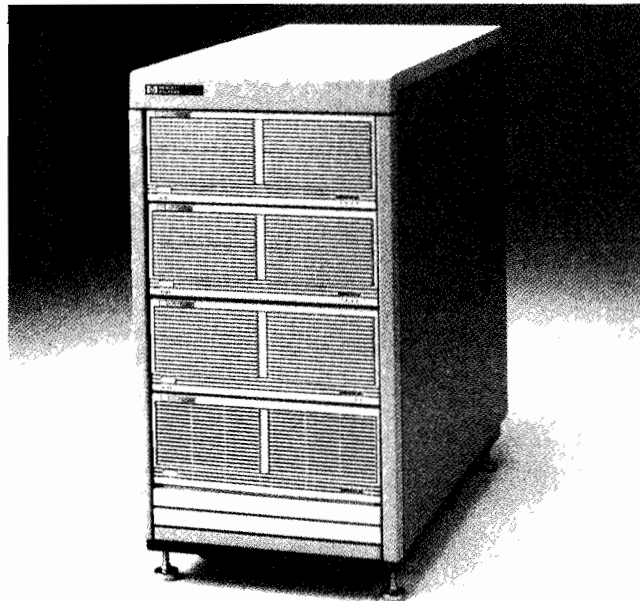
Figure 7-6. The HP C22XX Family

Technical details are as follows:

- 1.36 Gbyte (formatted) HP C2474S (SCSI)
- 673 Mbyte (formatted) HP C2473S (SCSI)
- 2.88 Mbyte per second internal burst data transfer rate
- 15 ms average seek time
- 1.34 Gbyte (formatted) HPC2204A (HP-FL)
- high reliability (mean time between failures (MTBF) greater than 150,000 hours)
- efficient use of floor space

■ low power consumption

HP Personal Computers

HP's personal computers are easily integrated with HP 3000 systems. Users can take advantage of the rich functionality available in PC applications while using the full range of HP 3000 resources. Processing power can then be focused on the PC, reducing the demand on the host system.

With HP Business System Plus, PCs are integrated into a complete departmental solution. Sophisticated mail systems electronically speed information such as documents, graphics, and program code throughout your organization. Access to host database information for authorized PC users reduces the demand for specialized MIS reports.

Shared printers, plotters, and disk storage maximize return on peripheral investments. Backing up PC hard disks to the HP 3000 increases data security, and centralized distribution of PC applications increases MIS control.

HP Vectra Personal Computers present a broad range of price/performance choices for the user who needs the local computing capability of PCs together with terminal access to the host computer.
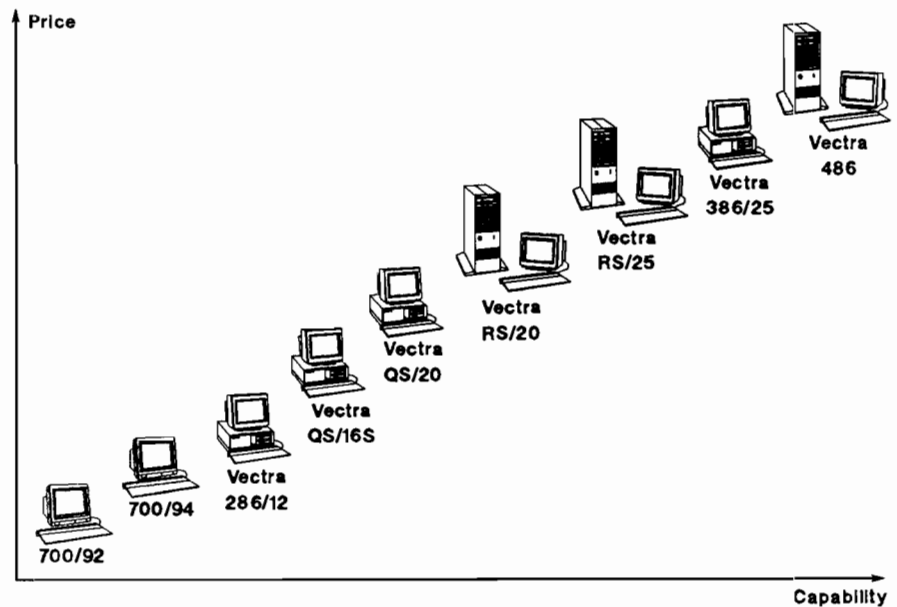
Figure 7-7. HP Workstation Family

HP Vectra PCs can be integrated with HP 3000 systems to take full advantage of HP 3000 data and peripherals while offering complete PC-based office functionality.

HP AdvanceLink and HP AdvancePrint software is available for file-transfer and shared printing/plotting with the HP 3000.

The HP Human Interface Link (HP-HIL) is supported on Vectra PCs. This allows you to use input devices such as HPTouch, HPMouse, HP Bar Code Reader, and HP Graphics Tablet.

HP Vectra Personal Computers are compatible with the IBM/PC/AT, or Industry-Standard Architecture (ISA). This means thousands of software packages and accessories are also supported on Extended Industry-Standard Architecture (EISA) PCs, such as the Vectra 486 PC. In addition, accessories take advantage of EISA's advanced capabilities are fully supported by the Vectra 486 PC.

Figure 7-8. HP Vectra 286/12

HP Vectra 286/12 PC   The HP Vectra 286/12 PC efficiently handles common business applications such as spreadsheets, business graphics, word processing, and databases.

The Vectra ES/12 features a 12-MHz Intel 80286 microprocessor, four accessory slots, three half-height mass storage shelves, 1 Mbyte of RAM, an integrated SuperVGA (800 x 600 resolution), and serial/parallel ports. Options include additional disk drives (1.2-Mbyte flexible disk or 20-, 42-, or 84-Mbyte hard disk), color and monochrome monitors, and expanded RAM up to 8 Mbytes.

HP Vectra QS/16S and QS/20 PC

The HP Vectra QS/16S and QS/20 personal computers apply state-of-the-art technology to deliver the speed and power you need for sophisticated office applications. These Intel 386 machines are ideal for running applications such as desktop publishing, large databases, and spreadsheets—right on your desktop.

The HP Vectra QS/16S features the Intel 386S 16-MHz microprocessor, while the HP Vectra QS/20 features the 20-MHz Intel 386 microprocessor. Both computers offer seven accessory slots; three half-height mass-storage shelves; serial/parallel ports; 360-Kbyte, 1.2-Mbyte, and 1.44-Mbyte flexible disk drives; and up to 304 Mbytes of hard disk storage.

HP Vectra RS/20C and RS/25C PC

The HP Vectra RS/20C and RS/25C offer superb PC performance and expandability. They are ideal for running demanding applications such as large spreadsheets or databases. The HP Vectra RS/25C features a 25-MHz 386 microprocessor; eight accessory slots; six half-height mass storage shelves; 1 Mbyte to 16 Mbytes of 32-bit memory; serial/parallel ports; 360-Kbytes, 1.2-Mbyte, and 1.44-Mbyte flexible disk drives; and up to 620 Mbytes of internal hard-disk storage. The HP Vectra RS/20C PC offers the same features but uses a 20-MHz Intel 386 microprocessor.

HP Vectra 386/25

The Vecta 386/25 offers excellent performance for the high-end PC user. The Vectra 386/25 features a 25 MHz 32-bit microprocessor, seven ISA accessory slots, three half-height mass storage shelves, a multifunction controller card, 2 Mbytes expandable to 32 Mbytes, serial/parallel ports, 32-Kbyte cache, and 64 Kbytes of BIOS ROM.

Figure 7-9. The HP Vectra 486

HP Vectra 486 PC

The HP Vectra 486 PC is the highest-performing member of HP's Vectra family. Utilizing the Intel 486 microprocessor, it has been designed with an optimized HP memory architecture, HP high-performance/high-capacity hard-disk drives, and the new EISA I/O bus to provide unprecedented system performance.

The Vectra 486 PC features a 25-MHz Intel 486 processor, eight EISA accessory slots, six half-height mass storage shelves, 2 to 64 Mbytes of 32-bit memory, two serial ports and one parallel port, 360-Kbyte and 1.2-Mbyte flexible disk drives, and up to 1.3 Gbytes of internal hard-disk storage.

Workstations

Hewlett-Packard designs and manufactures high-quality terminals specifically for HP 3000 systems. These terminals offer superior system performance and increase user comfort and productivity. HP terminals offer ergonomic features such as anti-glare displays with high-character definition and functional keyboard layouts. Many of HP's terminals provide display screen tilt and swivel.

HP 700/43 ASCII terminal

The HP 700/43 is a multipersonality ASCII terminal with 12 of the most popular compatibility modes. It provides a 14-inch screen, four pages of display memory, and an enhanced keyboard with tactile feedback. The display, with built-in tilt and swivel mechanism, can be switched from 800- to 132-column display, and is available in soft white, amber, or green phosphor.

Technical details are as follows:

- printer port standard
- selectable 80- or 132-column display modes
- detached adjustable keyboard with eight shiftable function keys

HP 700/92 blockmode display terminal

The HP 700/92 display terminal combines a 14-inch screen, 8 pages of display memory, and an enhanced keyboard with tactile feedback to make your work easier and more productive. The display, with built-in tilt and swivel mechanism, can be switched from 80- to 132-column display and is available in white, amber, or green phosphor.

Technical details are as follows:

- printer port standard
- selectable 80- or 132-column display modes
- detached adjustable keyboard with eight shiftable function keys
- block-mode operation

Figure 7-10. The HP 700/92 Display Terminal

HP 700/94 high-performance blockmode terminal

The HP 700/94 high-performance terminal incorporates advanced capabilities to help you make the most of your HP computer applications. The HP 700/94 provides forms cache for storing an average of 25 forms locally. Local edit checks, modified data tag, and 16 pages of display memory reduce costly host communications.

Technical details are as follows:

- printer port standard
- selectable 80- or 132-column display modes
- detachable adjustable keyboard with 8 shiftable function key
- block-mode operation

8
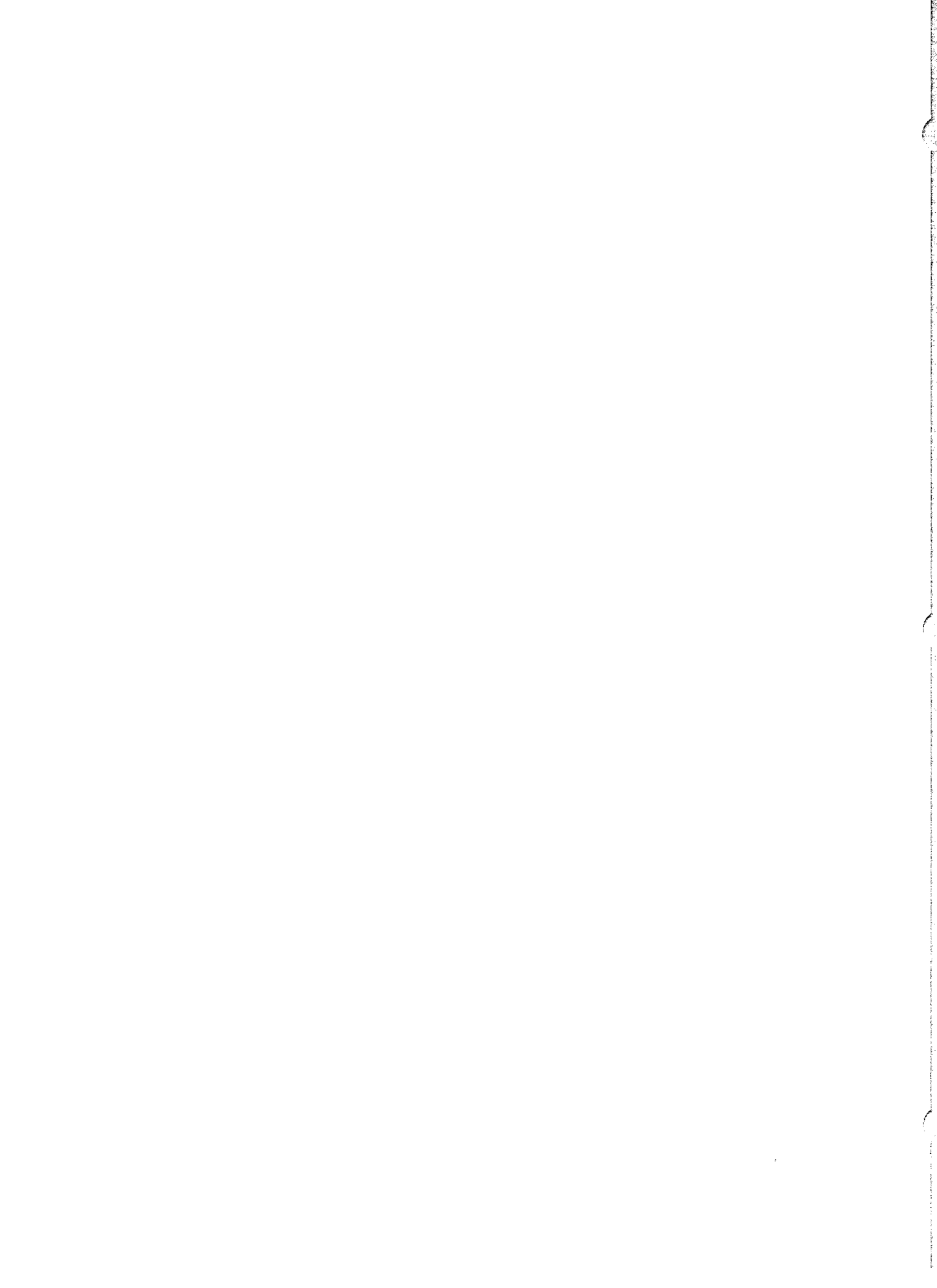
Commitment to Your Success

Hardware and software support

Customer support services

Hewlett-Packard's customer support services are designed to ensure long-term, productive use of HP 3000 systems. Support is available throughout the life of your system to meet the needs of your particular applications and working environment.

HP offers a complete range of customer support services for the HP 3000 systems:

- Hardware maintenance programs provide various levels of hardware support for systems, workstations, and office products.
- A comprehensive network support program covers your HP and multivendor networks.
- A choice of software support programs provides you with the level of software support that best meets your needs.
- Standardized and custom consulting services allow you to develop tailored solutions to meet your application needs.
- Fundamental and advanced training courses help you to quickly take full advantage of your system's capabilities.
- Disaster recovery planning and backup services prepare you for the unexpected.

Hewlett-Packard customer support is delivered by a worldwide network of systems engineers (SEs), customer engineers (CEs), and HP Response Center engineers (RCEs). These extensively trained professionals work closely with your HP sales representative to provide you with complete support for your HP 3000 products.

Hardware maintenance services

A 90-day on-site warranty is included with each HP 3000 system and all HP computer products purchased with the system. After the warranty period, service can be continued under an HP support agreement. All HP hardware services include parts and labor for remedial maintenance.

HP SuccessLine service, HP's hardware maintenance service, provides you with high-quality support that enables you to maximize computer system uptime and productivity. It provides superior value for your money and gives you the flexibility to choose response times and coverage periods that meet your service needs.

When you purchase an HP support agreement for your HP 3000, a CE assigned to your account personally manages your maintenance

program. Your CE performs preventive maintenance on a regularly scheduled basis as applicable and, if necessary, adjusts or replaces parts to ensure a continued high level of performance. Your CE also installs equipment, updates your system with engineering improvements, monitors your site environment, and maintains a current system log. Select equipment is customer installable.

HP hardware support for your HP 3000 system includes HP's remote support. A communications link using a phone line and a qualified modem enable specialists in the HP Response Center to access your system in order to run tests remotely and diagnose functional problems.

HP Predictive Support is also included with hardware support for most HP 3000 systems. HP Predictive Support software provides early warning of potential problems in HP disk drives, magnetic tape media, and system memory. This allows you to avoid unscheduled downtime and to increase system availability.

Should your system require trouble shooting, your CE has the training and materials to rapidly resolve most problems. The CE stays on site until your problem is solved, even if this involves working beyond your coverage hours. For very difficult problems, your CE can initiate an escalation procedure that enlists all the HP resources necessary to provide a solution.

Features included in HP 3000 hardware support agreements are detailed below:

HP SuccessLine Service features are listed below:

- account-assigned CE
- work to completion
- escalation management program
- HP Response Center network
- Local parts inventory
- HP Predictive Support software
- remote support
- preventive maintenance
- engineering improvements
- site environment survey (for most systems)
- warranty enhancement
- installation of add-ons (for most systems)

HP SuccessLine service offers you the flexibility to choose from four service levels:

Priority Plus Level Support

If your applications are extremely critical and call for maximum availability, Priority Plus Level Support service will provide you with maximum coverage hours and days and HP's best possible response. This coverage is ideal if you have crucial applications or multiple-shift operations.

Priority Support

If you require maximum availability during standard business hours and evenings and HP's best possible response, then Priority Support service level will meet your needs. On-site assistance is available for several business hours beyond the standard business day, and Hewlett-Packard will respond to your service request as quickly as possible. This coverage is provided during the normal work week.

Next Day Support

If your application allows for service delivery on the following business day, then Next Day Support service will be your most cost-effective solution for system support. This solution is ideal if you have spare or substitute equipment. HP engineers will be on your site as quickly as possible to begin solving the problem.

Scheduled Support

Scheduled Support service level offers the lowest cost on-site support for your HP workstation and office products. It is an economical support solution if you have alternative PCs or workstations and your users are running less critical applications. An HP engineer makes a scheduled weekly visit to a central site at your location. To qualify for HP SuccessLine Scheduled support, your monthly charges for a site for this service level must exceed a minimum dollar amount.

Support selection guide for HP SuccessLine service

	Priority Plus	Priority	Next Day	Scheduled
Coverage hours	24 hours 7 days	8 am-9 pm Mon-Fri	8 am-5 pm Mon-Fri	8 am-5 pm Mon-Fri
Response time	Best response; not to exceed 4 hours	Best response; not to exceed 4 hours	Next working day	Scheduled weekly visits
Usage environment	Highly critical	Urgent	Less critical	Workstation/ office products only; multiple units

For HP workstation or office products, HP Customer Return service offers an additional low-cost alternative. This service offers support for situations where your applications are not critical and service economy is a priority. With this service, you return the product to an HP Customer Service Center for repair. Within three days of its arrival, the repaired unit will be shipped (prepaid) back to you by a normal land carrier.

Hewlett-Packard can also fully support selected non-HP terminals and PCs and multivendor PC local area network (LANs).

HP Multivendor Network Support Program

The network life cycle

Hewlett-Packard recognizes that successful network management does not begin or end with your purchase of network products. You begin by recognizing a need to improve the flow of information in the organization, and then plan a network that will meet those needs. Implementation follows design, with the equipment purchased and installed, your people trained to use and manage it, and the system fully tested and operational. Once it is implemented, you operate the network as part of your business.

However, new information needs are always emerging that require planning for changes and enhancements, thus creating a continuous process—the network life cycle.

Integrated, flexible assistance

Hewlett-Packard's objective is to give you complete, integrated, and flexible support solutions. Recognizing that you have different support needs at different stages of the cycle, HP offers a variety of network support services. The HP Multivendor Network Support program integrates services so that they work together logically and so that the work performed at one stage increases the effectiveness of services performed at a later stage. The program is also flexible. HP recommends only the service you need to complement your own capabilities. Using HP's highly regarded implementation and support planning process, HP tailors various aspects of each service to your unique needs. For special needs, HP can provide custom consulting services that allow you to leverage HP's considerable experience in network support as your partner for success.

HP network consulting

Hewlett-Packard provides experienced network consultants who develop a custom network design that can best support your business needs. A range of service modules enables you to tailor services to help your organization achieve successful network implementation and operation.

HP WireTest

HP evaluates the suitability of your existing cables prior to implementing a new or upgraded network.

HP CableSite

HP takes responsibility for the design and installation of the cable infrastructure needed for information transport over LANs.

HP Network Startup

HP coordinates the installation and testing of your HP and multivendor network to ensure that it operates as designed.

HP NetAssure

HP provides you with a single point of contact for troubleshooting and managing fault resolution on your HP and multivendor network.

HP Network Operations

HP can efficiently operate and manage your network 24 hours a day, 7 days a week, working through HP Customer Network Centers worldwide.

HP's customer education offers a wide variety of training, from classroom to self-paced or even custom programs delivered at your site, all designed to help you get the most out of your network.

Software support services

HP's software support services are designed to provide you with the level of support that best meets your specific needs, even as those needs change. Added flexibility gives you the ability to adapt your support plan to meet the changing requirements throughout your system's life cycle.

HP TeamLine
Personalized Support

HP ResponseLine
Complete Software Maintenance

HP BasicLine
Enhanced Self-support
or
Additional System Service Level

HP Software Update Materials Service

HP Custom Support Plan Service
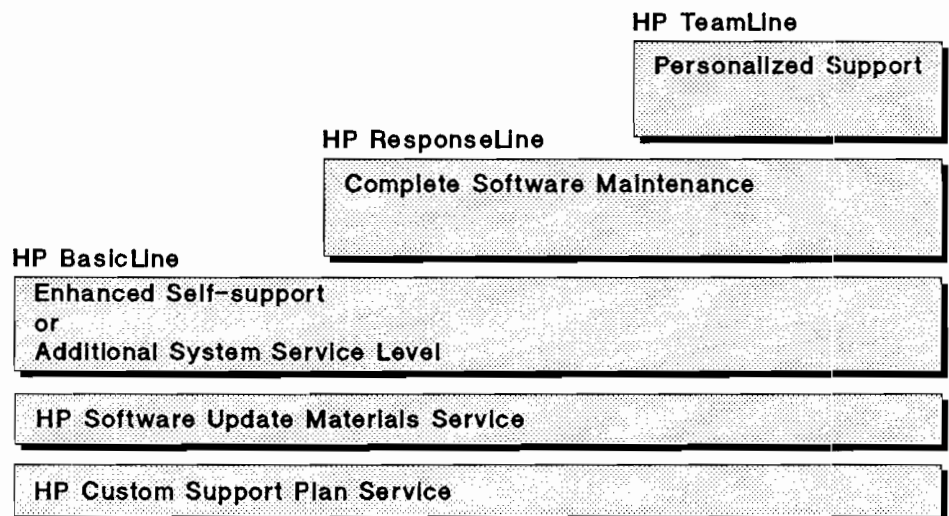
Figure 8-1. HP's Software Support for HP 3000 Systems

HP TeamLine

HP TeamLine software support service provides an HP consultant who personally ensures you have access to the HP support resources you need, when you need them. Your HP support consultant develops a thorough understanding of your system environment, operations, and business objectives; and provides specific recommendations and technical assistance to improve your system's productivity and maximize the effectiveness of your people.

HP ResponseLine

HP ResponseLine software support service provides comprehensive software maintenance. You receive unlimited telephone assistance to resolve software problems. You also receive access to HP SupportLine electronic support, preventive software maintenance, and problem escalation management for your HP 3000 system. The HP Response Center network brings together the worldwide resources of

Hewlett-Packard into a single source for complete software maintenance and guaranteed coverage and response times. In addition, HP ResponseLine provides the right to use software updates.

HP Startup ResponseLine

HP Startup ResponseLine software support service is specifically designed to grow with you as your system software support needs change during the first year you own your HP 3000 system. It includes services to help you successfully implement your new system and to help you maximize system availability after implementation is complete.

During the first three months of support, you receive system implementation assistance and on-site problem resolution assistance. In addition, HP Startup ResponseLine provides you with the full benefits of HP ResponseLine software support. The remaining nine months consist of standard HP ResponseLine support to meet your ongoing support needs.

HP BasicLine

HP BasicLine software support service delivers current, comprehensive support information by providing electronic access to support information and the right to use software updates. If you have questions or problems with your software, you can quickly research them in the electronic databases. The combination of valuable support data and powerful search mechanisms adds up to increased productivity in supporting and developing your applications. As another plus, you can use the electronic databases to stay current on the latest HP products, support programs, and training classes.

HP Custom Support Plan

HP Custom Support Plan service is designed for customers who need tailored software support. This service, which builds on HP TeamLine, HP ResponseLine, or HP BasicLine software support, is unique to you. Features depend entirely upon your needs and can incorporate anything from performance analysis and multiple site coordination to additional reviews and consulting.

Together, you and HP develop the plan. The result is an annual support plan that gives you the convenience of contractual billing.

HP Software Update Materials

Purchased in conjunction with HP TeamLine, HP ResponseLine, or HP BasicLine software support, HP Software Update Materials service ensures that your software and documentation are kept current. Hewlett-Packard continuously enhances HP software products through periodic updates. Updated software includes known defect repairs and may include additional functional and performance

improvements. You benefit from fixes or enhancements as they become available.

HP offers a compact disk read-only memory (CD-ROM) media option for HP Software Update Materials service on MPE V systems. With the CD-ROM media option, you save money on the price of updates, as well as reduce error rates and gain improvements in system uptime during updates. This program incorporates CD-ROM technology to distribute the MPE V operating system and all its subsystems software.

Optional services

In order to provide the complete solution, Hewlett-Packard also offers many optional features to enhance your standard support contracts:

- The additional technical review option provides incremental time with your SE for HP TeamLine software support.
- The additional HP Response Center caller option provides authorization for one additional person to call the HP Response Center.
- The software update installation option provides installation for one operating system or subsystem update at your site.
- The off-hours update installation option provides installation for one operating system or subsystem update during specified times outside of normal working hours.

HP 3000 Software Support Features

Features	HP TeamLine	HP ResponseLine	HP BasicLine
Account-assigned SE	S		
Support management review	S		
Software release planning	S		
HP Platinum Book	S		
Additional support management/technical reviews	O		
Access to HP Response Center	S	S	
Remote support	S	S	
Software problem verification	S	S	
Software patch	S	S	
PowerPatch	S	S	
HP SupportLine	S	S	
Extended-hours HP Response Center assistance	S	S	
Problem escalation	S	S	
Additional HP Response Center Caller	O	O	
Right to use updates	S	S	S
Electronic database access	S	S	S
Software update installation	O	O	
Off-hours update installation	O	O	
S = Standard			
O = Additional (optional) service			

Personal computer software support

HP ResponseLine software support service for personal computers provides telephone assistance with software problem resolution, installation, hardware configuration, and clarification of documentation. You receive telephone assistance on HP software and popular third-party software. You also receive access to HP support and product information, as well as a computer-based training course.

Support for PCs integrated with your HP 3000 computer system is also available as an option to your HP 3000 software support contract. Your PC users will receive the full benefits of HP ResponseLine software support service for PCs, plus the same benefits as your HP 3000 software support service.

Consulting services

Hewlett-Packard offers a comprehensive set of consulting services to help you obtain the most productive use possible from your HP 3000 system throughout its life cycle.

Throughout the planning, implementation and operation phases of your business cycle, HP's consulting professionals work with you to implement quality solutions.

Migration consulting

HP divides the migration process into the following stages:

- feasibility analysis
- system and application planning
- software preparation
- migration
- testing and tuning

At each stage, HP's specially trained consultants will work with your team, providing the level of service you need. By helping you make the most effective use of your time and resources, HP's consulting services offer you a powerful yet cost-effective way to streamline the migration process.

HP Disaster Recovery

The HP Disaster Recovery program provides you with a total recovery solution, from up-front planning and documentation to hardware backup and recovery of your disaster site. With HP's services, you can rest assured that when disaster strikes, your critical business applications are safe. Two services are available in the HP Disaster Recovery program: HP Disaster Recovery Planning service and HP Backup service.

HP Disaster Recovery Planning

HP Disaster Recovery Planning service provides you with the knowledge and tools necessary to develop a disaster recovery plan for your HP 3000 environment. It is designed to assist you in preparing contingency plans to protect against the disastrous loss of computer resources. This service helps you to do the following:

- reduce risks by using a proven planning methodology
- develop consistent, auditable plans through the use of planning templates
- formulate workable plans rapidly through project management templates
- write your own disaster recovery plans with our on-site customer training

HP Backup

HP Backup service helps keep your business running should a disaster occur. It gives you the hardware, technical support, and customized communications capabilities you need to keep your

critical applications up and running after a disaster strikes.
HP Backup includes the following features:

- access to fully operational HP 3000 hardware—Series 50, 70, and 950 systems—and telecommunications at our recovery facility
- access to resources and the expertise of HP's Worldwide Customer Support Organization 24 hours a day to help address your needs during a disaster
- annual rehearsals and reviews
- disaster site restoration assistance by your local customer engineers
- expedited delivery of replacement equipment

Customer Education

Hewlett-Packard offers a full range of courses to meet your needs to manage, operate, and develop applications on your HP 3000 system. Typical topics include system introduction, management, operations, application and systems programming, database administration, languages, and tools.

Please see the HP 3000 curriculum diagrams for the current customer training courses offered by Hewlett-Packard. For information on these courses or to find out about new releases contact in the U.S. at 800-HPCLASS (800-472-5277). Outside the U.S., contact your nearest HP Customer Education Center or local HP Sales Office.

Curriculum paths for new HP 3000 users

System operators and system managers

Fundamentals	Intermediate	Advanced	Migrating to MPE/XL
MPE/XL System Operational Skills –HP 31120C	MPE/XL System Management Skills –HP31119C	MPE/XL System Management Skills II –HP B1772A	Moving from MPE/V to MPE/XL: System Operations –HP 31117B

(Computer operators may stop here)

System administrators in a production application environment

Fundamentals

MPE/XL System Administration for Application Users –HP 81677A

Programmers, application developers, and systems analysts

Languages

Pascal Programming –HP 31112A

C Language Programming –HP 35130B

Learning COBOL II –HP 22832B

HP FORTRAN 77: Self–study Guide –HP 50697A opt 001 –HP 50697A opt 002

Fundamentals

MPE/XL Programming Skills –HP 31118C

Advanced

MPE/XL Programming Skills II –HP B2653A

Go to Data
Management Curriculum

General users

Using the HP 3000 900 Series: Fundamental Skills –HP 31126A opt 001	→	Using the HP 3000 900 Series: Advanced Skills –HP 31126A opt 002

MPE V migration to 900 Series

MPE V Experienced
System Operators

Moving from MPE V to MPE/XL: System Operations –HP 31117D

MPE V Experienced
System Managers

Moving from MPE V to MPE/XL: System Management –HP 31110D	→	MPE/XL System Management Skills II –HP B1772A

MPE V Experienced
Programmers

Moving from MPE V to MPE/XL: Appli– cation Programming –HP 31114C	→	MPE/XL Programming Skills II –HP B2653A

HP 3000 curriculum paths

Data management: programmers, database administrators, and system analysts

Fundamentals	Tools	Advanced Tools
HP VPLUS/3000 Fundamentals for Programmers −HP 22830E	HP Transact/3000 Fundamentals −HP 35014C	HP Transact/3000 II −HP 51402A
HP TurboIMAGE DMBS/3000 for Programmers −HP 35053C	HP TurboIMAGE II −HP 51480A	
HP TurboIMAGE Fundamentals for Database Administrators −HP B1779A	HP ALLBASE/Business Report Writer Fundamentals for Programmers −HP 36070CC	
HP ALLBASE/SQL on HP−UX and MPE/XL −HP 36389A	Programming in HP Transact/3000 −HP 22842A −HP 22842A opt 022	
HP TurboIMAGE Database Design Fundamentals −HP30606A	Using HP Dictionary/3000 −HP 22842B (1600 bpi tape) −HP 22843B opt 022 (cartridge tape)	HP VIRTUOSO Programming Environment −HP 30189A
HP ALLBASE/SQL Database Design Fundamentals −HP30701A	HP Dictionary−Inform− Report/3000 Fundamentals −HP 35013C	
HP QUERY Fundamentals −HP 50635A	HP 2680A Laser Printing System Basics −HP 22838C	

Languages: programmers, software developers, and application developers

Fundamentals   Advanced

| Pascal Programming
-HP 31112A | → | HP Pascal Advanced
and System
Programming
-HP 31113A |

C Language
Programming
-HP 35130B

Learning COBOL II
-HP 22832B

HP FORTRAN 77:
Self-study Guide
-HP 50697A opt 001
-HP 50697A opt 002

Selected self-paced topics

900 Series

MPE V

| HP 3000 MPE V/E:
Fundamental Skills
-HP H2516A | → | HP 3000 MPE V/E:
Advanced Skills
-HP J2515A | → | MPE/V to MPE/VL: Getting
Started
-HP 30367-60002 |

All HP classroom courses are taught by experienced professionals knowledgeable about HP products. Training is available at 45 HP Education Centers around the world and in many instances, at your site.

Course material is presented in a logical and professional manner so that students can quickly assimilate the new information. Typically, courses introduce key concepts and principles through illustrated study materials and lectures. Students then apply what they have learned with exercises and labs. In this way, principles are immediately reinforced through actual experience.

The training curriculum for the HP 3000 is designed to offer a flexible course path for all people involved in managing and using the system. The courses focus on the following user categories:

System managers and administrators
Taken at the beginning of implementation, these courses provide the students with knowledge of operations, file management, system commands, security, diagnostics, and configurations.

Applications programmers
Hewlett-Packard offers a full complement of language courses to assist programmers in the development of applications. HP also offers comprehensive training on the tools and techniques needed to develop, debug, compile, and run applications on the HP 3000 systems.

System programmers or those with advanced skills can learn about the new, sophisticated debugging tools and special capabilities of the system.

Database administration
Whether you have HP ALLBASE/SQL or HP TurboIMAGE, HP offers courses that cover topics such as accessing, reporting and maintaining data, transaction management, backup and recovery, programming basics, security and locking strategies, and much more.

General users
HP offers self-paced training for general users that need to learn the basics of the HP 3000 operating system.

Customer documentation

Hewlett-Packard has created comprehensive, high-quality documentation for HP 3000 hardware and software. Logically organized and fully indexed so that information is easy to find, the learning products are written from the users' point of view. They identify the actual tasks that users perform, supply clear explanations, and make frequent use of examples and illustrations. The learning products have been extensively tested by users for appropriate content, organization, readability, and ease of use.

The learning products are now *bundled* into sets according to different tasks that an end user may perform. They provide clear explanations for performing these tasks and supply many examples to help perform these tasks correctly the first time. Furthermore, these learning products provide more than just HP-specific information; they provide general discussions about topics such as database design and structured programming techniques.

Included with specified 900 Series system shipments is the System Management Core learning product set. The System Management Core Plus learning product set is also included with the larger systems. The learning products are orderable as sets from the local Hewlett-Packard sales office or as individual learning products from the HP DIRECT at (800) 538-8787.

Manual sets shipping with the following MPE/XL systems

| 9x7LX System Documentation | Ships with: 917LX 947LX 927LX 957LX 937LX 967LX |

| System Management Core | Ships with: 920 932 922LX 937 922RX 947 922 |

| System Management Core / System Management Core Plus | Ships with: 948 955 957 958 960 967 980 |

Manual sets purchased by product number

Programming Core	Programing Core Plus
HP System Dictionary/XL	HP ALLBASE/SQL
General Usage	Migration
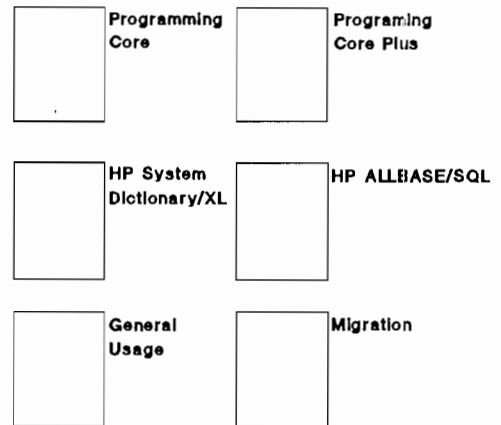
Figure 8-2. Manual Structure

The available learning product sets areas follows:

9x7LX System Documentation A1707-92001
These learning products cover basic system installation and efficient operation of a 9x7LX system. This set ships automatically with

9x7LX systems. Individual learning products can also be ordered from HP DIRECT.

System Management Core 36367A
These learning products aid users in efficient operation of an MPE/XL system. This set ships automatically with specified 900 Series systems. Additional sets can be ordered separately by using part number 36367A. Individual learning products can also be ordered from HP DIRECT.

System Management Core Plus 36368A
This set provides additional detail for the management of complex MIS centers and large networks, as well as more advanced system management and administration tasks. This set ships automatically with specified 900 Series systems. Additional sets can be ordered separately by using product number 36368A. Individual learning products can also be ordered from HP DIRECT.

Programming Core 36369A
Designed for basic programming environments, this learning product set describes the mechanics of compiling and linking as well as other MPE/XL programming techniques.

Programming Core Plus 36370A
The Programming Core Plus is a general reference set of learning products for larger, more advanced programming environments.

ALLBASE Set 36372A
These learning products are designed for programmers who will use ALLBASE/SQL, Hewlett-Packard's relational database management system.

General Usage Set 36373A
This set provides basic information about the usage of MPE/XL systems for additional users.

Migration Set 30231A
This set is designed to aid in the migration from MPE/V systems to MPE/XL systems.

HP LaserROM information service and software

By combining valuable system support information, proprietary retrieval software, and the benefits of CD-ROM, HP LaserROM offers quick single-user or multi-user access to vital user information. HP LaserROM is a compact disk-read only memory (CD-ROM)-based information distribution service which contains MPE system learning products, application notes, Software Status Bulletins, the HP Education Catalog, product catalogs, and much more. MPE users can significantly increase their productivity by quickly keyword searching valuable support information to answer their system questions.

For more information, please refer to the HP LaserROM datasheet (P/N 5952-0258).

HP Precision Architecture

Foundation for the Next-Generation HP 3000s

HP Precision Architecture-RISC (PA-RISC), incorporated in the 900 Series systems, is the foundation for HP 3000 computer systems for the 1990s and beyond. PA-RISC is a reduced-complexity architecture that is based on reduced instruction set computing (RISC) principles, coupled with key architectural extensions. The advantages of PA-RISC directly translate into high performance and industry leadership in price/performance and cost of ownership in commercial online transaction processing (OLTP) environments.

PA-RISC maximizes the performance benefits that can be realized for a given semiconductor technology. This potential allows for the development of high-performance systems that provide a cost-effective, compatible growth path designed to meet continually growing performance requirements in commercial environments. PA-RISC's inherent simplicity is ideal for fast, single-chip microprocessors that can be used for cost-effective desktop, workgroup, and corporate mainframe-class systems.

Finally, the 900 Series systems provide both object and source code compatibility with other HP 3000 systems, thereby preserving investments in application software and providing a smooth migration to next-generation 900 Series HP 3000 systems.

Designed to last

A key design objective of PA-RISC was to ensure that the architecture would be able to meet evolving computing needs and to take full advantage of new hardware and software technologies. Providing an architecture with high-performance potential and the capability to support a broad, compatible family of products was the first step. Next, PA-RISC was designed to accommodate multiprocessors and high-availability extensions, unlike the majority of today's systems, which must attempt to force-fit such features into existing architectures. Future PA-RISC systems can take advantage of these capabilities to meet expanding requirements for system performance and availability.

Finally, provisions have been made to ensure that the architecture has a large degree of flexibility and expandability. For example, industry analysts have estimated that addressability requirements of systems double every year. By allowing for either 48- or 64-bit virtual addressing, PA-RISC systems will be able to provide sufficient expandability to meet these growing requirements. Consider that 64-bit addressing provides over 4 billion times the addressing capability of typical 32-bit systems! It all adds up to an architecture designed to last through the 1990s and into the 21st century.

Key features

- reduced instruction set
- 32-bit, fixed-format instructions
- 48-bit or 64-bit virtual addresses
- hardwired, single-cycle instruction execution
- 32 general-purpose registers
- hardware support for floating-point and decimal calculations
- multiprocessors and coprocessors

Reasons for RISC

In the late 1970s and early 1980s, research in industry and at several leading universities showed that computers tend to spend most of their time performing relatively simple functions. In addition to directly supporting such simple functions in the instruction set, conventional computer systems typically provide instructions for many complex functions as well. For commercial workloads on conventional systems, 80 percent or more of the time is spent executing very simple instructions such as add, load, branch, and store. Only about 20 percent of the time is spent executing relatively complex instructions. Implementation of complex instructions results in additional processor overhead, which often results in a performance penalty for all instructions.

Instructions Executed

80% Simple: Add, Load, Branch, Etc.

20% Complex

Control Store Implementation

80% of Control Store for the Complex Instructions
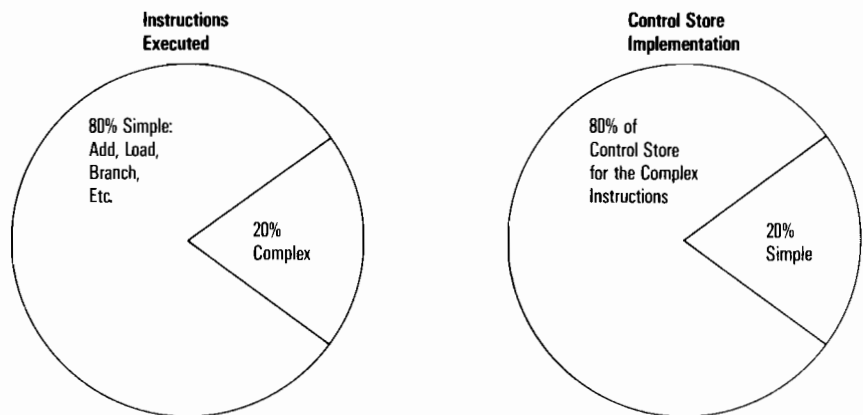
20% Simple

Figure A-1. RISC Motivations

Researchers concluded that optimizing the processor for the simple, often-executed functions would result in a significant performance advantage over more conventional designs. Thus, the RISC approach: maximize system performance by optimizing the processor for the simple, often-executed functions. PA-RISC not only embodies RISC principles, it also provides significant architectural extensions that allow for true high-performance, cost-effective business solutions.

The Advantages of Simplicity

Reducing processor complexity allows for several key advantages when compared with complex instruction set computer architectures. Compatibility, lower cost, and higher performance are all direct benefits of the reduced complexity approach of PA-RISC.

Compatibility

Compatibility has always been a cornerstone of the HP 3000 product strategy, and maintaining compatibility when moving to the next-generation HP 3000 systems was a critical design consideration. A simple instruction set is ideal for emulating more complex instruction sets; hence, the reduced complexity of PA-RISC allows for compatibility of nonprivileged mode object code as well as source code. When moving from the MPE V-based systems to the 900 Series systems, emulation of the MPE V-based HP 3000 instruction set allows object code to be run "as is"; this is called *compatibility mode*. Source code can simply be recompiled to exploit the full native mode performance potential of the 900 Series system. For detailed information on MPE V migration, please refer to Chapter 3, "The HP 3000 Operating System".

Lower cost

Eliminating much of the hardware complexity associated with conventional computer systems directly translates into a reduced part count and a system that is easier to design, to develop, and to manufacture. The result is a system that costs less to bring to market, and this cost saving is directly reflected in the superior price/performance of the 900 Series systems.

Higher performance potential

With the 900 Series systems, the performance potential of a wide variety of semiconductor technologies is maximized. For example, the Series 980/100, implemented in VLSI technology, delivers performance typically achieved by conventional systems only through use of more costly, less dense ECL semiconductors. With PA-RISC, a given level of performance can be achieved at a cost significantly lower than with conventional systems.
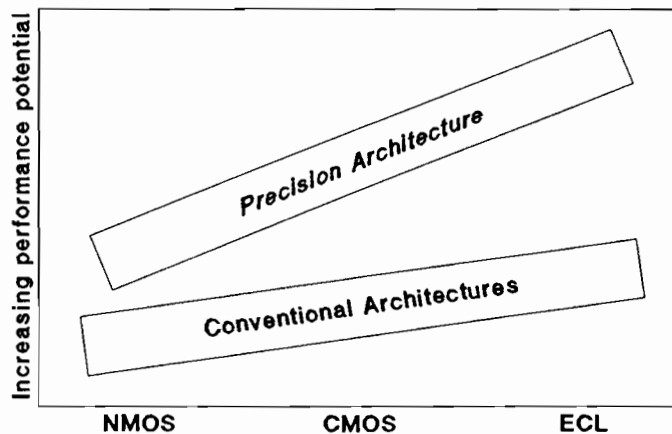
Figure A-2. Higher Performance Potential

Allows for a broad family of systems

The reduced amount of processor circuitry associated with a RISC-based design is ideal for development of fast, single-chip microprocessors that can be used to develop cost-effective computers. And at the high-end of the HP 3000 family, the performance advantage of PA-RISC, coupled with the ability to support multiprocessor systems, delivers very high-performance solutions with power comparable to today's water-cooled mainframes.

Ideal for advancing technologies

The simplicity of PA-RISC makes it ideal for maximizing benefits from advancing hardware technologies such as very large scale integrated (VLSI) components. Hewlett-Packard has long enjoyed a leadership position in using high-performance, high-density semiconductors, and this experience has been used to great effect in the 900 Series systems. Processor performance can be maximized by placing an entire CPU on a single chip, thus keeping signal delays short and allowing CPU cycle time to be decreased. With further integration, such as placing CPU and processor caches on-chip, instruction and data access times can also be minimized, providing additional performance gains.

Higher processor reliability

Just as requiring fewer parts to build a processor directly results in decreased cost, it also implies that there are fewer parts to fail. Thus, PA-RISC systems provide increased processor reliability. In addition, PA-RISC is designed to support future extensions for providing higher system availability. For example, future versions of multiprocessor systems could support the capability of redundant processors, such that if one processor failed, another could automatically take its place, allowing the system to continue operating without interruption.

RISC Attributes: Maximizing Processor Performance

The 900 Series systems are the first business computing systems that are true RISC systems. RISC actually goes far beyond simply implementing a reduced number of instructions. There are actually several key RISC attributes, and each of them is discussed below. Note that the 900 Series systems adhere to all of these principles.

Hardwired control and single-cycle execution

The goal with RISC systems is to perform the simple, often-executed functions as quickly as possible. Unlike conventional systems, which utilize a microcoded control store, typically require several machine cycles to execute even the simplest instructions. RISC instructions are executed directly by hardware in a single CPU cycle. More complex functions, which are often supported directly in the instruction sets of conventional systems, are performed using a sequence of simple instructions generated by high-level language compilers.

Reduced number of instructions

So that the machine can be cycled as quickly as possible, RISC systems support a reduced number of instructions and fewer addressing modes than typical systems. For example, typical complex architectures may use more than 300 instructions plus a large number of addressing modes; in comparison, 140 simple instructions are provided with PA-RISC systems. This reduced complexity allows the instruction decoding and control circuitry to be simplified, resulting in lower cost and higher performance.

Fixed instruction length and format

All instructions defined in the PA-RISC instruction set are fixed-length, 32-bit instructions. A fixed instruction length helps facilitate the simultaneous execution of multiple instructions, a capability known as *instruction pipelining*. Furthermore, all instructions are fixed format, which means that the instruction opcode and the operand registers are always specified in the same place in each instruction. Having fixed-format instructions allows instruction decoding and fetching of required operands to occur in parallel, thus increasing processor efficiency and performance.

Register-intensive operation

Calculations are performed only on operands held in high-speed, general-purpose registers in the CPU, so calculations are not slowed down by accesses to relatively slow cache or main memory. With a relatively large number (32) of these high-speed registers available, it is possible for compilers to produce and arrange instructions such that operands can be reused as often as possible, again minimizing the number of accesses to slower cache storage and main memory. Furthermore, register-intensive operation allows for simplified data and control paths, which simplifies pipeline design and helps minimize the CPU cycle time.

Load/Store memory

To minimize processor complexity and reduce CPU cycle time, only load and store instructions access memory. Since load instructions access storage that is relatively slow compared to CPU registers, these instructions take longer to execute. So that the CPU cycle time does not have to be increased because of these instructions, they are implemented in multiple cycles. However, the compilers schedule instructions so that multicycle load instructions are overlapped with other processing, thus allowing the effective execution rate to still approach one instruction per cycle.

Decreased effort at run time

With a reduced-complexity system, a fundamental principle is to shift the burden of complexity from the processor to the high-level language compilers. With a large degree of complexity in the processor, conventional systems pay a performance penalty each time a program is run. With a reduced-complexity system, complexity and effort are shifted to compile time, so that any penalties for having a more sophisticated compiler are paid only once, when the program is compiled. In this way, object code can be streamlined and optimized for performance and the program can be run as quickly as possible.

HP Precision Architecture: Extending RISC

The RISC principles are keys for providing high-performance processors. However, providing a long-lasting architecture that can deliver high-performance, cost-effective solutions in commercial processing environments requires additional architectural features. PA-RISC goes beyond RISC with the important extensions discussed below.

Expanded addressability

PA-RISC systems can be implemented with either 48- or 64-bit virtual addresses, thus expanding addressability far beyond that of typical 32-bit systems. For example, 64-bit addressability provides over 4 billion times the virtual addressability typically available on conventional 32-bit systems! This flexibility for supporting large virtual address spaces ensures that 900 Series systems will be able to meet expandability requirements as next-generation software evolves and as commercial processing needs continue to grow.

Multiprocessors

PA-RISC allows for systems that use tightly coupled symmetric multiprocessors. Multiprocessors share the same memory, I/O buses, and I/O devices. They can be used to enhance system performance through distribution of the system workload, and they provide higher availability using CPU redundancy.

Floating-point coprocessors

The modular design of PA-RISC allows for the addition of special-function coprocessors for accelerating execution of those complex functions that may be important in some application mixes. For example, some scientific, engineering, and statistical applications run on general-purpose systems may require high-performance floating-point calculations. For such applications, a floating-point coprocessor is available to enhance performance.
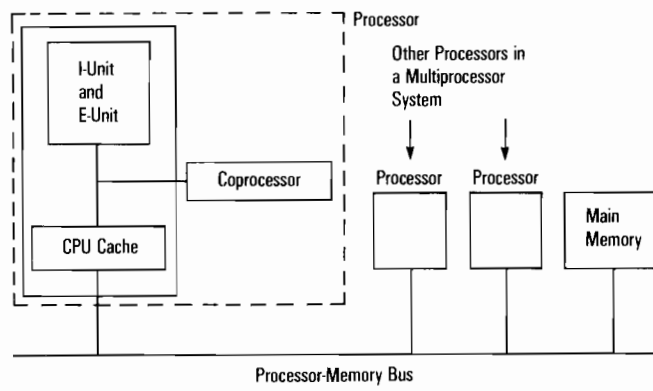
Figure A-3. Coprocessor and Multiprocessor

Decimal arithmetic support

Decimal arithmetic is a data type commonly used in commercial applications, and PA-RISC provides simple, powerful instruction primitives to ensure high-speed decimal calculations. For example, the Decimal Correct and Unit Add Complement instructions allow for packed and unpacked decimal addition to be performed with the binary add instruction. Decimal calculations actually require fewer CPU cycles to execute on 900 Series systems than on conventional systems.

High-performance input/output

Providing effective support of database management systems is one of the key strengths of the HP 3000 family. Thus, a key design objective of PA-RISC was to ensure a high level of data security and high throughput in I/O-intensive database applications. The first step was to provide a large virtual address space, which can be used very effectively by MPE/XL's file mapping schemes. Furthermore, PA-RISC incorporates a memory-mapped I/O scheme, whereby I/O operations are initiated and controlled using a series of load/store instructions to reserved virtual or real memory locations. A key advantage of this scheme is that I/O accesses use the same access protection mechanisms as code and data. Coupled with other I/O subsystem features such as DMA chaining, which allows multiple transactions to be processed without CPU intervention, I/O operations on PA-RISC systems carry less overhead and deliver increased I/O performance.

Instruction pipelining

Instruction pipelining refers to the simultaneous execution of multiple instructions. For example, in a five-stage pipeline the instruction is fetched from cache during the first stage and is decoded during the second stage. The CPU internal calculation or function is then performed during the third stage, and the fourth stage is used to generate the condition code for the corresponding result. Finally in the fifth stage, a general-purpose register is set with the corresponding cache or internal result.

Fixed-length, fixed-format instructions help streamline instruction pipelining. Additionally, load/store RISC-based machines are ideal for minimizing the number of pipeline stages required for high performance and for ensuring that the time required to perform each stage is as short as possible.

Instruction 1	Fetch	Decode	Execute	Condition	Store		
Instruction 2		Fetch	Decode	Execute	Condition	Store	
Instruction 3			Fetch	Decode	Execute	Condition	Store
Instruction 4				Fetch	Decode	Execute	Condition	Store
Instruction 5					Fetch	Decode	Execute	Condition	Store

Time
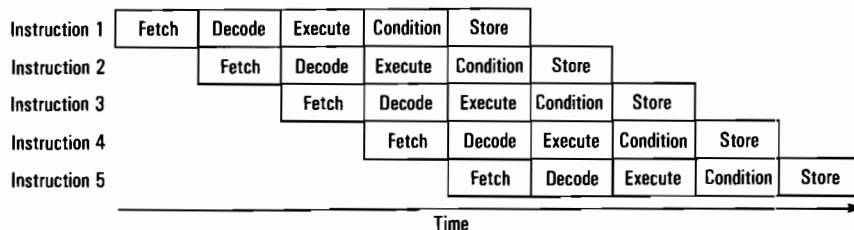
Figure A-4. Instruction Pipeline

Delayed-branch capability

On conventional computers, the instruction sequentially following a taken branch instruction is loaded into the pipeline but is not executed. The result is a *dead cycle* that is not used for processing. On PA-RISC systems, a branch instruction can specify that the instruction sequentially following the branch is to be executed, so that this cycle can be used for processing. Because branches constitute roughly one-sixth of typical instruction mixes, using the available cycle after a branch results in increased performance with PA-RISC systems.

Instruction Stream

Branch IA + X	← Branch can specify execution of instruction pointed to by instruction address counter while the instruction at IA + X is being fetched.
IA → Add R1 + R2	
IA + X → Add R4 + R6	
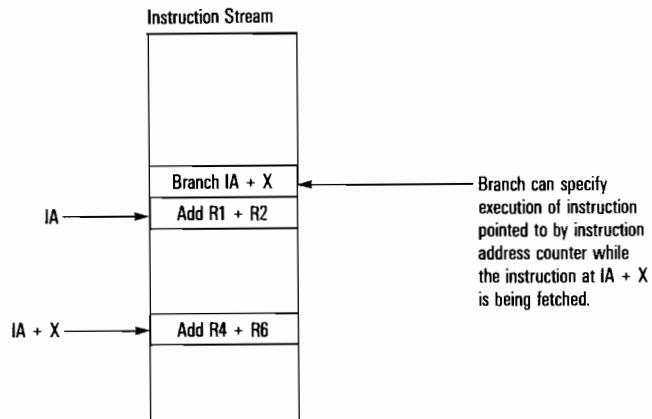
Figure A-5. Delayed Branch Capability

Optimizing compilers

Optimizing compilers ensure the best possible coupling between high-level languages and PA-RISC machine instructions. Reduced complexity systems are ideal for optimizing compilers, and consequently, the best performance on such systems depends on effective optimization. The optimizing compilers on the 900 Series systems analyze program behavior at a global level and ensure that instructions are executed in the most efficient order. Frequently accessed operands are allocated to CPU registers, so that the number of accesses to cache and main memory is minimized. Instructions are scheduled such that the efficiency of the instruction pipeline is maximized. For example, compilers schedule instructions so that the available cycle after a taken branch is used for useful processing, and they overlap other instructions with load instructions to keep execution rates close to one instruction per cycle.

Millicode

The 900 Series systems use *millicode* routines to perform some of the more frequently executed complex tasks. Millicode routines, quite simply, are sequences of PA-RISC instructions that can be accessed and executed very efficiently by the operating system and provide complex functions such as moving characters, and so forth. These performance-tuned millicode routines ensure effective support of complex functions sometimes required by high-level languages.

Extensive data and code protection mechanism

PA-RISC specifies a four-level privilege scheme for all code, data, and I/O accesses. This is supplemented by a 15-bit protection identifier that is assigned to each virtual page and checked each time the page is accessed. The flexibility of this scheme allows for efficient data and code sharing and ensures a high level of data and code security.

A Closer Look at HP PA-RISC

Additional information about PA-RISC is provided below. For more details, please refer to the *HP Precision Architecture Data Sheet.*

Instruction set

PA-RISC defines 140 instructions. Each instruction is 32 bits long and has a fixed format. To minimize complexity and to enable the machine to be cycled as quickly as possible, the instruction set directly supports only simple functions. Nonetheless, some of the PA-RISC instructions provide functions that typically would require multiple instructions on conventional systems. For example, the add and branch instruction performs a calculation and a conditional branch in a single cycle. Such a function on conventional systems typically requires multiple instructions.

Floating-point instructions

Floating-point calculations are specified by compilers for any high-level language variables declared by the programmer as *real numbers*. In particular, engineering, scientific, and statistical applications often use floating-point data types. PA-RISC supports single-precision (32-bit), double-precision (64-bit), and quadruple-precision (128-bit) arithmetic operations. Floating-point calculations can be performed in software by a sequence of integer calculations and conversions, but they can be executed much faster by the floating-point coprocessor hardware. With a floating-point coprocessor, floating-point calculations can be performed while the CPU continues to execute in parallel, thus allowing PA-RISC to provide high performance for applications that use floating-point calculations.

Data types

PA-RISC supports 16- and 32-bit integers, either signed or unsigned. Characters are stored as 8-bit quantities, conforming to the ASCII standard for values 0 through 127 and HP's 8-bit extended Roman 8 character set for values 128 through 255. PA-RISC supports both packed and unpacked decimal data representations. Single, double, and quadruple-word floating-point operands are represented in accordance with the ANSI/IEEE 754-1985 standard.

CPU register set

There are 32 available general-purpose registers, each 32 bits wide, for holding operands and results of processor computations. Additionally, a total of 32 control and status registers are available in the CPU for interrupt processing, virtual memory access protection, and other system functions. CPU status is maintained in the 32-bit processor status word (PSW), which reflects the state of key CPU flags and status bits.

Two CPU registers are used to point to the next instruction to be executed. The instruction address space register (IA Space) points to the 4-Gbyte space that holds the next instruction. The instruction address offset register (IA Offset) points to the location within that space that holds the instruction.

Virtual memory

Virtual memory allows the programmer to use a memory space that is actually many times larger than the physical memory installed in the system. The advantage of a virtual memory scheme is that a programmer generally does not have to be concerned about program or data size limitations in available memory space. The huge virtual address space available on the 900 Series systems is fully supported by the operating system.

Virtual memory is organized as a set of more than four billion linear regions divided into over 65,000 *spaces*, with each space 4 Gbytes in length. Spaces are further divided into fixed-length, 2-Kbyte pages, which can hold code, data, or both. Space registers hold either 16 bits (for 48-bit addressing) or 32 bits (for 64-bit addressing), and they are used to point to the virtual space to be accessed. The specific location within a space is specified by a 32-bit quantity called the *byte offset*. With eight space registers available in the CPU, multiple spaces can be supported simultaneously.
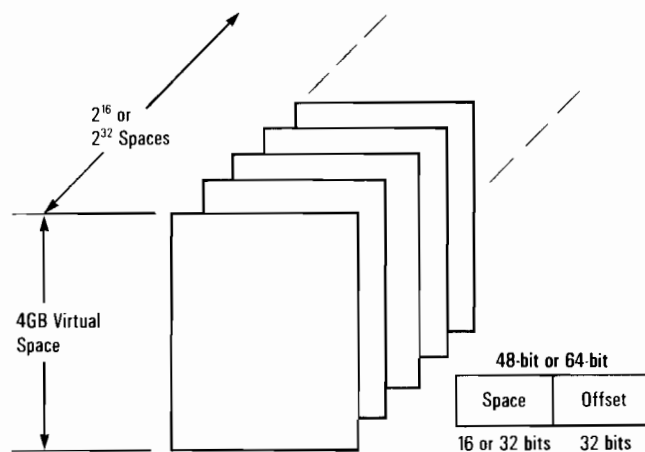
Figure A-6. Virtual Memory Organization

Virtual address translation

The 48-bit or 64-bit virtual address generated by the processor must be translated into a physical address that will be transmitted to physical memory to access the desired code or data. Virtual addresses are translated to physical addresses by the translation lookaside buffer (TLB) hardware in the processor. Conceptually, the TLB can be thought of as a table containing translations for recently accessed virtual pages.

Virtual address

Virtual page number	Offset in page

Virtual page #	Access info	Physical page #

Physical page #	Offset in page

Physical address

Translation lookaside buffer
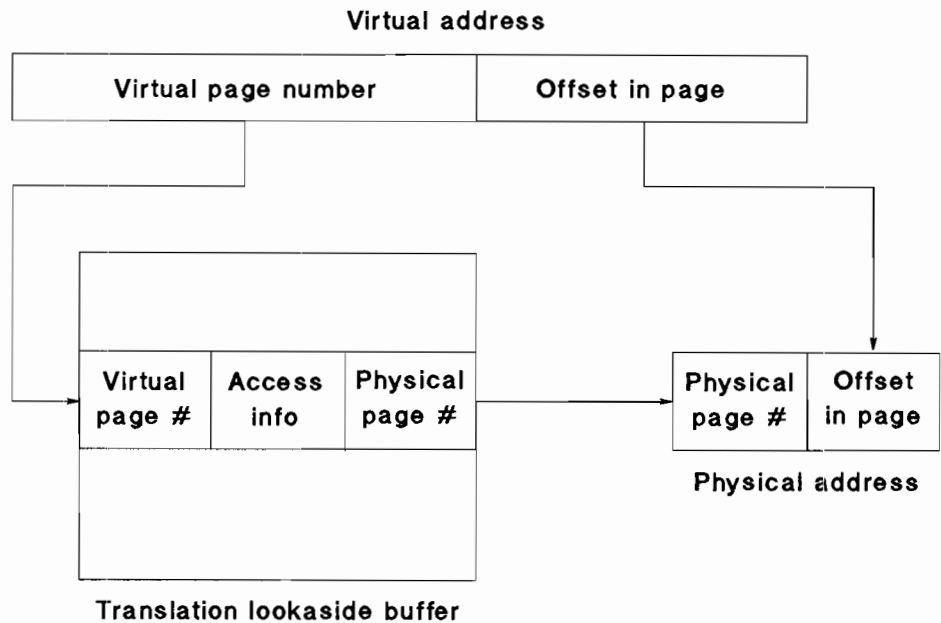
Figure A-7. Virtual Address Translation

Virtual memory access protection

The TLB hardware supports protection mechanisms to ensure that the currently executing process can perform only the code, data, or I/O accesses for which it is authorized. Included in the access-checking mechanisms are four privilege levels. Protection parameters associated with each page define the privilege level required to access that page and the types of accesses permitted. For each requested access, these privilege parameters are checked against the privilege level of the currently executing process to ensure that the process has sufficient authorization to perform that access. Additionally, within each protection access level, there is a 15-bit protection identifier associated with each page. This identifier, maintained by the operating system and checked by the TLB hardware, provides the flexibility for data and code sharing while providing a high level of protection against unauthorized accesses.

Instruction Set Listing

Memory Reference Instructions

Load Word	Load Offset
Load Halfword	Load and Clear Word Indexed
Load Byte	Load and Clear Word Short
Load Word Indexed	Store Word
Load Halfword Indexed	Store Halfword
Load Byte Indexed	Store Byte
Load Word Short	Store Word Short
Load Halfword Short	Store Halfword Short
Load Byte Short	Store Byte Short
Load Word and Modify	Store Word and Modify
Load Word Absolute	Store Word Absolute Short
Load Word Absolute Short	Store Bytes Short

Unconditional Branches

Branch and Link	Branch Vectored
Gateway	Branch External
Branch and Link Register	Branch and Link External

Conditional Branches

Move and Branch	Add and Branch if True
Move Immediate and Branch	Add and Branch if False
Compare and Branch if True	Add Immediate and Branch if True
Compare and Branch if False	Add Immediate and Branch if False
Compare Immediate and Branch if True	Branch on Variable Bit
Compare Immediate and Branch if False	Branch on Bit

Arithmetic and Logical Instructions

Add	AND
Add Immediate	AND Complement
Add Immediate Left	Unit XOR
Load Immediate Left	Unit Add Complement
Add Logical	Unit Add Complement and Trap on Condition
Add and Trap on Overflow	Decimal Correct
Shift One and Add	Intermediate Decimal Correct
Shift Two and Add	Add Intermediate and Trap on Overflow
Shift Three and Add	Add Immediate and Trap on Condition
Shift One and Add Logical	Add Immediate, Trap on Condition or Overflow
Shift Three and Add Logical	Compare Immediate and Clear
Shift One, Add, and Trap on Overflow	Variable Shift Double
Shift Two, Add, and Trap on Overflow	Shift Double
Shift Three, Add, and Trap on Overflow	Variable Extract Signed
Add with Carry	Variable Extract Unsigned
Add with Carry and Trap on Overflow	Extract Signed
Subtract	Variable Deposit
Subtract from Immediate	Variable Deposit Immediate
Subtract and Trap on Overflow	Deposit
Subtract Immediate and Trap on Overflow	Deposit Immediate
Subtract with Borrow	Zero and Variable Deposit
Subtract with Borrow and Trap on Overflow	Zero and Variable Deposit Immediate
Subtract and Trap on Condition	Zero and Deposit
Subtract and Trap on Condition or Overflow	Zero and Deposit Immediate
Inclusive OR	Divide Step
Exclusive OR	Compare and Clear

System Control Instructions

Break	Load Hash Address
Return from Interrupt	Purge Instruction TLB
Set System Mask	Purge Instruction TLB Entry
Reset System Mask	Purge Data TLB
Load Space ID	Purge Data TLB Entry
Move to Space Register	Insert Data TLB Address
Move to Control Register	Insert Data TLB Protection
Move from Space Register	Insert Instruction TLB Address
Move from Control Register	Insert Instruction TLB Protection
Move to System Mask	Purge Data Cache
Synchronize Caches	Flush Data Cache
Probe Read Access	Flush Instruction Cache
Probe Read Access Immediate	Flush Data Cache Entry
Probe Write Access	Flush Instruction Cache Entry
Probe Write Access Immediate	Diagnose
Load Physical Address	

Special Function Unit Operations

Special Operation Zero	Special Operation Two
Special Operation One	Special Operation Three

Coprocessor Loads and Stores

Coprocessor Load Word Short	Coprocessor Store Indexed
Coprocessor Load Word Indexed	Coprocessor Store Doubleword
Coprocessor Load Doubleword Short	Coprocessor Store Doubleword Indexed
Coprocessor Load Doubleword Indexed	Coprocessor Operation [*]
	Coprocessor Store Word

[*] Floating-point operations included

Index

W

X

HEWLETT PACKARD