**HEWLETT PACKARD**

HP 3000 Computer Systems

# General Information Manual

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# Preface

**Purpose of this manual**

The purpose of this manual is to present a broad overview of the HP 3000 family. This includes information on HP software 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 is interested in how HP 3000 systems can meet business data processing needs.

**Manual 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 MPE, the operating system of the HP 3000.

*Chapter Three* describes the information management capabilities of the HP 3000.

*Chapter Four* introduces HP Precision Architecture, the new architecture upon which the 900 Series is based.

*Chapter Five* is an overview of the hardware features of the entire HP 3000 family.

*Chapter Six* is a brief summary of the networking and communication capabilities of the HP 3000.

*Chapter Seven* describes some of the peripheral devices that are available for the HP 3000.

*Chapter Eight* summarizes HP's support services and user documentation for the HP 3000.

*Chapter Nine* describes the HP office information software that works with the HP 3000 to provide decision support and information sharing services.

**For more information**

**Primers**

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

- *HP Precision Architecture—A New Perspective* (5954-6677)
- *Relational Technology—A Productivity Solution* (5954-6676)
- *Data Dictionaries—Managing Information Networks* (5958-8527)
- *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)
- *The Hewlett-Packard NewWave Environment—Your Window to the Future* (5952-3755)

To obtain any of these primers, contact your local HP Sales Office. Or call HP's Direct Marketing Division at (800) 538-8787.

### Data sheets

For more information about HP 3000 systems and related topics, a variety of detailed data sheets are available from your HP Sales Representative, including:

- *MPE/XL Operating System Data Sheet*
- *Migration to 900 Series HP 3000 Systems Data Sheet*
- *Migration Planning Guide*
- *Migration Checklist*
- *Migration Toolset Data Sheet*
- *Information Management Specifications Guide*, a compilation of data sheets for the HP 3000 information management software products
- *HP Precision Architecture Data Sheet*
- *MICRO 3000LX Data Sheet*
- *MICRO 3000RX Data Sheet*
- *MICRO 3000XE Data Sheet*
- *Series 922 Data Sheet*
- *Series 932 Data Sheet*
- *Series 925 Data Sheet*
- *Series 935 Data Sheet*
- *Series 949 Data Sheet*
- *Series 950 Data Sheet*
- *Series 955 Data Sheet*
- *Series 960 Data Sheet*
- *Series 980 Data Sheet*
- *HP 3000 Data Communications Products Specifications Guide*
- *Performance Consulting Services Data Sheet*
- *Customer Education Planning Guide*

### Configuration guide

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

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# Chapter 1       **Introduction**

**Management overview**

The HP 3000 family offers a broad range of compatible systems and servers optimized for on-line transaction processing (OLTP). Well known for reliability and ease of use, the HP 3000 products offer a superior solution for business-critical functions, and provide customers improved operational efficiency; better, faster decision making and communication, and effortless growth in computing capacity; all while delivering outstanding price/performance.

The HP 3000 incorporates advanced hardware and software technologies to provide an excellent foundation for OLTP applications. The HP 3000 incorporates HP Precision Architecture, which is based on new Reduced Instruction Set Computer (RISC) technology. With the HP 3000, this new hardware architecture is coupled with an advanced MPE operating system specifically tailored for the performance and functionality demands of OLTP.

A common MPE operating environment is provided across the entire family of HP 3000 systems, ranging from products for fewer than 10 users to products offering mainframe-class performance. MPE is very easy to use, as is illustrated by low-end systems which are fully office-compatible and which can be utilized and managed without computer specialists. This ease-of-use is complemented with robust functionality, appropriate for the large-scale applications supported with the high-end HP 3000 products.

The HP 3000 is optimized for OLTP both as a traditional multi-user system, and as an application server in client-server OLTP environments as part of Hewlett-Packard's Cooperative Computing Environment (CCE). CCE, which is HP's strategic computing framework, seamlessly couples together PCs and intelligent workstations ("clients") with processors acting as servers, connected via industry standard and de facto standard networks.

Thousands of applications are available for the HP 3000, including solutions targeted for industries such as manufacturing, service, legal, retail, state/local government, and many others. In addition, for organizations which prefer to develop their own application solutions, the HP 3000 supports a variety of advanced application tools and database products.

Across the entire line of HP 3000 computers a wide array of networking capabilities, quality peripheral devices, personal computers, and personal computer integration products are offered. And, these are delivered by an HP sales and service organization recognized as one of the best in the computer industry.

## HP 3000 strategy

The HP 3000 product line strategy is built around the following key elements:

A. *A broad family of 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 and performance for a specific application environment. Beyond providing software compatibility, easy growth in capacity is provided by a number of simple, cost-effective field upgrades consisting of simply a faster processor board. This approach of software compatibility and simple hardware field upgrades ensures that customer investments in software, hardware, and personnel are protected. A common operating environment across the HP 3000 family, MPE, ensures that not only is software compatibility maintained as applications expand, but also that the same end-user, programmer, and system administrator interfaces are used.

B. *Products optimized for OLTP*
MPE has been specifically tailored to meet the demanding needs of on-line transaction processing (OLTP). OLTP environments need fast, easy access to up-to-date, reliable data, and need to ensure that the systems are highly available so that the data can be accessed when needed. HP 3000 systems are tailored to meet these needs. The efficiency of MPE, coupled with powerful HP-PA processors, provides fast response time and high system throughput. In the area of reliability, industry surveys continually rank the HP 3000 as being one of the most reliable products on the market. This high level of reliability is complemented with high availability extensions to MPE which provide for 24-hour production operation. With the MPE platform, a wide variety of application development tools are available to allow for OLTP applications to be easily generated and maintained.

C. *Multivendor networking*
HP 3000 systems support a wide variety of networking capabilities which allow information to be easily distributed and accessed in local and wide-area networks. The HP 3000 is committed to simplifying multivendor communications via a commitment to industry-standard networking protocols such as OSI, and key de facto standards such as SNA. With a comprehensive offering of networking capabilities, HP 3000 systems effectively integrate into networks with personal computers, minicomputers, and mainframes from HP and other vendors.

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**D.** *Commitment to industry standards*

Even beyond industry-standard networking, the HP 3000 family is committed to industry standards to provide customers maximum flexibility and easy integration into multivendor environments. Hewlett-Packard has helped develop virtually every major industry standard used today, and utilizes both these standards and de facto standards in a variety of database, user interface, and compiler products. Coupled with HP 3000 commitment to the support of a POSIX-compliant interface, this provides a high degree of application portability and better leverages customer investments in software and personnel.

**E.** *PC integration and client-server computing*

HP is recognized as providing leadership products in PC integration and client-server computing. This approach, which couples PC "clients" with HP 3000 servers, provides benefits in several key areas. First, it provides sophisticated decision support capabilities, allowing data residing on a server to easily be brought into PC applications via a simple intuitive user interface. Second, it provides centralized PC administration, for functions such as backup and PC software distribution. Third, it allows for shared workgroup resources such as printers, plotters, and data files. Finally, it extends the PC user interface to OLTP applications and electronic mail, providing a consistent, intuitive window-oriented interface across both PC and OLTP applications.

**F.** *Support and solutions*

Hewlett-Packard has long set the standard for effective customer support among computer vendors. A wide array of support services and products, coupled with a sales and support organization with many years of helping customers more easily collect and access information to better run their business, allows HP 3000 customers to use information as a competitive advantage. And, the HP 3000 is an effective foundation for many application solutions. HP and value added businesses offer thousands of software solutions for a wide variety of industries, including manufacturing, service, legal, retail, state/local government, and many more, and the availability of these solutions is complemented by sales and service expertise in specific markets and business functions.

**The HP 3000 systems**

A wide variety of HP 3000 processors are available to meet the price and capacity needs of specific application environments. All of the HP 3000 products support the MPE operating environment, which couples ease-of-use with a robust set of functionality for OLTP.

There are two versions of MPE for the HP 3000 family. The entry-level MICRO 3000 products utilize a version of MPE called MPE/V. The 900 Series HP 3000 systems discussed below utilize the new RISC-based HP Precision Architecture (HP-PA), coupled with the MPE/XL operating environment. MPE/XL is designed to take full advantage of HP-PA, and is object- and source-code compatible with MPE/V.

MPE/XL-based products are available in two configurations. First, they are available as multiuser systems for traditional terminal-based OLTP applications. Additionally, they are also available as application servers, which can be utilized in a client/server configuration with PCs. Server products are preconfigured solutions for PC-based environments, and provide access to traditional host-based and client-server applications. The multiuser products are referred to with a "Series" prefix (for example, "Series 925"), while the application server products carry a "Server" prefix (for example, "Server 925").

**Figure 1-1. HP 3000 processor summary**



| | Maximum concurrent users (Multiuser systems) | Relative performances |
|---|---|---|
| MICRO LX | 8 | 0.3-0.5 |
| MICRO RX | 24 | 0.3-0.5 |
| MICRO XE | 56 | 0.3-0.5 |
| S922LX | 32 | 1.2 |
| S922RX | 64 | 1.2 |
| S922 | 152 | 1.2 |
| S932 | 240 | 1.9 |
| S925 | 152 | 1 |
| S935 | 240 | 2 |
| S949 | 400 | 4 |
| S950 | 400 | 2.2 |
| S955 | 600 | 3.3 |
| S960 | 600 | 4.4 |
| S980 | ≥ 600 | Up to 14 (S980/200) |

Scale: 8 16 32 64 128 256 512 1024
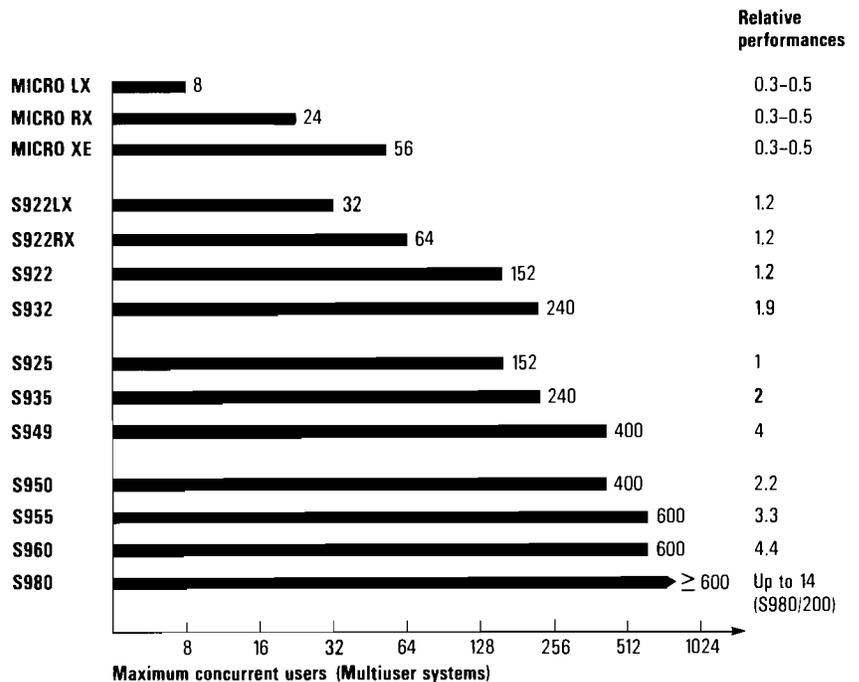
## MICRO 3000LX, 3000RX, and 3000XE

HP's MICRO 3000LX, 3000RX, and 3000XE computers are complete, entry-level business systems that combine low cost with ease-of-use for an ideal solution to fit departmental, distributed branch office, and small business applications. With the MPE/V operating environment, they bring the power of transaction processing, text and graphics processing, data communication, and data management to the office in a small, unobtrusive package. These products also support a menu-driven system interface which allows these systems to be utilized and managed without computer specialists.

The MICRO 3000LX is a low-cost system for up to 8 users, while the MICRO 3000RX supports up to 24 users with extended data storage and I/O options. The MICRO 3000XE supports up to 56 users, and with its greater memory and data communications support, it's the right choice for expanding distributed processing networks, growing branch offices, and small to medium businesses.

## HP 3000 Series 922, 932 and Server 922, 932 processors

The HP 3000 Series 922, 932 and Server 922, 932 processors are the entry-level HP Precision Architecture system and server. Designed for the office environment, a full S922 system configuration takes up no more floor space than a two-drawer file cabinet. The S922 is also available in two entry system configurations, the S922LX, which supports up to 32 users, and the S922RX, which supports up to 64 users.

The S922 can easily be upgraded to the S932. This upgrade involves the simple replacement of a single printed circuit board, yet offers an additional 50 percent more processing capacity.

**Figure 1-2. The HP 3000 platforms**
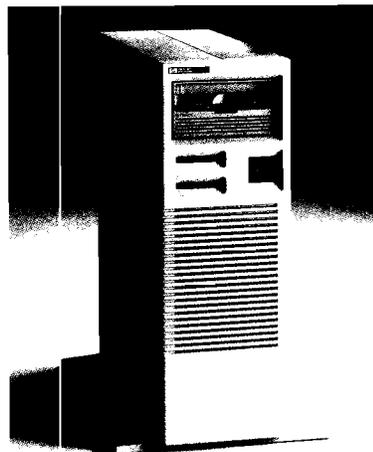


MICRO 3000RX
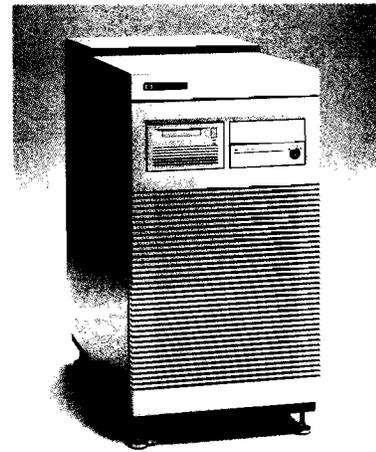
S932
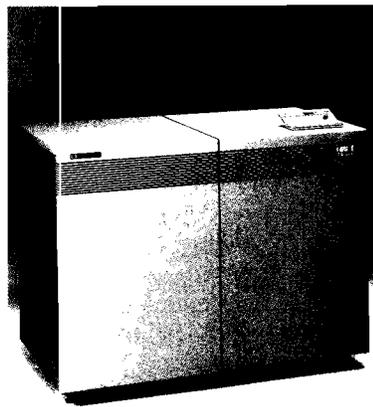
S980
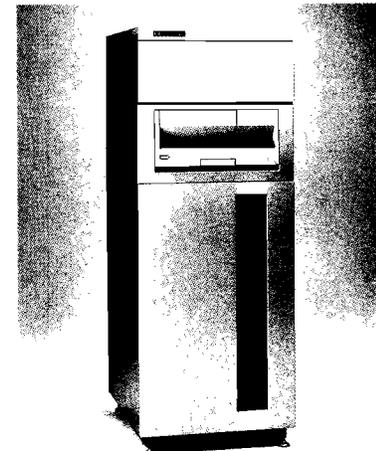
S949

The S922 can support up to 152 users, while the higher performance S932 supports up to 240 users.

### HP 3000 Series 925, 935, and 949 and Server 925, 935, and 949 processors

The S925, S935, and S949 systems and servers are midrange products that can be utilized in office environments. These products all share the same 1.6 meter high system package, which contains the processor, disk storage, tape backup, and connections to terminals and PCs.

The S925 is a cost-effective midrange system supporting up to 152 users. The S925 can easily be upgraded to the S935, which offers twice the processing power of the S925 via a simple board upgrade.

The S935 can similarly be upgraded on-site to the S949. The S949 provides up to twice the performance of the S935, and delivers industry-leading price/performance for midrange systems.

### HP 3000 Series 950, 955, and 960, Server 950, 955, and 960 processors and Series 980/100, 980/200 processors

There are five high-end HP 3000 processors. Similar to the midrange HP 3000 products, these products are all available as simple board upgrades that can easily be installed on-site to provide significant increases in capacity. Each of these products utilizes highly reliable VLSI semiconductor technology and is optimized for high performance in OLTP environments. Targeted for EDP room environments, these products are air-cooled and require significantly less floor space and input power than today's mainframes.

The HP 3000 S950, S955, and S960 utilize NMOS III VLSI technology developed by Hewlett-Packard. These products offer outstanding price/performance for application environments supporting several hundred on-line users.

The HP 3000 Series 980/100 is based upon new CMOS semiconductor technology developed at HP. The multiprocessor version of this product, the Series 980/200 couples 2 CPUs in a symmetric multiprocessor configuration within a single cabinet. These products offer outstanding performance, reliability, and functionality for large-scale OLTP applications, and couple mainframe-class performance with HP 3000 ease of use.

The S950 supports up to 400 users. The S955 and S960 support up to 600 users. The number of users supported by the S980/100 and S980/200 are yet to be determined as of this printing.

**HP Precision Architecture**

The new HP Precision Architecture, which forms the basis of the 900 Series systems, offers major price and performance advantages over more complex architectures and provides the flexibility to meet user requirements through the end of this century. HP-PA represents a fundamental change in computer design. This new architecture is based on RISC (Reduced Instruction Set Computing) concepts, with significant extensions for Cobol applications, high performance I/O, and OLTP.

RISC is the result of the discovery that computer performance can be increased by reducing and simplifying the computer instruction set. This allows computer instructions to be implemented directly in hardware, eliminating the system overhead associated with the microcode of conventional computers.

Pipelining, which provides higher performance by overlapping the execution of multiple instructions, is enhanced through the uniformity of the HP-PA instructions.

The architecture can be implemented in a number of technologies and is ideal for VLSI design. By eliminating the chip space required for microcode, highly integrated VLSI designs can be achieved.

Improved performance also results from the memory hierarchy design of the new architecture and its use of optimizing compilers. 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.

Optimizing compilers generate very efficient object code, allocate registers, and schedule instruction sequences to maintain an efficient pipeline operation.

HP-PA transparently supports a 48-bit 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.

The new architecture has been specifically designed to support multiprocessing, and the high-end Series 980/200 product utilizes the symmetric multiprocessing capabilities of HP-PA. HP-PA also provides for a variety of coprocessors to meet specific computing requirements For example, all 900 Series systems utilize hardware floating-point coprocessors to accelerate the performance of applications utilizing floating-point data types for scientific, engineering, or statistical applications.

The architecture provides significant benefits in design and development time, reliability, and reduced manufacturing costs. It allows simplified system designs that require substantially fewer system components than complex computer architectures.

HP-PA is on the leading edge in computer design. It is the "wave of the future" in computer design, and represents a significant contribution to the computer industry.

**The MPE operating system**

MPE (Multiprogramming Executive) is the operating system for the HP 3000 family. A disk-based operating system, MPE manages all system resources and coordinates the execution of all programs running on the system.

Starting with the original version of MPE, HP has added new functions and capabilities to MPE's performance, ease-of-use, and reliability, yet maintained compatibility and interface consistency.

There are now two versions of MPE supported on the HP 3000. MPE/V is supported on all MICRO 3000s. MPE/XL (MPE with Extended Large Addressing) is the operating system for the 900 Series systems. MPE/XL is upwardly compatible with MPE/V.

MPE/XL is a major new version of MPE, designed specifically to take full advantage of HP-PA.

MPE offers a powerful combination of high performance, ease-of-use and robust OLTP functionality. MPE/XL's high OLTP performance is achieved via tight integration of the operating system with both HP-PA and HP's database management systems, and via an advanced operating system design that not only processes I/O operations very rapidly, but also minimizes the number of physical I/Os which must actually be performed. MPE offers a simple, intuitive interface for end users and system administrators, coupled with powerful program development and debugging aids for application developers. A full range of OLTP functionality is offered with MPE, including built-in capabilities to ensure data integrity and security; sophisticated spooling and job control capabilities; products to ensure 24-hour, 7-day data availability; and a set of sophisticated performance measurement tools.

Other major features of MPE/XL include:

- multiprogramming: Concurrent transaction processing, data communication, on-line program development, and batch processing
- extended large addressing: 48-bit 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
- comprehensive access security and complete accounting resources
- concurrent multilingual capability: seven programming languages, including HP-extended versions of COBOL, RPG, FORTRAN, BASIC, and Pascal
- powerful command language including user-defined commands, command files, conditional job control, extensive on-line HELP facility, and meaningful error messages
- device and file independence simplify application development and maintenance
- spooling of input and output tape label facility
- complete, automatic terminal management for local and remote terminals
- power fail/automatic restart

**Information management**

HP offers a wide range of information management products to help you deliver more capable solutions in less time, for less money, and with improved quality. These products, which form HP's information management framework, are briefly reviewed here, and discussed in detail in Chapter 3.

**Figure 1-3. HP's information management framework**
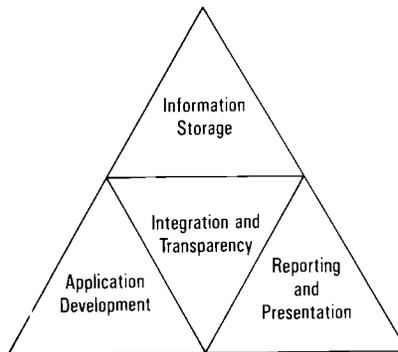
The HP 3000 offers two complementary database management products for information storage. HP ALLBASE/SQL is HP's relational database management system, and HP TurboIMAGE is the award-winning network model DBMS. Software developers are provided with a rich selection of programming languages and tools that support these databases. Reporting and presentation tools are available that allow access to the stored data without programming. And, a common data dictionary provides the integration necessary to tie the system into a unified whole.

## Information storage

HP ALLBASE/SQL is HP's strategic relational database management system for the 900 Series HP 3000. This database is based upon the industry standard SQL. ALLBASE/SQL is optimized specifically for HP Precision Architecture systems.

TurboIMAGE provides the best performance DBMS on the HP 3000. HP QUERY/V, a database support tool included with HP TurboIMAGE, makes it possible to locate, update, and report on data items within a TurboIMAGE database.

Another way of storing information is with Keyed Sequential Access Method (KSAM) files. The HP KSAM file system allows you to create and maintain disk files where records are accessed by the value of the key fields within the data records.

## Application development

HP offers a broad range of third generation languages including COBOL, FORTRAN, Pascal, C, BASIC, RPG, and SPL/V.

ALLBASE/4GL for MPE/XL systems is an advanced Fourth Generation Language for developing data- or transaction-processing applications. ALLBASE/4GL can access and update data stored in HP ALLBASE/SQL tables, TurboIMAGE data sets, HP KSAM files, and serial files. HP also provides other programmer productivity aids such as symbolic debuggers for COBOL, FORTRAN, C, and Pascal.

HP's Screen Management Facility includes HP VPLUS and HP FORMSPEC for the creation of forms and terminal I/O portions of applications.

## Reporting and presentation

HP ALLBASE/BRW for MPE/XL systems is a high-performance report-writing system for data processing professionals. It can access data stored in HP ALLBASE/SQL tables, HP TurboIMAGE data sets, KSAM files, and serial files. The report writing facility for MPE/V systems, BRW/V, can access HP TurboIMAGE and IMAGE/V database, MPE files, and KSAM/V files.

HP BRW-Desk is a companion product to ALLBASE/BRW and BRW/V. It enables you to send reports to the Intray of selected accounts in HP DeskManager, HP's electronic mail facility.

Information Access is an information management tool that provides authorized PC users with secured access to departmental and corporate information.

The HP 3000 query management facility for data stored under ALLBASE/SQL and TurboIMAGE is ALLBASE/QUERY. ALLBASE/QUERY enables end users to perform database queries, to create or modify SQL tables, and to customize reports.

## Integration and transparency

HP System Dictionary provides a central information resource for documenting data, applications, programs, files, users, input forms, and network configurations for HP 3000 systems. It assists data administrators in effectively managing system and network resources.

ALLBASE/Net provides transparent and secure remote database access to SQL data as though it were stored locally. Since the database access is completely transparent to a user and the application, a programmer can freely write code without having to know where the database resides. In addition, the database administrator can move the data around the network without requiring application changes.

**Networking products**

The HP 3000 supports a wide variety of data communication capabilities, which fit under the umbrella of HP AdvanceNet. HP AdvanceNet is a family of hardware and software communication products that enable HP systems to communicate with each other and with equipment made by other manufacturers. HP AdvanceNet 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 AdvanceNet product design. HP also offers an array of communication products to effectively integrate with IBM products within the SNA and bisynchronous environments.

HP 3000 networking products provide solutions for both local and wide-area communications needs. These products, discussed in detail in Chapter 6, include products covering five different areas:

- *workstation to system communications,* including both terminal-based and PC-based communications facilities.
- *system-to-system communications,* with HP's focus on industry-standard protocols to simplify multivendor communications.
- *HP-to-IBM system communications,* utilizing both SNA and bisync protocols.
- *HP network management products,* including network monitoring and diagnosing capabilities, as well as remote system management.
- *messaging services,* which provide transparent background delivery of messages and files within a network.

**Office information products**

HP's NewWave Office products, discussed in detail in Chapter 9, provide powerful communication, decision support, and information sharing services. It provides tremendous flexibility to manage the flow and use of information, and allows for easy information sharing and improved decision making.

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 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. Via the Object Management Facility, changes made in the output of one application are automatically reflected in the output of others.

**Compatibility and migration**

Compatibility is the most important element in the HP 3000 strategy. HP has made a very large investment to ensure that the 900 Series systems are compatible with the rest of the HP 3000 family. The result is the smoothest path to next-generation systems ever offered in the industry.

MPE/XL has two run-time environments, which are transparent to the user:

- compatibility mode: for object code compatibility with MPE/V-based applications.
- native mode: provides source code compatibility with MPE/V applications; delivers the full performance benefits and advanced capabilities of HP Precision Architecture.

With the flexibility of both compatibility mode and native mode, MPE/V applications can be easily moved to MPE/XL systems. In addition, HP has provided tools so that migrating to the 900 Series can be performed in stages as your schedule permits without interruption of operations.

- *object code compatibility.* You can move MPE/V applications and data to the Series/Server 900 systems by a simple backup procedure. Just store the applications and data on a tape and restore them on the 900 Series system without modifications. The applications will run on the 900 Series system in compatibility mode.
- *source code compatibility.* To achieve the maximum performance for applications, applications can be recompiled with HP's optimizing compilers to run in native mode.
- *migration flexibility.* You have ample flexibility in upgrading to the 900 Series systems because native mode applications can access compatibility mode and vice versa. And programs can communicate with one another regardless of the mode in which they are running.
- *operational compatibility.* MPE/XL is a functional superset of MPE/V. The two versions are nearly identical in terms of user interface, system management, accounting, and security. Your investment in MPE/V training is 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.

**HP 3000 naming conventions**

Hewlett-Packard's naming convention for HP 3000 software products is to add either the suffix "/V" or "/XL" to a product name. Software products with the "/V" suffix are designed for use with MPE/V and also may run in MPE/XL compatibility mode. Software products with the "/XL" suffix are specifically designed for use on the 900 Series systems.

Compilers with the suffix "/XL" (such as COBOL II/XL) generate object code that runs in native mode on the 900 Series systems. Compilers with the suffix "/V" (such as RPG/V) generate object code that runs under MPE/V and in compatibility mode under MPE/XL.

In this manual, the term "MPE/V-based system" refers to those members of the HP 3000 family that operate under the MPE/V operating system.

# Chapter 2             **The MPE Operating System**

**Introduction**

The functional heart of the HP 3000 is the MPE operating system (MultiProgramming Executive). The disk-based operating system is optimized for OLTP and business data processing. It supervises and manages all processing done on the HP 3000.

MPE's powerful combination of ease of use, high performance, and robust functionality makes it an ideal operating environment across the wide range of HP 3000 systems.

### Single operating environment

A common MPE operating environment is provided across the entire family of HP 3000 systems. The entry-level MICRO 3000 products support the MPE/V operating environment. The 900 Series products support an enhanced version of MPE, called MPE/XL (MPE with Extended Large Addressing). MPE/XL is designed to take full advantage of HP-PA, while maintaining a compatible growth path for MPE/V applications.

### Superior performance

MPE is optimized for high performance in I/O intensive on-line transaction processing environments (OLTP) and general purpose business data processing. MPE's high OLTP performance is achieved via tight integration of the operating system with the underlying hardware architecture, and with HP's database management systems. MPE/XL further gains additional performance by not only processing I/O operations very rapidly, but also by minimizing the number of physical I/Os which must actually be performed.

### Ease-of-use

MPE offers a simple, intuitive interface for end users and system administrators, coupled with powerful program development and debugging aids for application developers. Additionally, an on-line help facility is provided. With these capabilities, system management and administration requirements are simplified relative to traditional computers in the HP 3000 performance range.

### Robust functionality

A full range of OLTP functionality is offered with MPE, including built-in capabilities to ensure data integrity and security; easy account management and job control; and sophisticated performance measurement tools. MPE/XL offers significant functionality extensions, with a greatly extended address space for more application expandability; an enhanced command interpreter; more sophisticated system administration tools; multiprocessing; support for the high performance HP-FL fiber-optic disk interface; and optional configurations supporting very high data availability for mission critical applications.

### Standards

MPE is complemented by a wide variety of industry-standard and de facto standard networking, database, and language products. These include X.25 wide area networking and X.400 distributed application services based on the International Standards Organization's (ISO) Open Systems Interconnect Model (OSI), IBM's de facto standard SNA network architecture, and the SQL database management system.

**Versatility**

### Interactive processing

MPE provides both interactive and batch processing. In interactive processing, you enter commands and data at the terminal and receive immediate response. This is called a session, and is especially useful for data entry and retrieval, program development, text editing, and any other application in which a direct dialogue with the computer is preferred.

Sessions can be used to access:

- 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 on-line workstation and MPE connects you to the Command Interpreter. You may then enter commands 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. These multiple levels of user control help to pre-define appropriate access and capability for HP 3000 users.

**Batch processing**

Batch processing lets you submit to the computer, as a single unit, commands that request various operations such as program compilation and execution, file manipulation, or utility functions. Such a unit is called a job. Jobs contain all necessary instructions to MPE and all references to programs and data required for their execution. Once a job is running, you need to supply no further information.

Batch processing is a logical extension of the interactive functions available through MPE. Any capability, with the exception of BREAK, that is available in one mode is available in the other and employs the same MPE commands. Languages, utilities, and application development software can be run in either batch or interactive mode without changes. The standard input and output devices are automatically redefined.

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 will be executed in its entirety, as pre-defined in the job control statements, without active intervention.

**User-friendliness**

**User interface**

The many features and capabilities of the MPE operating system are designed to meet the needs of different kinds of users. Each type of user is associated with a particular set of capabilities and responsibilities, and each has access to MPE features to assist with specific tasks.

There are five categories of users:

- the *end user*, who can range from an order entry clerk to a functional manager, takes advantage of all the capabilities of the operating system through an application program that he or she can run without any knowledge of MPE itself.

- *programmers* are users who create application programs that run on the system. MPE provides two major areas of system interface for these users: an interactive interface that includes a command language, an on-line HELP facility, and job control facilities, and a programmatic interface that includes programming intrinsics and the MPE file system.
- the *system manager* creates accounts (basic structures for user access), defines resource-use limits, controls scheduling queues, alters the system configuration, and maintains 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.
- the *system operator* operates the system console and is responsible for responding to all system requests. MPE provides a range of operational capabilities that help in keeping the system operating as smoothly and efficiently as possible and in performing day-to-day operations such as system startup, backup, maintenance, and recovery.

### Command language and interpreter

MPE's command language, which is processed by the Command Interpreter, contains all necessary commands to direct and control the system. The simplicity of MPE's command language greatly enhances the system's usability.

You can enter MPE commands interactively during a session or through a batch job. The commands are the same: MPE does not have a separate control language for batch jobs. MPE commands also can be issued programmatically.

The more than 175 MPE 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 MPE commands supply.

Actions you can perform through MPE commands include:

- 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 Command Interpreter detects an error in command syntax during a session, it informs you with a meaningful error message that specifies the erroneous parameter and prompts you to reenter 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, you can specify that the Command Interpreter ignore errors during a job so that the job will be completed.

You can use the command language 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.

**Figure 2-1. Sample session**

```
: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.
```

The example above is somewhat simplified since it does not include the various informational messages, compilation output, and program output generated by MPE, 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 MPE and text editor commands in addition to the COBOL statements that constitute the program.

## MPE/XL enhancements

MPE/XL provides a superset of the features of the MPE/V Command Interpreter. It includes features that provide greater productivity for all users.

New features include system- and user-created variables that can be accessed directly via commands and programmatically. Over 30 system variables provide information such as the date, time, system serial number, day of week, etc. Other new features include a significantly enhanced REDO facility, search paths, and built-in calculator.

## User-defined commands and command files

MPE allows you to define your own commands by combining several MPE 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 system-wide. It is also possible to redefine existing MPE commands and messages to suit your particular situation.

MPE/XL 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 just use the name of the file to execute the commands.

## Spooling facility

MPE provides a flexible spooling facility for output devices and batch job input. (SPOOL is an acronym for Simultaneous Peripheral Operations On-Line.)

The MPE 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 spoolfiles 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. Spoolfile priorities can be changed by the system operator.

The spooling facility for MPE/XL has been enhanced with additional functionality and capabilities which increase productivity still further. For example, under MPE/XL, spool files can be easily scanned, archived, or routed to other systems in a network for printing. There are no practical limits to spoolfile size or number of spool files under MPE/XL.

**Tape drive management**

MPE/XL provides the capability for the systems operations staff to allocate tape drives to specific application requests. This allows applications to be written without referencing specific tape devices.

**Job control facilities**

MPE contains 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.

You can use both system-defined JCWs and your own JCWs to store job status information and to pass such information between programs and between a program and the MPE Command Interpreter. JCWs are defined and accessed by commands from the Command Interpreter and by intrinsics from your programs.

You can also use JCWs 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.

**On-line HELP facility**

Whenever you need assistance with command syntax, or even the name of a command, you can invoke the on-line HELP facility.

The HELP facility provides encyclopedic information on all MPE 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. You can also request information on the operation and parameters of each command.

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

**Figure 2-2.  Using MPE's On-line HELP facility**

```
:HELP ————————————— Example of HELP being used in "subsystem" mode

Information is available on the following classes of commands:
Running Sessions
Running Jobs
Managing Files
Running Subsystems and Programs
SystemManagement, Status, and Accounting
Operator Control
Spooler Control
Utility Functions

For more information, enter a KEYWORD. You can also enter any
command name as a Keyword. Enter "help' for information on help.
Enter "exit' to leave help.
KEYWORDS: SESSIONS, JOBS, PROGRAMS, FILES, MANAGE, OPERATOR,
          SPOOLER, UTILITY
>
Running Sessions. Following are the commands used:
COMMAND ( ) LOG ON
ABORT
BYE
DSLINE
EOD
EOF
HELLO
HELP
REMOTE
REMOTE HELLO
RESUME

You can use any command as a keyword.
>EXIT———————————————— You EXIT the HELP Subsystem

: ————————————————————— MPE Prompt
```

## System utilities

MPE includes subsystems and other utilities that are not included
with most operating systems. The following utility subsystems are
supplied with MPE:

- HP EDIT, 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 screen 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

Also available are the HP ALLBASE/SQL and HP TurboIMAGE data-
base management systems as well as a variety of third-party database
management systems.

Special-purpose utilities are provided for system administration tasks. For instance, the MPE 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.

### Native language support

MPE 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.

**Designed for performance**

MPE is optimized for interactive, I/O-intensive, 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.)

### Scheduling

**Job scheduling**
The MPE job/session scheduler schedules jobs and sessions according to their assigned priorities. The user can specify the priority of a job by assigning a priority number to the job. The system operator can reset the priority of the job and can 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 called a "jobfence" are free to execute. For example, if the jobfence is 8, then jobs with an assigned priority number of 8 and below will 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.

MPE 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)

MPE 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, MPE transfers control to the next process ready to be executed.

The objective of the process dispatcher and the memory manager is to provide for optimum efficiency in the use of system resources while satisfying the requirements of executing processes. This is done automatically by MPE without assistance from the system users.

**Multiprocessing**

The MPE/XL operating system supports fully symmetric multiprocessing. The concept of multiprocessing is to have the operating system transparently distribute the system workload over multiple CPUs, thus increasing overall system throughput via processing different workloads in parallel.

MPE/XL multiprocessing provides additional capacity for on-line, mixed on-line/batch, and multi-batch application environments. It is completely transparent to end users, applications, and system administrators.

Both MPE/XL and HP-PA have been designed for high performance multiprocessing. HP Precision Architecture provides an outstanding hardware platform for multiprocessing, with several key architectural features which optimize MP performance. For example, in a multi-processor system, one CPU may need to access data which is currently held in the cache storage on another CPU. With some architectures, managing such occurrences can require significant system overhead in software or hardware, as caches are checked for common data and then updated accordingly. With HP-PA, the ability to efficiently manage this has been designed into high-speed hardware, transparent to system software.

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

The MPE/XL 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 access to a section of data is allowed to one CPU at a time. 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 access to a data structure.

MPE/XL multiprocessor systems take advantage of the parallel I/O paths provided in HP 3000 hardware and software, ensuring delivery of maximum performance via system-level parallelism. Other multi-processor 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, MPE/XL will note the failure upon reboot, deconfigure the failed processor, and continue normal boot and operation. Load balancing among the multiple CPUs is transparently managed by MPE/XL, ensuring the maximum efficiency of available processing capacity.

## Virtual memory management

By swapping portions of code and data that are on disk into and out of main memory, MPE virtual memory management allows programmers to create programs and access data files that are too large to be kept in main memory. This capability makes programming easier, since the programmer need not be concerned with segmenting and swapping code and data. Virtual memory management is also the basis for MPE disk caching.

### MPE/XL demand-paged virtual memory

The "XL" in MPE/XL stands for "extended large addressing," one of the operating system's most important features. MPE/XL provides one of the largest address spaces in the industry, the benefits of which include:

- applications can be written that are much larger than available main or secondary memory; further, 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 of MPE/XL can meet addressing requirements throughout the rest of this 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. MPE/XL provides this capability to an extraordinary degree by taking advantage of HP-PA's extremely large addressing potential.

MPE/XL provides a virtual address space that consists of a set of 4-billion byte spaces. Most 32-bit architectures in the industry support up to 32-bit virtual addressing, which is the equivalent of one of these spaces. Far more addressability is provided on HP-PA systems, with the number of spaces dependent on the processor model. The S980 products support 4 billion of these spaces that is, 4 billion times the addressability of most computers. All other HP-PA systems support 48-bit addressing, or 65,000 4Gbyte spaces.

All open files on the system are encompassed in MPE/XL's virtual address space. This space is managed by MPE/XL transparently to the programmer.

**Figure 2-3. MPE/XL's extremely large virtual address space**



Typical 32-bit systems provide up to 4 billion bytes of virtual address space.

4 Gigabytes

Other Systems

2$^{16}$ Spaces

4 Gigabytes

MPE/XL

MPE/XL provides approximately 281 trillion bytes of virtual address space.
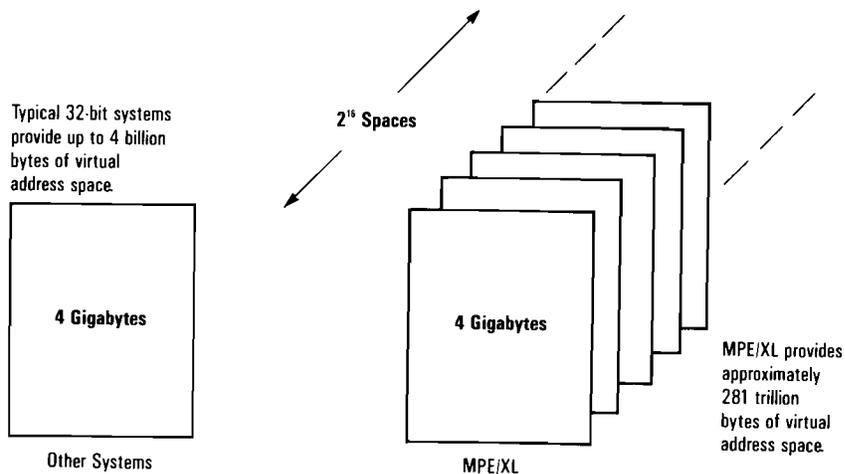
Every virtual space is subdivided into fixed-size blocks called pages. MPE/XL ensures that a page can hold either code or data, but not a combination of both. Since active code pages are nonmodifiable, multiple users are able to share a single copy of a program's code.

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

MPE/XL 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.

MPE/XL allows a program's pre-declared data structures to be up to 1 Gbyte in size. Access to multiple 4-Gbyte data areas is provided through mapped files. Very large files can be supported on MPE/XL without performance overhead.

**Disk caching**
Disk speeds are not improving as rapidly as memory and CPU speeds, and memory costs are moving down constantly. Therefore, increasing memory size and using main memory as a buffer for disk is an important way to increase performance for I/O-intensive applications. MPE reduces physical I/Os to disk by performing logical I/Os to portions of disk that are buffered in main memory.

### MPE/V disk caching

MPE/V disk caching places those frequently accessed portions of files and directories in available portions of main memory, where they can be read repeatedly by an executing program. Thus, instead of going immediately to the disk to get requested information, disk caching first checks to see if the information is already in memory, that is, in the disk cache.

When the information is located in the disk cache, I/O performance is improved in two principal ways. First, several time-consuming disk accesses are eliminated. Second, since information can be accessed in main memory 10 to 100 times faster than it can be accessed from disk, disk caching greatly reduces the time required to complete an I/O operation. This dual improvement means better response and higher throughput for I/O-intensive applications.

Disk caching is most effective in applications that have a high hit rate. The disk cache hit rate is the frequency with which the desired information is found in main memory, and an access to disk is eliminated. The hit rate is particularly high and the performance improvement from disk caching is greatest with applications where multiple users share the same information.

Programs that share IMAGE databases, for example, benefit greatly. Disk caching not only reduces the contention for these databases, it also reduces the lock service times of the database control blocks. Because I/O requests can be serviced more quickly with disk caching, the locking delays are reduced, and the throughput is increased.

The MPE memory manager controls the operation of disk caching and handles file information in the cache dynamically. As a result, special areas of main memory need not be dedicated for the disk cache. However, if you wish to gain significant performance benefits from disk caching, you must configure an adequate amount of main memory on your system. Global memory allocation allows the processor to take advantage of all available memory in the system. This is important as conditions change. Your local system engineer or performance specialist can help you decide how much, if any, additional memory will be required.

### MPE/XL mapped files

MPE/XL employs a very sophisticated technique for performing file access. This technique, referred to as ''mapped files,'' is an improved version of the disk caching capability of MPE/V.

The mapped files technique significantly improves I/O performance without imposing additional CPU overhead or sacrificing data integrity and protection. This technique also eliminates file system buffering and optimizes the global memory management of the system.

Mapped files are based on MPE/XL'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 significantly improved when the code and data portions of files required for processing can be found in memory most of the time. This enhances file access performance because accessing memory is much faster than performing physical disk I/O operations. It also enhances performance over MPE/V disk caching, since both reads and writes are cached.

**Figure 2-4. MPE/XL's mapped files**



Traditional Operating System          MPE/XL's Mapped Files
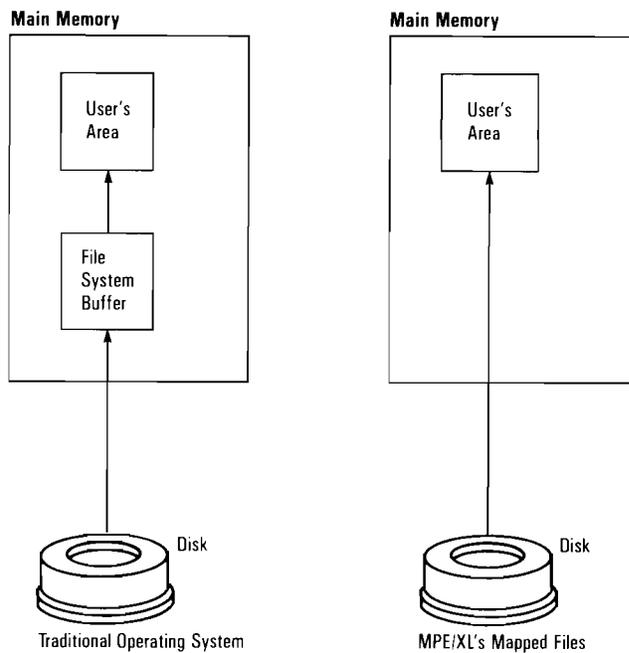
Traditional disk caching schemes impose a CPU overhead penalty. MPE/XL takes advantage of the system architecture and hardware so that you can obtain the benefits of increased I/O performance without incurring this penalty.

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

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 where the data is moved into the user's area in memory. Since MPE/XL's 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.

**MPE/XL high availability**

Increasingly, HP 3000s are used for operationally critical applications where the operation of the business is dependent upon the availability of the system; if the system stops, the business stops. MPE/XL offers significant MPE enhancements to deliver very high data availability for operationally critical business applications. Some high availability features, such as Automatic Powerfail Recovery and Transaction Manager, are standard features of all 900 Series HP 3000s. Others, such as HP Mirrored Disk/XL and HP TurboSTORE/XL, are separate products that can be purchased to tailor your system to the specific requirements of your environment.

The High Availability strategy for the HP 3000 is called Continuous Data Access Control/XL or CDAC/XL. CDAC/XL gives you the ability to configure your system with high availability options to meet the high availability needs of your environment. Specifically, CDAC/XL provides products that allow you to 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 and system configuration modification. CDAC/XL products provide system availability of 99.9 percent with respect to unplanned downtime, limit downtime from any given failure to 30 minutes or less, and allow 24 hour a day operation.
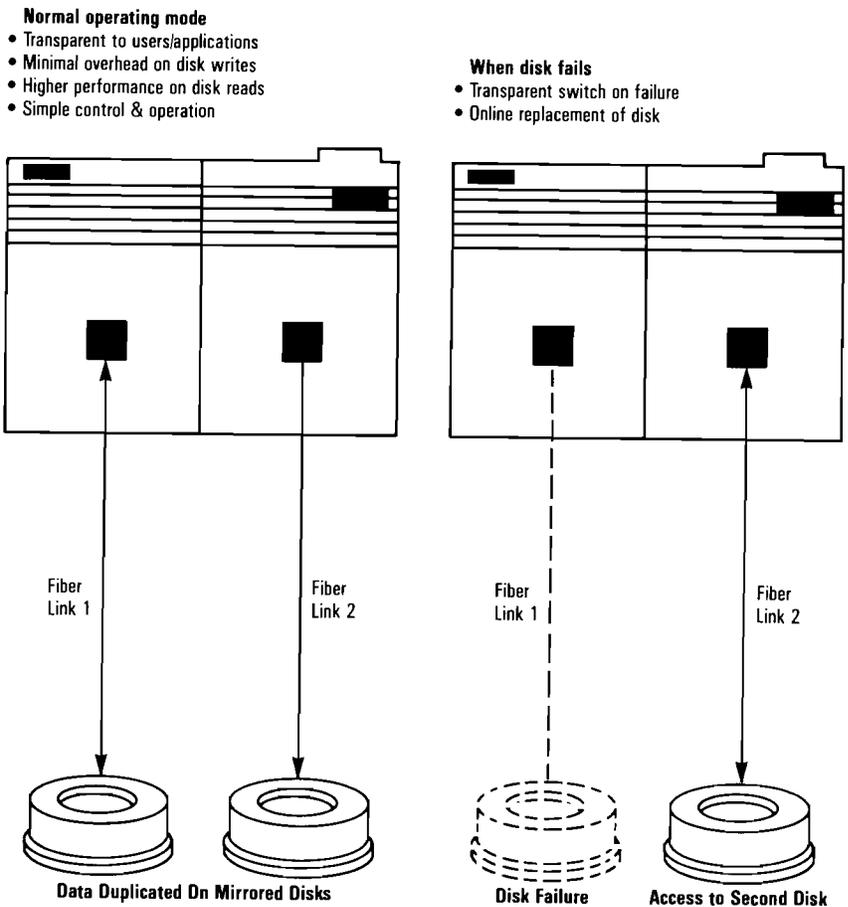
## Automatic power fail recovery

Automatic power failure recovery is provided by MPE 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 complete loss of power. A battery pack (supplied standard with each HP 3000 model) 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 on the system continue where they were interrupted, with programs unaware of the interruption.

## 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 CDAC/XL offers HP Mirrored Disk/XL.

**Figure 2-5. HP Mirrored Disk/XL**

**Normal operating mode**
• Transparent to users/applications
• Minimal overhead on disk writes
• Higher performance on disk reads
• Simple control & operation

**When disk fails**
• Transparent switch on failure
• Online replacement of disk

Fiber Link 1     Fiber Link 2     Fiber Link 1     Fiber Link 2

**Data Duplicated On Mirrored Disks**     **Disk Failure**     **Access to Second Disk**

HP Mirrored Disk/XL is a CDAC/XL product that provides redundant disk drives for critical application data. In the event of failure of a disk drive that is mirrored, Mirrored Disk/XL automatically and transparently switches all I/O activity for the mirrored pair to the mirrored partner. Repair and resychronization of the failed mirrored disk are also performed transparently to users and applications. Figure 2-5 illustrates these features and benefits of Mirrored Disk/XL.

Mirrored Disk/XL is transparent to users and to application designers. Neither existing MPE applications nor new applications require any special coding to take advantage of Mirrored Disk/XL.

### HP TurboSTORE/XL

HP TurboSTORE/XL offers a wide range of backup capabilities that address the primary cause of planned system downtime, data backup. These and other features of TurboSTORE/XL are listed below:

- interleaved reads from the disk subsystem for higher performance
- data backup to Digital Audio Tape, allowing for unattended backup
- fast search, limiting file search on Digital Audio Tape to a maximum of 20 seconds
- on-line data backup (available as an additional option)
- support for up to eight backup devices running in parallel
- support for IBM and ANSI labeled tapes
- tape format and operator interface compatible with HP STORE/XL
- support for dissimilar tape devices such as 7980 and 7979

These capabilities give the 900 Series HP 3000 family unmatched possibilities for high performance dedicated and on-line data backup as well as unattended backup.

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 the transfer rate from the disk subsystem. Using these means, TurboSTORE/XL is able to reduce system backup by up to 75 percent. TurboSTORE/XL also restores from multiple devices running in parallel.

**Figure 2-6. HP TurboSTORE/XL**
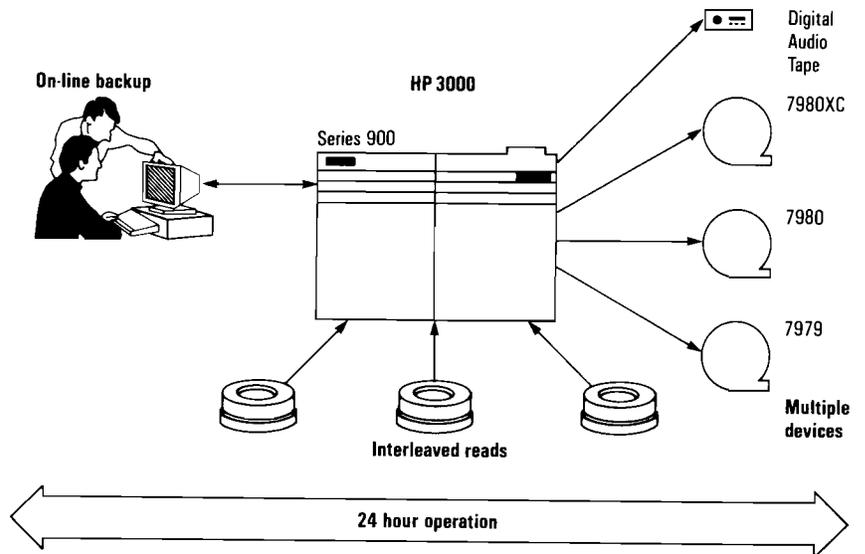


## Logging

Over the last 20 years, computers evolved from batch-oriented systems to systems that are characterized by a large number of users performing on-line transactions. Transaction systems have very stringent requirements for response times, accuracy of data, and the ability to recover from system and hardware failures.

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 ensure that the same seat is not assigned to more than one passenger. This is done by locking common data so that only one user at a time may change it.

Finally, the application must not lose any data in 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 in which data is destroyed. This is done by "logging," or copying data to a log 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.

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 performed. This method of recovery just re-applies all the transactions to some checkpoint version of the file.

### System logging
MPE includes a system logging facility that can be enabled and disabled at the system manager's convenience. This facility records details of system resource requests in a series of log files on disk. The system manager or operator can select which system events are to be recorded. For example, log records are provided for job and session initiation and termination, program termination, file closing, file spooling completion, and system shutdown. I/O device failures are recorded in the system log, which can be used to detect problems before they interfere significantly with overall system operation.

### Database logging
The HP ALLBASE/SQL database management system includes a logging facility that ensures the physical and logical integrity of information maintained in ALLBASE/SQL databases. Rollback recovery is an automatically activated recovery feature which ensures that the database is always in a logically consistent state. ALLBASE/SQL logs before-images and after-images for each write transaction to a log file on disk. In the event of a system failure or program abort, this log file is used to automatically back out any partially completed transactions. Rollforward recovery protects the physical and logical integrity of the database against media failure. In the event of a hardware or software failure, the transactions from the log file can be reapplied to a back-up copy of the database to bring it up to the current state.

The HP TurboIMAGE database management system also includes a logging facility and Intrinsic Level Recovery (ILR) feature. These features ensure the physical and logical integrity of information maintained in TurboIMAGE databases. You can also choose between rollforward and rollback recovery in case of data loss.

### User logging
MPE also includes a user logging facility to provide a means by which applications can maintain integrity of the data upon which they operate. This facility is provided via intrinsics, or system procedures, which allow application transactions to be logged to disk or tape. The application can choose to wait until the transaction is physically posted to the logging device before continuing to the next transaction, or it can continue immediately.

## Transaction management

The Transaction Manager has been integrated with MPE/XL and is present on every MPE/XL system. The MPE/XL Transaction Manager performs automatic checkpointing and logging activities for critical system data structures such as the system directories and HP TurboIMAGE databases. In the event of system software failure, automatic data integrity recovery of these critical data structures is performed by the MPE/XL Transaction Manager during system restart.

In most commercial computing environments, different file system access methods, databases, and applications manage transactions and recovery differently. The result is a complex solution that requires duplication of effort, high administrative and support overhead, and compromised performance. MPE/XL's Transaction Management con-solidates all of these functions into a single, efficient, and consistent module that is common to 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 HP-PA protection hardware.

High availability is a long-term direction for the 900 Series HP 3000 family. The businesses of tomorrow will require computer systems that minimize or eliminate the impact of component failures and that can continue transaction processing through normal system main-tenance activities for 24 hour a day operation. CDAC/XL, with the ongoing introduction of new products and capabilities, will ensure that the 900 Series HP 3000 family will continue to meet the needs of today's and tomorrow's businesses for even greater availability.

Figure 2.7. CDAC/XL high availability design
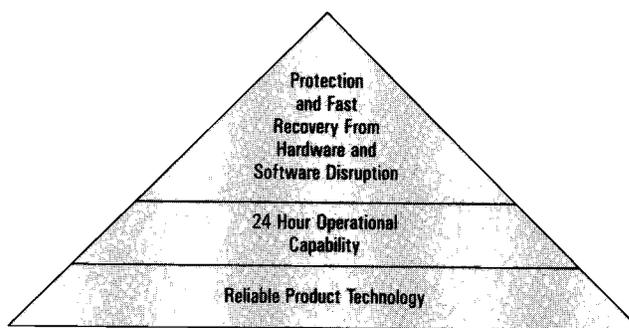


**Standards**

HP 3000 supports multivendor connectivity and application portability by supporting key industry and de facto standards in the areas of database, languages, and networking. These include X.25 wide area networking and X.25 distributed application services based on the International Standards Organizations (ISO) Open Systems Interconnect (OSI) model, IBM's de facto standard SNA network architecture, and the SQL database management system. This commitment to support key standards has been extended by HP's commitment for support of

a POSIX interface on the MPE/XL operating system, and support for the X-Windows™ PC-based graphical user interface.

POSIX is an industry-standard interface to operating system services allowing for application portability, and is particularly heavily utilized by UNIX-based systems. X-Windows is a standard graphical user interface, again utilized by many UNIX applications. Coupling support of X-Windows and POSIX will allow the HP 3000 to easily support such applications.

**Protecting your investment**

Within the HP 3000 family, simple upgrade paths are provided to higher-performing systems. Simple hardware field upgrades and return credits on older systems mean that upgrades are cost-effective. A simple backup and restore procedure with object code compatibility means your applications run without changes or recompilation and no disruption of your business.

### Native mode and compatibility mode

HP ensures compatibility and provides a smooth migration path when moving from MPE/V-based HP 3000s to HP-PA systems. MPE/XL is a compatible superset of MPE V/E. (MPE V/E is an extension to MPE/V).

#### Native mode
Native mode, the native run-time environment of MPE/XL, offers the highest performance on HP-PA. In accordance with Hewlett-Packard's design objectives, native mode on an HP-PA 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 an MPE/XL compiler to get the performance benefits of HP-PA.

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 an MPE/XL 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/E environment, including MPE V/E code and stack structures and callable MPE V/E system intrinsics. As a result, compatibility mode also allows cross development of MPE/V applications on MPE/XL systems.

## Flexibility and phased 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, MPE/XL 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 MPE/XL, you can recompile your applications using native mode compilers for the 900 Series. These compilers provide source code compatibility with the rest of the HP 3000 family. Typically, little or no code modification is required.

Applications can run partly in native mode and partly in compatibility mode. MPE/XL switches between modes transparently. This transparency in operation is made possible by MPE/XL's 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.

**Figure 2-8. Migration flexibility**
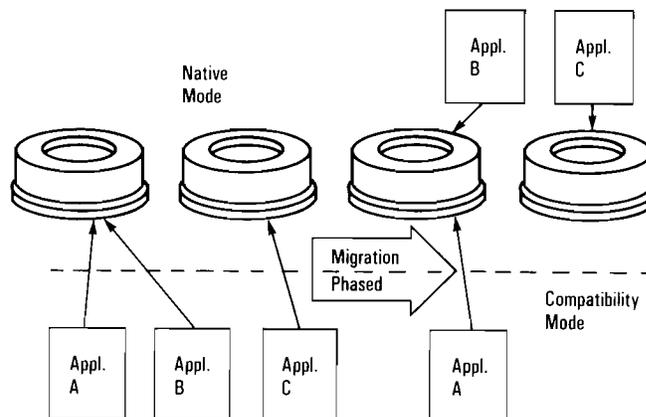


Native mode compilers are available for COBOL II, FORTRAN 77, C, Business BASIC, Pascal, RPG, and Transact.

Figure 2-8 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 via 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 XL)

You can develop applications 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 MPE/XL to facilitate cross-family development in these languages.

## System management and security

MPE is designed for optimum ease-of-use and can be tailored to meet your specific system security requirements. It has security features that prevent unauthorized access and maximize data integrity.

### Ease of management

The system management commands and utilities provided by MPE simplify system maintenance operations. Compared to other computers of similar power, the HP 3000 requires significantly less time and effort for system administration and operation.

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

## System startup

MPE 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 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 when your jobs will run. For instance, if a job will impact system response time, it can be scheduled to run when fewer users are logged onto the system. The job will be executed automatically without requiring operator intervention. Automatic job scheduling can be used to automate many daily operation routines such as backup.

## Self-adjusting system tables

In MPE/XL, 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.

## Diagnostics

A comprehensive set of on-line diagnostics can be used by HP Customer Engineers (CEs) to diagnose system hardware and peripheral problems. These tests can be executed while the system is in operation. HP 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 you can run it prior to requesting service from HP.

All 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 via the 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.

**Minimized operator requirements**

Recognizing that smaller enterprises can not afford a great deal of operation intervention and larger enterprises with smaller replicated sites would prefer minimal operator intervention, the HP 3000 is designed for minimal operator requirements.

Digital Audio Tape and HP TurboSTORE combine to make unattended backup possible. Just as remote console capability allows HP to remotely support customer systems, remote console capability allows larger enterprises to exercise remote console management and central site management. These capabilities are further enhanced by remote boot functionality.

**Transparent disk space management**

When creating a new account, it is only necessary to specify how much disk space that new account receives. There needs to be no concern as to where the system will allocate space for the new user. Disk space is globally allocated transparently.

**System account structure**

The MPE accounting facility provides a flexible and powerful means of coordinating access to the system and 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 amounts 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 optional password. Limits may be established on the permanent disk space, CPU time, and connect time used by a group. MPE maintains running counts of resource usage for each group and the sum of these group counts always equals that of the account in total.

*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. MPE maintains a running count of each resource that the account uses. MPE also stores a list of user names and group names recognized by the account, the maximum job priority at which jobs in the account may be scheduled, and limits established on the account's usage of disk file space, CPU time, and connect time.

To illustrate how accounts, groups, and users interrelate, consider the following example. Figure 2-9 represents a system that includes interactive terminals dispersed throughout a company. The system manager has assigned three accounts: Marketing, Engineering, and Finance. The marketing account manager has defined two users who can access the system: Bill and Dave. Each user has his private group (assigned as his home group) where he stores his private programs and files. Bill and Dave can also access programs and files stored in the other groups in the account.

**Figure 2-9. MPE/XL system account structure**
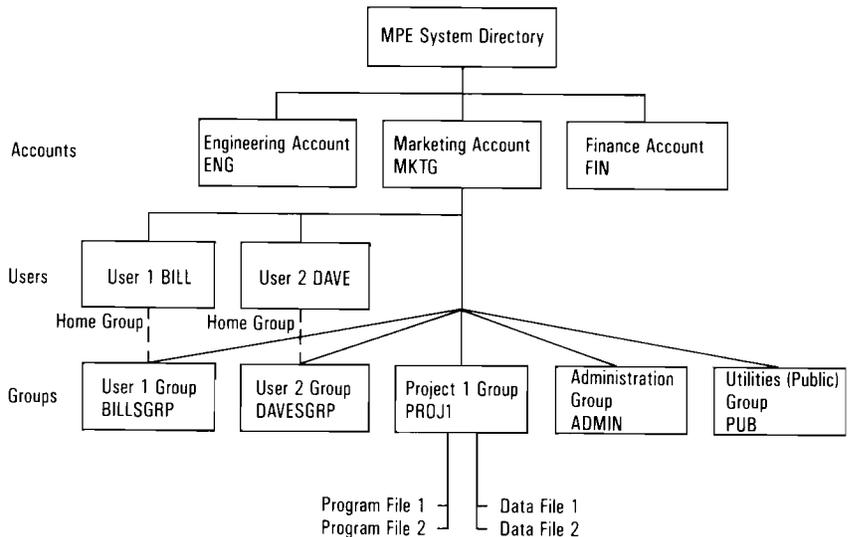
A group named PROJ1 was created to contain programs and data files relating to current projects. An administrative group was created to contain administrative work such as schedules and budgets. The public group, to which no password was assigned, contains general purpose utility programs for use by all.

Bill can log on to the HP 3000 from a terminal with the command:

:HELLO BILL.MKTG

user name     account name

By default, Bill now has access to all programs and data files in his home group: BILLSGRP. Bill can gain access to a file in the PROJ1 group by using the fully qualified file name that specifies both the account and group under which the file was created. The file Bill wants is called ''Forecast,'' so he enters:

FORECAST.PROJ1.MKTG

file     group     account

Alternatively, Bill could have logged on to the HP 3000 and requested access to all programs and files in the PROJ1 group by appending the group name to his log on request, as follows:

:HELLO BILL.MKTG,PROJ1

user     account     group

Bill now has access to all files in the PROJ1 group.

To summarize, you can log on the system using only your assigned user and account names, in which case you are automatically given access to your home group. Or, you can log on specifying your user name, account name, and a group name, which gives you access to the group you specify whether or not it is your home group.

As you can see, 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. Figure 2-10 illustrates both an unsuccessful and successful log-on procedure where passwords are required.

## System security

To protect your system from tampering and interference, MPE provides ample system security. MPE is designed so that the user capabilities, the account structure, and system security measures are intertwined.

### Restricting user access

Passwords can be assigned for each account and for each group within an account. Further, passwords can be assigned to each user name. Thus, to log onto the system, you 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 onto the system and access files in your home group, but you would be unable to access other groups in the account whose passwords are unknown to you.

**Figure 2-10. MPE system access security**

```
:HELLO MANAGER.FINANCE,SALES
CPU=2. CONNECT=2. WED, JUL 18, 1984, 9:41 AM
ENTER ACCOUNT PASSWORD:

ENTER ACCOUNT PASSWORD:

ENTER ACCOUNT PASSWORD:

ENTER USER PASSWORD:
                                                    The password is typed but not
ENTER USER PASSWORD:                                displayed to ensure privacy

ENTER USER PASSWORD:

ENTER GROUP PASSWORD:

ENTER GROUP PASSWORD:

ENTER GROUP PASSWORD:                               Access denied after incorrect
                                                    password is entered  To log on
INCORRECT PASSWORD. (CIERR 1441)                    you must reenter the HELLO
                                                    command and passwords. if
                                                    prompted
:HELLO MANAGER.FINANCE SALES
USER PASSWORD (PASS)? ____
GROUP PASSWORD (PASS)? ____
HP 3000 / MPE V G.A0.00 (BASE G.A0.00). WED, JUL 18, 1984, 9:41 AM

        The user now has access to all HP 3000 resources as defined by his user capability set
```

Once you are logged onto the system, what you are able to do can be restricted in a number of ways. For example, you can be restricted from saving files or using nonshareable devices such as tape drives or line printers. You can be limited regarding the amount of CPU time and disk space you may consume. Also, you can be restricted from accessing system tables, utilizing system resources such as process management and logging, and using data communication subsystems. You can even be restricted 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, you 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, you can be restricted from any or all of the following: reading, locking, appending, writing and saving files, and executing program files. In addition, you cannot access files that are not in your account (except for files in PUB.SYS meant for general usage) unless the file has been released.

### HP Security Monitor/V

HP Security Monitor/V can be ordered as a separate product when greater security is needed. It is a fully integrated system security program that protects both system resources and sensitive data from unauthorized access. Building on the strong security of the HP 3000 systems, it allows improved password protection, stricter audit trails, and tighter terminal security. Some of its key features are:

- password encryption and aging
- terminal passwords
- terminate idle sessions
- log selected commands, file opens and closes
- disable selected commands

HP Security Monitor/V is available now for MPE/V-based systems, and will be available in the future for MPE/XL-based systems.

### Private volumes

MPE provides a private disk volume facility that allows you to create and access files on removable disk volumes. Private volumes consist of removable disk packs that, when mounted on a disk drive, can be accessed by MPE through the file system. Under private volumes, the disk packs mounted on the drives during a cold load are dynamically allocated to the system domain for normal use or to the non-system domain for private use. Non-system-domain packs can be both physically and logically mounted and dismounted during normal system operation.

Failure of a private volume or non-system volume does not disrupt users and applications on other disks. System security is improved, since sensitive information can be maintained on a separate disk.

## System backup and recovery

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

With MPE, 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 MPE STORE utility to permit unattended backup. This will allow the system operator to leave or attend to other tasks without having to monitor the backup process.

## Performance management tools

### HP LaserRX/MPE

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

Use this performance management software tool to contain costs, streamline your internal data processing operation, or deliver defined service levels efficiently. 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 in enabling you and your organization to maximize the return on your systems and applications investments.

HP LaserRX software and the HP Vectra PC (or IBM PC AT) with state-of-the-art CD-ROM (compact disk read-only-memory) technology serve as a central performance management workstation. With it you can display and analyze collected data from one or more MPE-based 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 MPE/XL and MPE/V systems without incurring significant overhead costs. Unique among HP 3000 performance tools, this software lets you collect only what you consider to be "interesting" information. You get more pertinent data while using far fewer resources to process system information.

## HP GLANCE

HP GLANCE software is an interactive performance monitoring tool for HP 3000 systems. HP GLANCE/XL provides on-line examination of MPE/XL system activity, while HP GLANCE/V provides similar functionality for MPE/V systems. Both software tools allow the system manager to gain a "quick look" at system performance and resource utilization.

Simple, quick, and easy-to-access information regarding system performance and resource utilization enables the system manager to identify and resolve potential performance problems promptly. HP GLANCE enhances performance management decision making by directing attention to sessions or processes that exceed user defined threshold values for CPU utilization, disk transfer rates, transaction rates, or response times.

### HP Application Program Sampler

HP Application Program Sampler/V (APS/V) is an interactive performance measurement software product for tuning application programs on MPE/V systems.

APS/V helps the programmer identify CPU bottlenecks in the source code of application programs. APS/V does this by monitoring the execution of application programs using a status sampling technique. Since an application program frequently calls for the services of the operating system, such as intrinsics and library calls, APS/V reports the CPU time spent in system services as well as the CPU time spent directly in the user code.

APS/V can monitor the single execution of a program or the multiple execution of shared programs. APS/V can be used either during program development or on existing programs. Although APS/V is intended primarily for interactive use, it can also be executed in batch mode. The histograms can be displayed on any HP terminal, and a hard copy of the display can be generated on a line printer for future study.

**Professional consulting services**

### Performance management consulting

The services in this category are designed to maximize the performance and return on investment of your current systems.

These services help you determine your system's current resource utilization levels, identify performance bottlenecks, and tune your system and applications for improved response time and transaction throughput.

The situations where these services can be of most benefit are when you have system slowdowns, problems with turnaround on one or more applications, difficulties in scheduling batch jobs, or wish to proactively manage your system's performance in order to prevent performance problems occurring.

## HP SNAPSHOT

HP SNAPSHOT is a performance consulting service for customers who have specific system performance concerns and require consulting assistance on an individual request basis. HP Performance Specialists provide this service, which includes identifying specific problem areas and making tuning recommendations.

## Capacity planning consulting

The services in this category help you plan for business and system growth. They provide a forecast of your system's performance as your users, applications, and system configuration change and grow.

The HP Performance Specialist will use sophisticated software tools to build a model of your system based on accurate measurement of your system's current performance. The specialist will then use analytic modeling and other techniques to predict your system's performance under a number of different scenarios. These scenarios will be determined in consultation with you, and will match your future business requirements.

These services can be of most benefit to you when you need to determine future system resource requirements to meet your predicted business changes and growth. This type of capacity planning can assist in your business and budget planning process.

## HP CAPLAN

HP CAPLAN is a capacity planning service performed by HP Performance Specialists. This service answers your "what if" questions by providing information on how system performance will be affected by capacity increases (such as the addition of more memory, peripherals, or on-line terminals), and how to best plan for capacity increases. HP CAPLAN services can also provide performance projections for the migration of MPE/V-based applications to compatibility mode and native mode operation on a 900 Series system.

## HP custom performance consulting

For large multi-faceted performance consulting or consulting requirements which cannot be met by one of the structured consulting projects.

# Chapter 3      Information Management

Hewlett-Packard offers a wide range of information management products to assist you in all phases of the software development life cycle. They will allow you to deliver solutions in less time, for less money, and with improved quality.

## Product name suffixes

In this chapter, if the product name does not indicate the operating system on which it is available, then it is available on both the MPE/XL and MPE/V operating systems.

## The MPE operating system

The MPE operating system provides a productive and efficient environment for the application developer. MPE programming features include:

- corsistent command language interface to all programming tools
- procedure libraries for external references
- a device-independent file system
- flexible file security
- subroutines callable across languages
- access to all systems intrinsics
- native language support

The MPE operating system is friendly and easy to learn. Programmers can create their own commands. A single command can be created to perform multiple tasks, thereby improving the productivity of the application developer.

**Software life cycle**

The development of an information system can best be thought of as a process. It begins with analysis and design of the new system, proceeds through development and testing, and finally reaches fruition when the system is installed and continues over the life of the system.

Figure 3-1. Software life cycle
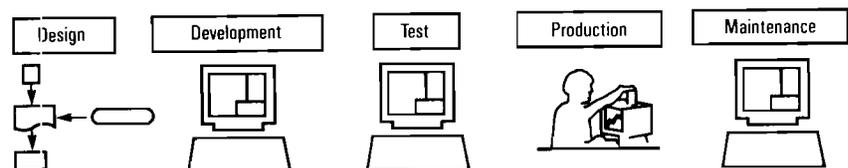
## Analysis and design

One of the first steps in the development of a new project is to define the required data flows within the system. HP's System Dictionary allows you to document the attributes of the data required by the system. HP System Dictionary becomes the central repository of the data that drives your organization. Because of the integration between HP System Dictionary and the other HP information management products, you can ensure that data is being defined and used consistently.

Once the data requirements of the system have been defined, design of the database can begin. HP provides a complete family of network and relational database management systems for the HP 3000 family.

The screen management facility makes it easy to define application screens. The end users will be able to see what the application looks like early in the design phase so they can provide valuable input before coding begins.

## Development

You have a broad choice of languages for creating applications. HP supports all major third-generation languages on both MPE/V and MPE/XL systems. There is also a powerful set of productivity tools centered around the HP ALLBASE/SQL and HP TurboIMAGE database management systems. These are HP ALLBASE/4GL, HP ALLBASE/QUERY, and HP ALLBASE/BRW.

ALLBASE/4GL provides impressive productivity improvements for the professional software developer. Its automatic screens and logic reduce coding, its screen painter allows you to make significant changes quickly, and its external interface can pass parameters to applications written in other languages.

To give applications greater flexibility or to allow end-users to make ad hoc queries or generate reports, there is ALLBASE/QUERY. ALLBASE/QUERY is a query management facility for data stored under ALLBASE/SQL and TurboIMAGE. Developer involvement or prior knowlege of the database is not required because the names of tables, columns, and databases are supplied as options to choose from.

Also available is ALLBASE/BRW, a high performance report writing system for data processing professionals. ALLBASE/BRW can be used to create reports on data stored under ALLBASE/SQL, TurboIMAGE, and in KSAM and serial files. These reports can then be tuned for optimum performance using facilities within ALLBASE/BRW.

## Testing

Testing is a critical but often neglected part of the application development process. HP's products provide sophisticated debugging capabilities that make it easy to isolate and correct problems. In addition, many of the fourth-generation languages provide their own integrated test facilities.

## Production

The HP 3000 computer family—including software tools and database management systems—has been optimized for transaction processing. The systems support both interactive and batch execution. Performance tools allow you to monitor the status of the system and tune your applications for peak performance.

HP offers a variety of products to augment your applications. Powerful end-user reporting tools allow users to access information themselves. The Information Access product moves information from the HP 3000 down to a PC for further analysis using a variety of popular PC-based products. By integrating PCs into the environment, end users get the data they need, and the HP 3000 is free to concentrate on transaction processing functions.

## Maintenance

If your organization is like most, a substantial portion of your resources are being spent maintaining existing applications. Hewlett-Packard's integrated information management products can help you reduce the time and energy required to maintain applications. The HP System Dictionary, serving as a central repository for system information, allows you to easily identify the impact of changes to your applications. The integration between the dictionary and the development and reporting tools minimizes the difficulty of making system changes and allows you to react quickly to changing business conditions.

To be successful in developing applications, you need tools to assist you in all phases of the software life cycle. Hewlett-Packard's integrated information management products provide a comprehensive environment for developing applications.

## Information management framework

To help convey its broad family of information management products, HP uses the framework illustrated in figure 3-2. Those basic four functions are explored in detail in the following pages.

Figure 3-2. HP's information management framework
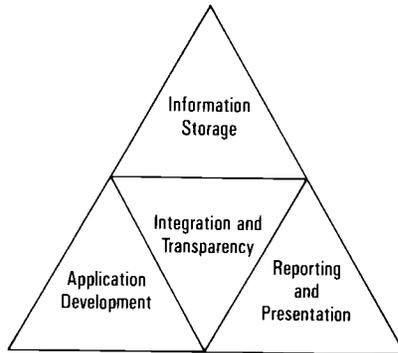


This chapter summarizes the offerings available on the HP 3000 systems in each of the four basic information management areas. For more detailed information about the specific information management products, ask your HP sales representative for HP's "Information Management Specification Guide".

## Information storage

Hewlett-Packard offers compatible relational and network databases across the entire HP 3000 family:

Figure 3-3. Information storage
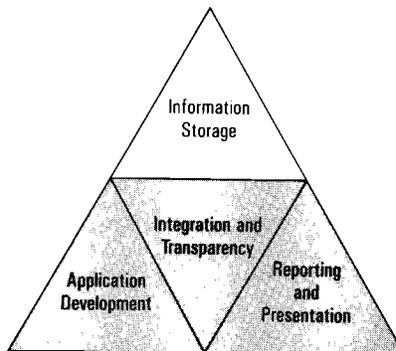
- HP ALLBASE/SQL—HP's high-performance relational database management system based on the industry-standard SQL relational language. Available on both MPE/V and MPE/XL, HP ALLBASE/SQL is HP's strategic RDBMS and has been optimized for HP Precision Architecture.
- HP ALLBASE/NET—provides transparent and secure remote database access to SQL data
- HP TurboIMAGE—a network model DBMS. HP TurboIMAGE/XL runs on MPE/XL-based systems, while HP TurboIMAGE/V runs on MPE/V-based systems
- HP DBChange/V and HP Profiler/V—utilities for use with TurboIMAGE/V. DBChange/V also runs in compatibility mode on MPE/XL
- HP KSAM—keyed file management system

## HP ALLBASE/SQL

HP ALLBASE/SQL is HP's functionally complete, high-performance Relational Database Management System (RDBMS), based on the industry-standard SQL relational language. SQL is a non-procedural language whose powerful commands operate on entire sets of data at a time, rather than the one-record-at-a-time procedural approach of network model and hierarchical databases.

ALLBASE/SQL does not require that explicit relationships between different tables (data sets) be defined. Relationships are determined at the time a query is performed by matching values between common columns in two or more tables. ALLBASE/SQL's relational data model allows the user to specify only what data is required without having to specify how to retrieve it.

ALLBASE/SQL runs in native mode on MPE/XL, and its superior performance is based on HP's advanced RISC-based architecture that maximizes throughput, facilitates multiuser transactions in a production environment, and guarantees data consistency. Complementing the ALLBASE/SQL RDBMS are the ALLBASE tools for all levels of users—from the applications developer to the casual end user. Together, they provide you with the best integrated solution for all your information management needs—from robust product applications to forms, reports, and ad hoc queries.

- The ALLBASE/SQL architecture has been optimized and tuned to provide unparalleled performance on MPE/XL systems. ALLBASE/SQL's high availability features and performance tuning make it the best RDBMS solution for all your database applications, whether they are on-line transaction processing or decision-support oriented.
- ALLBASE/SQL's remote network interface (ALLBASE/NET) allows you to access remote SQL data as though it were stored locally. The data access is transparent to the user and the application.

- HP Interactive SQL (ISQL) is the comprehensive interface to the RDBMS, and is used by programmers, database administrators, and end users to query the SQL database without programming.
- language preprocessors let you access and manipulate data in HP ALLBASE/SQL by allowing SQL statements to be embedded in COBOL, C, Pascal or FORTRAN languages.
- A sophisticated query optimizer relieves the programmer of the details of query planning without sacrificing performance.
- Fast data access is supported through B-tree indexes.
- Data independence allows changes to be made to the database structure without requiring that applications be modified.
- Views may be defined which allow a group of users to view parts of one or more tables as a single, virtual table customized to their particular needs.
- Date/time data types allow dates and time stamps to be stored in the database, for fast performance of applications that are driven by time stamps or have a critical dependency on dates.
- Security is maintained by allowing specification of appropriate levels of access privileges to individual users or groups of users.
- Dynamic restructuring allows the database structure, table capacities and security to be changed without unloading and loading the database.
- Four locking options are available to provide you with maximum concurrency and throughput when a large number of users are accessing the database.
- Automatic rollback recovery guarantees logical data integrity in the event of a soft failure, and it can also be invoked programmatically.
- Rollforward recovery guarantees logical and physical data integrity in the event of a hard failure, providing you with a consistent database.
- Database administration tools are available for integrity verification and migration, as well as monitoring performance.
- ALLBASE/SQL's dual logging capability guarantees the integrity and availability of your data, by automatically invoking the dual log if the first log becomes damaged.

ALLBASE/SQL is a transaction-oriented RDBMS. That means that a specific inquiry or access to the database will complete as a logical unit of work. The RDBMS ensures this in a multiuser environment where many transactions are accessing the database.

With release 2.1 of MPE/XL, performance for ALLBASE/SQL has doubled relative to its performance with MPE/XL 1.2. ALLBASE/SQL is the fastest relational database management system that runs on the HP 3000 and is well suited for production OLTP as well as decision support.

## HP ALLBASE/NET

HP ALLBASE/NET provides transparent and secure remote database access to SQL data as though it were stored locally. ALLBASE/NET's client-server capability allows applications running on a 900 Series and Server HP 3000 client to transparently access HP ALLBASE/SQL tables that reside on a 900 Series server across the network. ALLBASE/SQL tables can be remotely accessed and manipulated by a comprehensive set of tools such as Interactive SQL, HP ALLBASE/4GL, HP ALLBASE/QUERY, third generation language preprocessors, and user-written applications. ALLBASE/NET uses NS (NetIPC) protocol to communicate between systems.

ALLBASE/NET provides complete location transparency to 900 Series HP 3000 users. Since the database access is completely transparent to a user and the application, a programmer can freely write code without having to know where the database resides. In addition, the database administrator can move the data around the network without requiring application changes.

For the software developer and end user, ALLBASE/NET provides maximum use of systems resources by allowing the user to take advantage of the processing power of the client system while accessing the database on the server. In other words, the user can offload work to the client machine, thereby reducing the work load on the host CPU.

One of the key differentiators of ALLBASE/NET is superior security. A special utility in ALLBASE/NET maintains names of users that are permitted access to the database, preventing unauthorized users from accessing the data. Security is configured through ALLBASE/NET, and therefore remote users do not need to explicitly log on to the server system.

Features

- transparent remote access to ALLBASE/SQL tables across a network
- client-server capability across local and wide area networks
- flexibility to move databases between systems without requiring any changes to existing applications
- security to prevent unauthorized access to your data
- the ability to support multiple alias names for the same DBEnvironment promotes programmer productivity through speedy development and testing of new applications

## HP TurboIMAGE

HP TurboIMAGE continues in the DATAPRO-award-winning tradition of HP IMAGE/3000 database management systems designed for use with the HP 3000 computer family. The database architecture is a two-level network model DBMS.

Figure 3-4. Simplified HP TurboIMAGE network structure
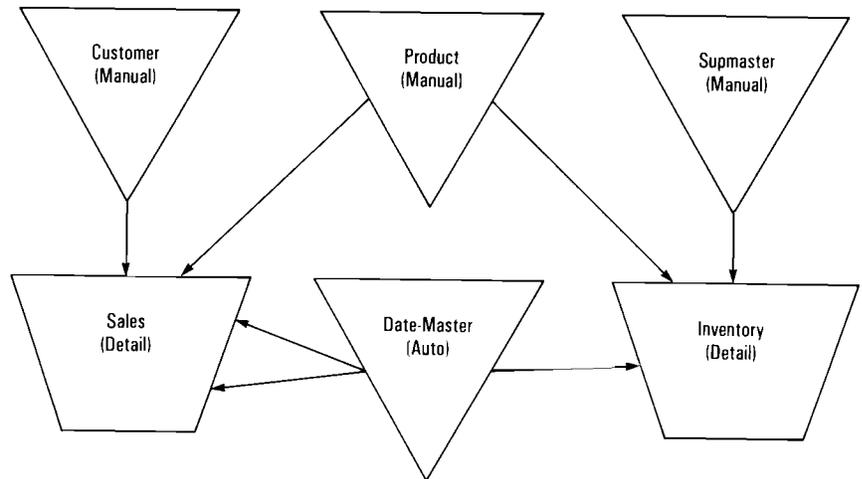


TurboIMAGE offers the capabilities to describe data structure, define data relationships, and create databases. A high-level language interface is provided for access and maintenance of the data within the database. This interface supports applications written in COBOL, RPG/V, Pascal, SPL, FORTRAN, BASIC, Transact, C/XL, and fourth-generation languages.

TurboIMAGE allows data to be related logically between data sets. This linking minimizes data redundancy and facilitates fast information retrieval. In addition, a two-level security facility (at the data set and data item levels) protects the database against unauthorized access.

Since locking is controllable from the database level to the data entry level, applications and interactive users may share the database concurrently. With NS networking products, programs are able to access databases remotely. Remote access allows the user or program on one HP 3000 to access an HP TurboIMAGE database on another HP 3000 computer.

Performance enhancements have been incorporated into TurboIMAGE to support large, high-performance databases as well as those with less demanding requirements. The TurboIMAGE database management systems provides the basis for developing information systems tailored to today's corporate, industrial, and educational needs.

Features

- Logically related files can be handled as a single entity (a database), relieving the application of low-level details.
- Network structure allows fast access to complex relationships among data.
- HP TurboIMAGE intrinsics are callable from COBOL, RPG/V, Pascal, SPL, FORTRAN, BASIC, Business BASIC, Transact, C/XL, and fourth-generation languages.
- Files within a database may stand alone or be logically linked together, allowing flexible data storage.
- Serial, direct, calculated, and chained access methods provide flexible choices for data retrieval.
- Access to multiple databases allows you to logically associate the data while maintaining database independence.
- Deleted record space is automatically reused.
- Concurrent interactive and batch access allows multiple users to access data simultaneously.
- Privacy and security features allow you to control access to restricted information. Two-level security, at the data set and data item levels, defines subsets of the database, providing customizable access to data.
- Transaction Manager guarantees the physical integrity of the database in the event of a soft crash.
- Intrinsic-Level Recovery guarantees the physical integrity of the database in the event of a soft crash (HP TurboIMAGE/V).
- Rollback recovery guarantees the logical and physical integrity of the database in the event of a soft crash.
- Rollforward recovery guarantees the logical and physical integrity in the event of a hard crash.
- Changelog facility provides a logical link to new log files. It automatically switches to the new log files on disk or tape when the current log file becomes full.
- A user-defined locking strategy, at database, data set, and data entry levels, allows optimum concurrence-level control.

**HP QUERY/V**

HP QUERY/V is a database support tool included with TurboIMAGE. It is designed for use by application programmers and database administrators. Through the use of QUERY/V, it is possible to locate, update, and report on data items within an HP TurboIMAGE database.

HP QUERY/V communicates with HP TurboIMAGE through a command-driven interface. It can be executed interactively (from a terminal) or in a batch mode. Output can be directed to a terminal or to any other output device (for example line printer, tape, disk). Frequently used QUERY/V procedures can be stored on disk for future use.

QUERY/V honors the TurboIMAGE database security system. A user must supply an appropriate TurboIMAGE password before access to the TurboIMAGE database is granted. Because QUERY/V supports DS/3000 and NS, it is possible to access databases located on remote computers.

Features

• On-line help facility provides information about commands and required parameters.
• Interactive or batch interrogation allows for flexible database access.
• TurboIMAGE updating through addition, deletion, and modification of data records facilitates on-the-fly database maintenance.
• Boolean logic provides fast access to variable data values.
• ADD command supports quick entry of test data into new database structures.
• Extensive locating, reporting, and updating commands support the testing of new database applications and structures.
• QUERY/V honors TurboIMAGE security to maintain database integrity.
• QUERY/V utilizes TurboIMAGE logging to maintain logical and physical integrity of the database.
• Remote database access allows for database inquiry across computers.

**HP DBChange/V**

HP DBChange/V is the interactive utility that allows dynamic restructuring and capacity expansion of an HP TurboIMAGE database. Database changes are input from a menu and executed on-line or in batch mode.

Because multiple restructuring changes can be requested during one DBChange/V session, there is no need to run separate programs for each change. DBChange/V allows you to review multiple change requests before actual updates are processed.

DBChange/V provides the database administrator with an important, easy-to-use tool to aid in the use and support of TurboIMAGE databases.

Features

- Interactive forms access allows flexible and friendly database manipulation.
- Two-stage update process allows input and review of changes before actual update.
- Multiple changes can be made to the same database in one HP DBChange/V session.
- Database restructure requests are input and stored in a change file, which DBChange/V uses to process database modifications.
- Modifications can be processed immediately or scheduled for later batch processing.
- HP TurboIMAGE database modifications can be made in real-time, without requiring that the database be unloaded and reloaded.
- The database root file is checked for path information inconsistencies, allowing DBChange/V the option to make corrections.

## HP Profiler/V

HP Profiler/V is an analysis tool that works with TurboIMAGE/V to guide developers in tuning databases and application programs.

Profiler/V provides performance and usage statistics that can be used to determine the optimal design of an HP TurboIMAGE/V database. Profiler/V uses trace data gathered while TurboIMAGE/V applications are running and, via a friendly, forms-driven interface, provides a wide range of statistical reports.

Features

- collects trace data at the job/session level or system-wide
- collects trace data only during user-specified time intervals
- consolidates trace data into manageable statistics
- provides default or custom-tailored reports
- runs without operator intervention

## HP KSAM

HP KSAM (Keyed Sequential Access Method) allows you to create and maintain disk files whose records are accessed by the value of the key fields within the data records. Each data record contains 1 primary key field and may include up to 15 alternate key fields. Data records are written to a KSAM file in any order without regard to a key sequence, although they may be presorted if desired. 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.

Features

* multiple keys: one primary and up to 15 alternate keys
* duplicate key values allowed
* retrieval by generic key value or by approximate match
* access from COBOL, RPG, FORTRAN, Pascal, BASIC, Business BASIC, C/XL, or SPL
* fixed- or variable-length data records

HP KASM/XL includes the following additional features

* native mode implementation for higher performance
* immediate data access after modify for faster sharing data
* automatic recovery via transaction management for improved data protection
* system logging for better data integrity
* single data and key file
* New Command Interpreter commands
* REUSE option to recover deleted record space
* KSAM/XL file size limit (2 Gbytes) for greater data capacity

**Integration and transparency**

Figure 3-5. Integration and transparency
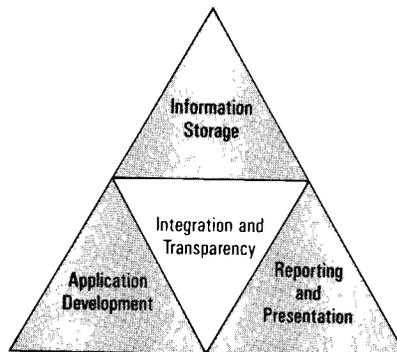


**HP System Dictionary**

HP System Dictionary provides a central information resource for documenting data, applications, programs, files, users, input forms, and network configurations for HP 3000 systems. It is a global dictionary that assists data administrators in effectively managing system and network resources. It also increases programmer productivity by providing timely and accurate system information schemas and COBOL copylibs.

As a component of HP's Distributed Application Technology, it assists software developers and network administrators in documenting data, applications, and hardware within a network. With the addition of compiled dictionaries and a copy/merge facility, HP System Dictionary can assist in managing distributed data and applications within a network.

HP System Dictionary plays a key role in HP's software development, reporting, and data modeling solutions. HP System Dictionary can be accessed and updated by software productivity tools as well as by packaged or user-written applications. HP System Dictionary is ideal for HP ALLBASE/BRW and Transact users.

Features

- entity-relationship model provides a documentation structure that closely matches the user's conceptual data model
- compiled dictionaries are fast, compact, read-only subsets of a HP System Dictionary that facilitates data sharing with a network
- copy/merge capability allows versions of data definitions to be merged within one dictionary or to be merged into a HP System Dictionary residing on another node in the network
- handles name conflicts by putting conflicting sets of definitions in separate "name spaces" or domains
- HP Dictionary/V conversion utility automates conversion from HP Dictionary/V to HP System Dictionary
- database utilities create HP TurboIMAGE schemas and root files from dictionary definitions and produce dictionary definitions from a TurboIMAGE root file
- HP VPLUS forms definition loader loads information about VPLUS forms files into the dictionary

**HP Dictionary/V**

HP Dictionary/V (formerly known as HP Dictionary/3000) is a data dictionary and data directory that provides the means to control and coordinate an organization's data processing resources more efficiently. Dictionary/V is required when you are using Transact, Report, and Inform. The data dictionary consists of a TurboIMAGE database that stores information about the data processing environment, a high-level user interface, and a set of powerful utilities. In the interactive mode, the dictionary guides the user through entry, update, deletion, and reporting operations. A friendly dialogue interface makes HP Dictionary/V easy to use and maintain.

Features

- provides one consistent source for all data definitions and locations
- documents programs, HP TurboIMAGE databases and security, KSAM and MPE files, and VPLUS forms files
- supplies data definitions for COBOL, Pascal, and Transact; provides data environment documentation through built-in reporting capabilities
- supplies definitions for Report and Inform/V
- loads TurboIMAGE database definitions and definitions for VPLUS forms files into the dictionary automatically
- provides interactive user commands and prompts for dictionary entry
- generates TurboIMAGE schemas and root files automatically
- links to Materials Management and Production Management

**Application development**

Figure 3-6. Application development
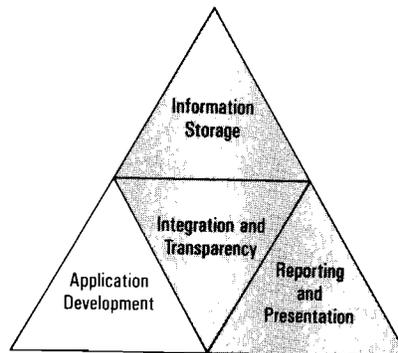
The HP 3000 family supports a rich set of facilities and languages for program development.

- HP COBOL II implements the X3.23-1985 ANSI COBOL standard with extended features
- HP FORTRAN 77 implements ANSI FORTRAN standards with HP extensions
- HP Pascal/V and HP Pascal/XL implement 770X.397-1983 ANSI Pascal standards with extended features
- HP C/XL is a general-purpose language that is an excellent choice for the development of transportable software
- HP BASIC/V and HP Business BASIC include both interpreters and compilers. (HP Business BASIC runs on both MPE/V and in native mode on MPE/XL systems
- HP RPG is highly compatible with industry-standard RPG II

- HP SPL/V is the system programming language for MPE/V based systems.
- HP ALLBASE/4GL is a fourth generation language for quickly developing applications that are easy to use.
- HP Transact is a high-productivity programming language designed for the development of transaction processing applications. It runs on both MPE/V and in native mode on MPE/XL systems.
- Cooperative Services facilitates development of cooperative processing applications where processing is shared between the PC and the HP 3000.
- HP Toolset contains a symbolic, source-level debugger for programs written in COBOL, Pascal, and FORTRAN.
- HP Symbolic Debugger/XL provides source-level debugging for HP C/XL, HP FORTRAN 77/XL, and HP Pascal/XL programs.
- Screen Management Facility includes tools to simplify the creation of forms and development of terminal I/O routines.
- HP EDIT is a full function, screen oriented, interactive text editor for programmers.

This wide selection of languages gives customers the freedom to choose the language with which their programmers are most familiar. In addition, a program written in one language can call programs and routines written in any other 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.

### Debugging facilities

Toolset contains a symbolic, source-level debugger for programs written in COBOL, Pascal, and FORTRAN. Also, HP Business BASIC contains its own powerful debugging facility. HP Symbolic Debugger/XL provides source-level debugging for HP C/XL, HP FORTRAN 77/XL, and HP Pascal/XL programs.

### Forms management

Screen Management Facility includes tools to simplify the creation of forms and development of terminal I/O routines.

## 900 Series native mode and compatibility mode compilers

Languages with the "/XL" suffix provide compilers for native mode, the native run-time environment of MPE/XL. In native mode, source code has been compiled into the native instruction set of the 900 Series HP 3000.

Languages with the "/V" suffix provide compilers for MPE/V-based systems and for compatibility mode on MPE/XL-based systems. Compatibility mode is the MPE/XL run-time environment that provides object-code compatibility between MPE/V-based systems and the 900 Series.

## 900 Series compiler optimization

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

These 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 900 Series. They also allocate the processor's registers very efficiently to take full advantage of HP-PA's LOAD/STORE design. In addition, they can compensate for some inefficiency in source code. For instance, they can eliminate duplicate computations and unused code.

## Run-time support

MPE/XL provides run-time library support for all MPE/V and MPE/XL languages. MPE/V provides run-time library support for MPE/V languages and compatibility mode compilers.

## HP ALLBASE/4GL

HP ALLBASE/4GL is an advanced Fourth-Generation Language (4GL) for developing data- or transaction-processing applications. For the professional software developer, ALLBASE/4GL significantly improves productivity, compared with conventional methods. And the simplified application maintenance of ALLBASE/ 4GL provides even more significant gains.

HP ALLBASE/4GL supports multiple databases. You can access relational databases under HP ALLBASE/SQL, network databases under HP TurboIMAGE, or you can use multi-key indexed files or serial files. ALLBASE/4GL also offers a powerful external interface to applications written in other languages.

Features

- computer-assisted development of applications, significantly increasing the developer's productivity
- fully integrated development environment that requires no additional editors, compilers, or debugging utilities
- easy, interactive development of applications in consultation with end users for quick prototyping
- dictionary for definition of all field specifications, messages, records, and files, simplifying development and significantly reducing maintenance time and effort
- Screen Painter, where the process of design simultaneously produces application screens and menus automatically
- Report Writer for interactive development of reports, with full control over layout and content
- comprehensive logic commands for procedural logic, plus decision tables for complex conditional expressions
- Module Builder which automatically generates all logic and screens necessary to examine and update SQL tables, HP TurboIMAGE data sets, multi-key indexed files, or serial files
- external program interface, with full parameter passing, allowing access to existing packages or code written in conventional languages
- application tailoring which supports multiple versions of applications: changes to the parent application are automatically applied to common areas of versions
- security locks to selectively protect part or all of an application from unauthorized change
- Run-Time Environment supporting delivery of completed applications, and providing System Administrator functions including end-user security control
- full access to ALLBASE/SQL and TurboIMAGE databases, including remote access
- function key access to HP ALLBASE/QUERY, the query management facility for ALLBASE/SQL
- support for European and Asian language applications

### HP Transact

HP Transact is a high-level programming language for transaction processing applications. HP Transact/V includes the programming language and an interpreter. HP Transact/XL adds a native mode compiler, and debugger.

Designed as a procedural language, Transact provides the functionality of a third-generation language, such as COBOL or Pascal, combined with a comprehensive set of powerful, high-level constructs that can perform several functions within a single statement.

Applications written in Transact require fewer lines of code than those in traditional third-generation languages. They are not only easier to write, they are also easier to understand and maintain. The result is significantly lower development and maintenance costs.

Integration with file management facilities is a major strength of Transact. Data definitions and locations can be accessed through HP System Dictionary or HP Dictionary/V, so they do not have to be defined individually in each program. With HP Dictionary/V, data resolution can take place dynamically as the program is executing, for total data independence, or at compile time, for increased performance. With HP System Dictionary, data resolution is accomplished at compile time.

Access to HP TurboIMAGE databases, MPE/V files, KSAM files, and VPLUS forms files supports the creation of a wide variety of transaction-oriented applications.

Features

- Automated resolution of data and file definitions through either HP System Dictionary or HP Dictionary/V eliminates the need for data definitions within the program.
- Both automatic and programmatic error handling and recovery support flexible error trapping.
- The ability to call HP 3000 system intrinsics offers extended capability to the application programmer.
- The ability to call run-time procedures written in other languages (such as COBOL II, Pascal/V, HP Pascal/XL, FORTRAN 77, and SPL/V) and in Transact permits sharing of commonly used routines.
- The ability to call Report/V, Inform/V, and Business Report Writer/V allows easy-to-design formatted output for reporting purposes.

## Cooperative Services

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

- Connection and Session Management enables the PC application to establish a connection to an HP 3000, initiate a session, terminate the session, and disconnect from the HP 3000.
- TurboIMAGE Intrinsic Support provides for the packaging of HP TurboIMAGE requests, transmitting the requests to the HP 3000, and returning the responses to the application.
- MPE Intrinsic Support provides for the packaging of file access requests, transmitting the requests to the HP 3000, and returning the responses to the application.
- Remote Procedure Call Support provides for the packaging of procedure requests, transmitting the requests to the HP 3000, and returning the responses to the application.
- Special Function Support provides for the loading of specialized code modules such as conversion routines, status messages, and version checks.
- Popular PC development languages are supported; depending on the personal computer chosen for development, software designers may choose from a variety of languages.

## HP Pascal

HP Pascal allows several extensions to the ANSI IEEE standards for Pascal. HP Pascal/XL also 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.

HP Pascal/XL features

- integrated program development via HP Toolset/XL provides symbolic debug, full screen editing, softkeys for compile and execute, and source and version management. Additional symbolic debug support is available via HP Symbolic Debugger/XL for HP Pascal/XL
- conformant array parameter type provides flexibility in parameter passing for HP Pascal/XL
- HP Dictionary/V support for generation of TYPE and VAR declarations from previously stored definitions for HP Pascal/V
- character and string types, when coupled with predefined string handling functions, allow powerful string management operations

## HP RPG

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

HP RPG/XL has been written to take advantage of HP Precision Architecture. RPG/XL compiles source code faster than RPG/V and generates object code (native mode) that executes faster. Space limitations associated with RPG/V have been eliminated in RPG/XL. Therefore, compiler options $OPT1 and $OPT2 are not needed even for very large RPG programs. Compatibility of HP RPG with RPG II languages of other vendors has been maintained in HP RPG/XL.

## HP SPL/V

HP SPL/V is the system programming language for the MPE/V-based HP 3000 systems. Because it combines the efficiency of a machine-dependent language with the simple structure of a high-level language, SPL/V was used to write the operating system, language compilers, system utilities, and database management and data communication subsystems for the MPE/V-based computers.

Features

- self-documenting for ease of readability
- permits access to all hardware features and data types
- dynamic allocation of local storage for working space and local variables in procedures; memory is de-allocated on exit form procedures
- program segmentation feature
- assemble statement permits machine-level coding
- six data types—logical, byte, integer, double integer, real, and long real

## HP BASIC/V

HP BASIC/V (formerly known as BASIC/3000) is an easy-to-learn language designed especially for interactive terminal use. BASIC/V provides most of the features commonly found in a BASIC system.

BASIC/V consists of both an interpreter and a compiler, which allow you to create and debug your BASIC programs interactively and then compile them for faster operation. The BASIC/V compiler provides the means for converting BASIC/V programs (including those that have been written, debugged, and saved via the BASIC/V interpreter) into machine code. Compiled BASIC/V programs exist in the system as actual code segments and can be run directly, rather than through line-by-line interpreting.

BASIC/V runs in compatibility mode only on 900 Series HP 3000 systems.

Features

- four numeric data types: real, integer, real extended precision, and complex
- mixed-mode arithmetic
- all standard functions (SIN,COS,LOG,etc.) plus matrices (up to 2 dimensions), strings, and files
- program segmentation with common storage
- user-definable security including password
- interpreter can be used alone or in conjunction with BASIC compiler
- HP IMAGE database calls built into the language
- compiler provides shareable machine code

**HP Business BASIC**

HP Business BASIC/V (formerly known as HP Business BASIC/3000 and HP Business BASIC/XL) offer the complete language solution. With 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/V runs in Compatibility Mode on 900 Series systems. HP Business BASIC/XL runs in native mode on 900 Series systems.

The interpreter provides immediate feedback on the effect of program modifications and indicates syntax errors as the program lines are entered. Extensive debugging tools also simplify application development. All or part of a program may be compiled, resulting in significant performance improvements for most types of applications.

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

Features

- Six numeric data types: short integer, integer, short real, real, short decimal and decimal are supported.
- All program development tasks are integrated; the interpreter and compiler, as well as all features of an editor, debugger, and calculator, are directly accessible through HP Business BASIC commands and statements.
- Callable subprograms and multiline functions are supported with parameter passing and shared common data areas.
- The Program ANALYST, a code inspection tool, simplifies the task of optimizing, restructuring, and maintaining applications.
- Flexible Report Writer statements easily generate reports and tabular output.
- Advanced database statements provide easy but flexible data manipulation and access capabilities including retrieval, sorting, searching, and automatic packing of buffers.
- Full support is provided for calling intrinsics for operating system services or access to other subsystems.
- Long identifier names and alphanumeric labels improve program maintenance; keywords can be used as identifiers.
- Conversion utilities and tools, such as direct KSAM interface, HP JOINFORM (an HP 260-like forms package) and HP JOINFORM EDITOR (which creates and modifies JOINFORM files) are included for HP BASIC/V and BASIC/260 application conversion.
- Native language support is provided for date, time, and collating sequence.

## HP C/XL

HP C/XL is Hewlett-Packard's implementation of C for the
900 Series HP 3000. 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 effi-
ciency of assembly language. It is widely used for application program-
ming and is regarded as an excellent vehicle for transporting software
between vendors' systems.

Features

- 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.
- Pragmas are provided to specify optimization options, copyright infor-
  mation version identification, listing control, and MPE/XL intrinsic
  access.
- Programs can access MPE/XL, PARM, and INFO values.
- A preprocessor performs conditional inclusion, macro processing, and
  source file inclusion.
- Programs can be debugged using HP Symbolic Debugger/XL.

## HP COBOL II

HP COBOL II is a high-level language for business data processing that
operates on the HP 3000 systems. It takes full advantage of the sys-
tem's capabilities and architecture. COBOL II's performance was spe-
cially 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 struc-
tured 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 which conform to the 1974 stan-
dard, ANSI X3.23–1974.

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

* the preprocessor function which provides statements that allow the programmer to equate a particular macro or sequence of code ($DEFINE) or a file ($INCLUDE) to an identifier; this identifier can be referenced throughout the program, and at compilation it is replaced with the expanded source code or source program file it represents
* 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
* the ability to call the system intrinsic functions and programs written in other languages

## 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 INPUT/OUTPUT 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.

HP FORTRAN 77 is an implementation of FORTRAN 77 for the HP 3000 computer systems. It is highly compatible with FORTRAN 66/V (formerly known as FORTRAN/3000).

HP FORTRAN 77 provides:

* 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
* MPE system access
* symbolic debug support

## HP EDIT

HP EDIT is a full function, screen oriented, interactive text editor for programmers. The HP EDIT editing environment is designed to meet the editing requirements of most users, with excellent customizability to suit individual needs. HP EDIT can manipulate or generate regular ASCII files which are compatible to files used by most applications. It runs on the HP 3000 under MPE/V and MPE/XL. An Asian 16-bit version of HP EDIT is also available on MPE/XL. HP EDIT can be used on the HP262X, HP239X or HP700/9X terminals or compatibles, or accessed by PCs using terminal emulator packages such as AdvanceLink.

HP EDIT vastly improves programmers' productivity with many advantages over other editors:

- better full screen editing using character mode
  - automatic save of changes
  - protection from changes loss in case of a system crash
  - greater efficiency in many cases than a block-mode editor; full screen read not required for minor changes
  - more interactive dialogue with the editor than is possible with a line or block-mode editor, thus more people efficient
  - more granular undo of changes
- powerful undo
  - undo or redo capability of any commands issued during the entire editing session (up to 32000 changes—not just bringing back deletes)
- built-in recovery procedures
  - each line entered is logged to a permanent file, which is recoverable after a system crash
- more on-line help than other editors, and extensive documentation
  - on-line help is organized by topic, command, or key-assignment
  - manual and on-line help are detailed and contain examples and related command references

Features

- full screen editing including support for cursor keys and standard terminal keys for text entry purposes
- efficient use of CPU
- user-configurability with user command key assignments and macro definitions
- support for standard and COBOL line numbering with automatic line bumping
- split screen editing
- find by characters, string, or matching delimiter
- query search and replace with wildcard patterns
- access to MPE commands
- advanced programmer features:
  - cut and paste between documents
  - shift lines left or right
  - swap characters, words or lines of text
  - mark and jump to multiple spots in file
  - sorting, encryption, calculator features

### HP Symbolic Debugger/XL

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

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

Features

* provides language-sensitive expression evaluation for HP COBOL II, HP C/XL, HP FORTRAN 77/XL, and HP Pascal/XL
* friendly user interface including on-line help, support of multiple skill levels, and windowing with up to three panes for viewing source statements and assembly instructions simultaneously
* breakpoints can be set, deleted, suspended, and activated at specified locations, allowing the user to examine the state of a program
* single-stepping through a program or over procedures is provided at the source statement or the equivalent assembly instruction level
* assertions allow the execution of a list of commands before every source statement for tracing elusive bugs
* allows the display and modification of program variables
* multilevel stack tracing allows the user to trace program flow
* extensive interrogation of the state of the debugger, including breakpoints, files, globals, procedures, and variables, is provided
* record and playback of debug commands recreate debugging sessions
* provides access (within the debugger) to the MPE/XL operating system via the command interpreter
* macro facility allows users to define their own names for command strings

### HP Toolset

HP Toolset provides a set of tools that work together to maximize the productivity of HP COBOL II and Pascal programmers in the coding, symbolic debugging, and version management phases of development on HP 3000 systems running MPE/V. Toolset is also available on MPE/XL systems which include support for FORTRAN 77. For larger system development on MPE/XL systems, we recommend a combination of HP Edit, HP SRC, and Symbolic Debugger/XL.

Features

- Workspace File Manager for COBOL II and Pascal/V
- friendly and powerful user interface
- full-screen editor for COBOL II and Pascal/V
- COBOL II COPY library editing and management
- COBOL II and Pascal/V data definition retrieval from HP Dictionary/V
- symbolic debug capability
- program translation manager for COBOL II and Pascal/V
- HELP facility

### HP SRC

HP Software Revision Controller (SRC) is a sophisticated revision control system that manages changes to files in an effective, efficient way. It is ideally suited for project team development environments where multiple versions of programs are maintained and supported. HP SRC is also excellent for managing text files in a documentation development environment. HP SRC can be used with HP COBOL II, Pascal, FORTRAN 77, RPG, and Transact.

Features

- flexible and friendly user interface
- efficient storage of file revisions
- quick access to file revisions
- prevents two people from modifying the same file at the same time
- allows parallel development on and subsequent merging of two files
- allows files to be grouped within the HP SRC environment and treated as a whole for release management

### Screen Management

HP's Screen Management Facility simplifies the creation of forms and the development of terminal I/O portions of applications. These services consist of HP FORMSPEC and HP VPLUS. Screen Management Facility runs on MPE/V systems and in compatibility mode on 900 Series systems.

### HP FORMSPEC/V

HP FORMSPEC/V is an easy-to-use, menu-driven, interactive form design facility for application programmers. The form developed with FORMSPEC/V can be manipulated by applications using HP VPLUS intrinsics. Separating the screen interface from the application allows you to maintain the screen image without having to change the application.

Application screen formats are laid out interactively on a terminal screen. Each format contains fields with characteristics defined from a set of standard descriptions such as type of field (for example, required, options, or display only) and data type (for example, character, numeric, or date). Default values can be provided for each field.

HP FORMSPEC/V runs on MPE/V systems and in compatibility mode on 900 Series systems.

Features

• Comprehensive data editing capabilities include length checking, range checking, list checking, equality checks, pattern matching, and check digit verification (module 10 or 11).
• Data can be formatted as it is being collected; standard routines are available that justify, fill, strip, and upshift data in the fields specified.
• Data movement can be specified to transfer values between fields in a single form or between forms. For example, the sum of several fields can be moved to another field in the same form reserved for the total.
• Arithmetic and conditional processing, dependent on the value entered in a field, can be specified as needed.
• Customer error messages to be displayed at run-time can be specified with each error characterization.
• Through use of the Application Ready Buffer, programmers can specify the data editing rules and final format for all the data fields within a form. HP VPLUS will then handle the entire form display, data entry, validation, and transformation process before returning to the application with the data ready to use.
• HP FORMSPEC/V supports the creation of forms that utilize the various special features of HP workstations.

## HP VPLUS

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

VPLUS provides facilities to:

• configure 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 terminal management routines with high-level intrinsics
• perform diagnostic activities during program development and debugging

### HP VPLUS/Windows

As part of HP's strategy for optimizing computer resources through a co-operative computing environment, VPLUS/Windows is introduced early in 1990. VPLUS/Windows allows VPLUS applications sitting on an HP 3000 computer to be run under Microsoft™ Windows on a PC. No changes to the code of VPLUS applications is required.

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 bit-mapped windowing system and can store part of the application on the PC. This increases performance and frees applications from the terminal's architecture.

Key benefits

- ease of use—VPLUS applications can be operated through Microsoft Windows
- productivity—multiple VPLUS and PC-based applications can be used simultaneously
- immediate implementation—no changes are required to the VPLUS code
- increased performance—screen definitions and other parts of the application are stored on the PC
- strategic investment—VPLUS/Windows helps users maximize computing resources and move toward a Cooperative Computing Environment (CCE)

**Reporting and presentation**

Figure 3-7.  Reporting and presentation
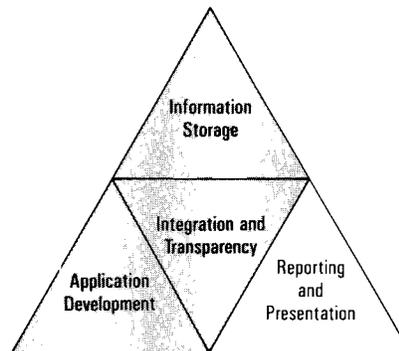
## HP ALLBASE/BRW

HP ALLBASE/BRW is a high performance business report writing system for information management professionals. Comprehensive report development no longer requires numerous lines of programming code nor complex report syntax. Its ease-of-use significantly reduces the time taken for report development. Maintenance of reports is simplified and you can even tune report generation to optimize performance and conserve system resources. HP ALLBASE/BRW is upwardly compatible with the HP BRW/V software, the Business Report Writer for MPE/V systems.

HP BRW-Desk is an add-on product to ALLBASE/BRW and BRW/V, and enables you to send reports to the Intray of selected HP DeskManager accounts.

Features

- easy, interactive development of reports
- calculation features which allow raw data to be turned into analyzed information
- iterative reporting which allows the output file of a report to be accessed by other reports or applications
- generation of output files suitable for use without conversion by other tools (such as PC spreadsheet and graphics packages)
- integration with HP System Dictionary, HP Dictionary/V, Application Dictionary, and Information Access which allows reports to be generated from data in several applications
- use of a serial file as the dictionary, eliminating the need for a separate data dictionary and enabling BRW to be used with PowerHouse
- performance tuning allowing performance optimization and conservation of system resources
- access to multiple data managers (HP ALLBASE/SQL tables, HP TurboIMAGE data sets, KSAM files, and serial files), including any combination of these managers and remote access
- security locks that ensure protection of report specifications and execution
- on-line help facility that guides users through report design and maintenance
- intrinsics for programmatic access to reports, with no need to exit an application
- conversion utility to convert HP Report/V or HP Inform/V report definitions to HP ALLBASE/BRW definitions

Additional features with HP BRW-Desk

- electronic distribution of reports
- report splitting, which allows reports to be split into separate files and sent to individual HP DeskManager users
- support of delivery audit trail messages

## Information Access

Information Access is a unique information management tool. It is an information server that extends the reach of your data processing systems by delivering key business data to authorized PC users. Information Access can provide the means for your people to make better decisions based on up-to-the-minute information wherever it resides. Additionally, centralizing the administration of information access improves the manageability of essential data processing systems.

Features

- Host processing is reduced because Information Access combines PC, HP 3000, and mainframe processing power to make the best use of your organization's computing resources.
- The Database Administrator utility provides control over the access and distribution of database information by centralizing its administration.
- An upload capability allows PC data to be transferred to the HP 3000 and saved in a variety of standard formats. PC or HP 3000 data can also be transferred to the mainframe and stored in a Cullinet C/ICMS format.
- Automatic conversion of business data into many popular formats is accomplished in one easy step. Information Access reformats PC, HP 3000, and C/ICMS information for use in popular applications such as Lotus® 1-2-3® RBase 5000™ dBASE II® C/ICMS tables, or popular word processing and graphics packages.
- A tabular view of data is provided so end-users do not require knowledge of data structure or data location; users can view data from several mainframe, HP 3000, and PC databases just by selecting a menu item.
- The built-in personal report writer allows generation of both ad hoc and routine reports; the report writer is menu-driven and allows preprinted forms and custom templates for repeated use.
- Batch capabilities allow data access requests to be run as batch jobs.

### HP ALLBASE/QUERY

HP ALLBASE/QUERY is an easy-to-use, terminal-based interface to data maintained under HP ALLBASE/SQL. It can also access data stored under HP TurboIMAGE via the dual access tool. The flexible selection of access and reporting modules available in ALLBASE/QUERY enables end users or database administrators to perform queries, modify data or tables, and generate their own reports, without involving a programmer. ALLBASE/QUERY also provides powerful facilities for programmers to use in preconfiguring complex tasks, or to improve their own productivity when working with ALLBASE/SQL databases.

Features

- a common, forms-based interface ensuring that no matter what module is in use, related tasks are performed in the same manner
- context sensitive help, available at any time with a single keystroke, allows quick question resolution
- two access methods provided: menu-driven EZAccess for novice or infrequent database users; SQLAccess for users familiar with both HP ALLBASE/SQL and the database structure
- creation facility that allows ALLBASE/SQL tables to be created or ALLBASE/ SQL table definitions to be modified
- update facility that allows data in SQL tables to be added, deleted, or updated
- queries, reports, and sequences of commands can be saved for future use, thus streamlining frequently performed tasks
- data security is maintained: the ALLBASE/SQL system catalog determines each user's authority to access data
- default mode of operation shields novice users from complex functions and smoothly steps them through tasks that cross module boundaries
- experienced users can run ALLBASE/QUERY in the mode that allows them to easily select advanced features
- batch mode of operation is available to automate time-consuming tasks
- full support for European and Asian language applications

## HP Inform/V

HP Inform/V is an interactive inquiry and report generation facility oriented toward end users (for example, managers, purchasers, clerks, or secretaries). Inform/V provides an interactive menu that allows access to data and the generation of reports in a fraction of the time needed by traditional methods.

Inform/V and HP Dictionary/V work together to simplify data access. Inform/V accesses the dictionary for definitions and locations of data stored in HP TurboIMAGE/V databases and KSAM/V and MPE/V files. It can also access HP TurboIMAGE/XL databases and KSAM/XL and MPE/XL files on 900 Series and Server HP 3000 computers. End users can access information without knowing how or where it is stored.

Inform/V protects the integrity of corporate data by allowing read-only access to databases and files. In addition, security can be assigned to individuals to prevent unauthorized access to sensitive data.

**Figure 3-8. HP Inform/V**
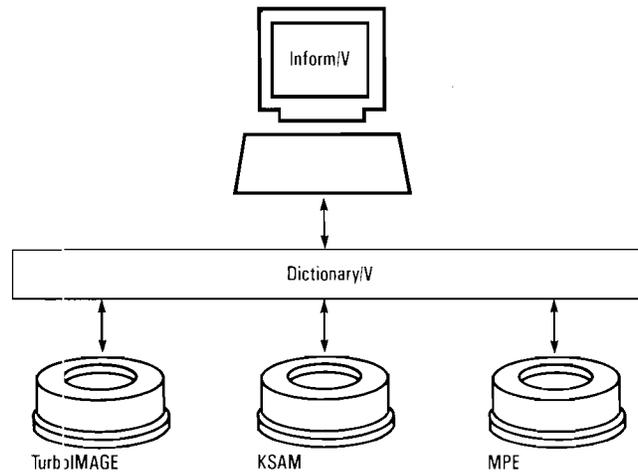


HP Inform/V can generate reports either on-line at the terminal or in batch mode. In batch mode, Inform/V can perform all of its work in the background and return terminal control to the end user immediately.

Features

• fast, friendly, direct interactive link between end users and data stored in HP 3000 databases and files
• Inform/V security limits user access to data to authorized users.
• Inform/V is designed specifically for the end user, relieving the programmer of the time consuming task of report writing
• immediate report production information as it is needed
• report definitions can be saved and reused
• access to multiple HP TurboIMAGE databases and KSAM, MPE/V, and MPE/XL files means reports can be created from more than one file source
• automated report formatting supports easy report generation
• friendly menu interface
• automated resolution of data and file definitions through HP Dictionary/V provides data access transparency

# Chapter 4                    HP Precision Architecture

**Foundation for the next-generation HP 3000s**

HP Precision Architecture (HP-PA), incorporated in the 900 Series HP 3000 systems, is the foundation for HP 3000 computer systems for the 1990s and beyond. HP-PA is a reduced-complexity architecture that is based on Reduced Instruction Set Computing (RISC) principles, coupled with key architectural extensions. The advantages of HP-PA directly translate into high performance and industry leadership in price/performance and cost of ownership in commercial on-line transaction processing (OLTP) environments.

HP-PA maximizes the performance benefits that can be realized for a given semiconductor technology. This performance potential allows for development of high-performance systems that provide a cost-effective, compatible growth path designed to meet growing performance requirements in commercial environments. And the inherent simplicity of HP-PA is ideal for fast, single-chip microprocessors that can be utilized for cost-effective desktop and workgroup systems.

Finally, the 900 Series systems provide both object and source code compatibility with the other HP 3000 systems, thereby saving investments in application software and providing a smooth migration to these next-generation 900 Series HP 3000 systems.

**Designed to last**

A key design objective of HP-PA was to ensure that the architecture will be able to meet evolving computing needs and 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, unlike the majority of today's systems, which must attempt to force-fit features such as multiprocessors and high-availability extensions into existing architectures, HP-PA has been designed with these capabilities taken into account. Future 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-bit or 64-bit virtual addressing, HP-PA systems will be able to provide sufficient expandability to meet these growing requirements. Consider that 64-bit addressing provides over 4 billion times the addressability of typical 32-bit systems! It all adds up to an architecture designed to last through the 1990s and into the next 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

## Why RISC?

In the late 1970s and early 1980s, research in industry and at several leading universities showed that computers tend to spend the great majority of the time performing relatively simple functions. In addition to directly supporting such simple functions in the instruction set, conventional computer systems typically provide instruction set support 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, but implementation of these instructions results in additional processor overhead, often resulting in a performance penalty for all instructions.

**Figure 4-1. RISC motivations**
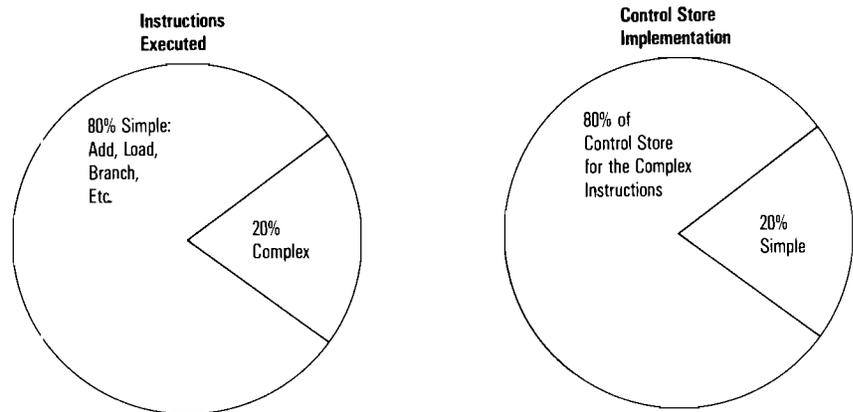


Researchers concluded that optimizing the processor for the simple, often-executed functions would result in a significant performance advantage over more conventional designs. Thus, the RISC approach: maximize system performance by optimizing the processor for the simple, often-executed functions. HP-PA 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 to conventional system architectures. Compatibility, lower cost, and higher performance are all direct benefits of the reduced complexity approach of HP-PA.

## 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, and thus the reduced complexity HP-PA allows for compatibility of non-privileged object code as well as source code. When moving from the MPE/V-based systems to the 900 Series systems, object code can be run "as is," via emulation of the MPE/V-based HP 3000 instruction set. Or, source code can simply be recompiled to exploit the full performance potential of the 900 Series 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, develop, and 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 as compared to competitive offerings.

## Higher performance potential

With the 900 Series systems, the performance potential of a wide variety of semiconductor technologies can be maximized. For example, the S949, implemented in VLSI technology, delivers performance that typically is achieved by conventional systems only via utilization of more costly, less dense ECL semiconductors. With HP-PA, a given level of performance can be achieved at a significantly lower cost than with conventional systems.

Figure 4-2. Higher performance potential
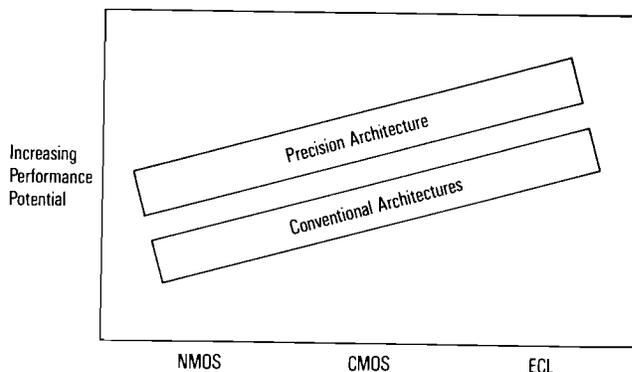
**Allows for a broader family of systems**

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 desktop or workgroup computers. And at the high end of the HP 3000 family, the performance advantage of HP-PA, coupled with support for multiprocessor systems, allows for products delivering very high performance solutions with the power of today's water-cooled mainframes.

**Ideal for advancing technologies**

The simplicity of HP-PA 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 high-performance, high-density semiconductors, and this experience is extremely beneficial with 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 for 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, HP-PA systems provide increased processor reliability. In addition, HP-PA is designed to support future extensions for providing higher system availability. For example, future 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 micro-coded control store and thus typically require several machine cycles to execute even the most simple instructions, with RISC systems, instructions are executed directly in hardware in a single CPU cycle. More complex functions, which are often directly supported in the instruction sets of conventional systems, are performed via 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 utilize over 300 instructions plus a large number of addressing modes, compared to the 140 simple instructions provided with HP-PA 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 HP-PA 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 the instruction. Having fixed-format instructions allows for 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 do not have to be slowed 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, 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

So that processor complexity can be minimized and CPU cycle time reduced, only Load and Store instructions access memory. Since Load instructions access storage that is relatively slow compared to CPU registers, these instructions require longer to execute. So that the CPU cycle time does not have to be increased because of these instructions, they are implemented such that they require multiple cycles. However, compilers can schedule instructions so that multicycle Load instructions are overlapped with other processing, thus allowing the effective instruction execution rate to still approach one cycle per instruction.

### 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. HP-PA goes beyond RISC with the important extensions discussed below.

## Expanded addressability

HP-PA systems can be implemented with either 48-bit 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

HP-PA allows for systems that utilize tightly coupled symmetric multiprocessors. Multiprocessors share the same memory and 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 via CPU redundancy.

## Floating-point coprocessors

The modular design of HP-PA 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 4-3. Coprocessor and multiprocessor**
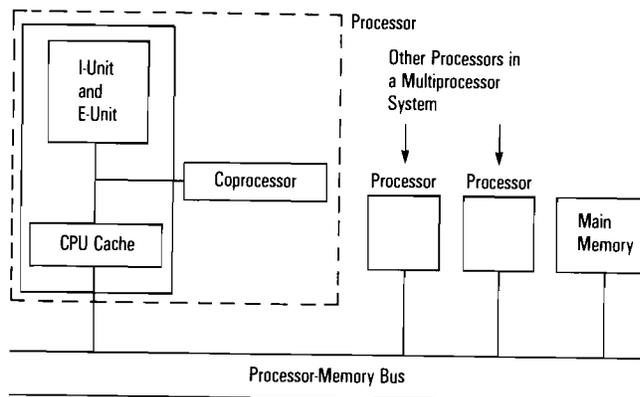
## Decimal arithmetic support

Decimal arithmetic is a data type commonly used in commercial appli-
cations, and HP-PA 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, one of the key design
objectives with HP-PA 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 very effec-
tively utilized by MPE/XL's file mapping schemes. Furthermore,
HP-PA incorporates a memory-mapped I/O scheme, whereby I/O oper-
ations are initiated and controlled via a series of Load/Store instruc-
tions to reserved virtual or real memory locations. A key advantage of
this scheme is that I/O accesses utilize the same access protection
mechanisms as code and data. Coupled with other I/O subsystem fea-
tures such as DMA chaining, which allows multiple transactions to be
processed without CPU intervention, I/O operations on HP-PA 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 resulting 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 correspond-
ing 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 perfor-
mance and for ensuring that the time required to perform each stage
is as short as possible.

**Figure 4-4. Instruction pipeline**

| 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 ⟶
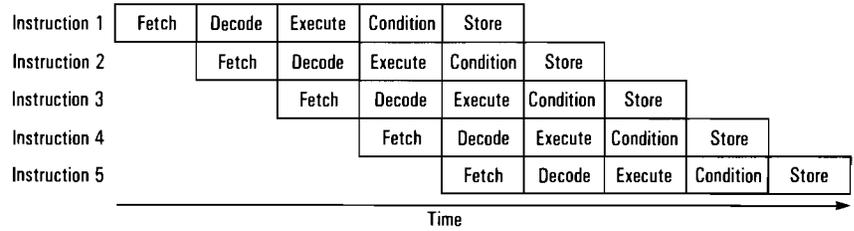
## Delayed-branch capability

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 utilized for useful processing. On HP-PA systems, a branch instruction can specify that the instruction sequentially following the branch is to be executed, so that this cycle can be utilized for processing. Because branches constitute roughly one-sixth of typical instruction mixes, utilizing the available cycle after a branch results in increased performance with HP-PA systems.

**Figure 4-5. Delayed branch capability**

Instruction Stream

| | |
| --- | --- |
| | Branch IA + X |
| IA ⟶ | Add R1 + R2 |
| | |
| IA + X ⟶ | Add R4 + R6 |
| | |

Branch can specify execution of instruction pointed to by instruction address counter while the instruction at IA + X is being fetched.
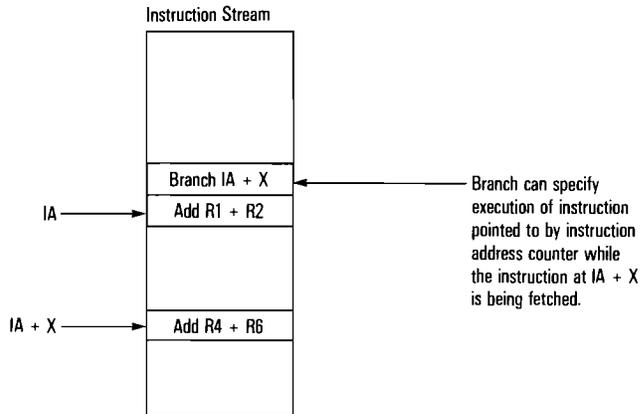
## Optimizing compilers

Optimizing compilers ensure the best possible match between high-level languages and HP-PA machine instructions. Reduced complexity systems are ideal for optimizing compilers, and the best performance on such systems depends upon effective optimization. Optimizing compilers utilized with 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 utilized for useful processing, and they overlap other instructions with Load instructions to keep execution rates close to one cycle per instruction.

## Millicode

The 900 Series systems utilize "millicode" routines to perform some of the more frequently executed complex tasks. Millicode routines, quite simply, are sequences of HP-PA instructions that can be accessed and executed very efficiently by MPE/XL, 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

HP-PA 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 from unauthorized accesses.

## A closer look at HP Precision Architecture

Additional details of HP-PA are provided below. For further information, refer to the "HP Precision Architecture Data Sheet."

## Instruction set

HP-PA defines 140 instructions. Each 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 HP-PA 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 utilize floating-point data types. HP-PA 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 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 HP-PA to provide high performance in applications that use floating-point calculations.

## Data types

HP-PA supports 16-bit 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. HP-PA 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 limitations in available memory space. The huge virtual address space available on the 900 Series systems is fully supported by the MPE/XL operating system.

Virtual memory is organized as a set of linear regions called "spaces," with each space 4 Gbytes in length. Spaces are further divided into fixed-length, 2-Kbyte pages, which can hold either code or data. 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 that space is specified by a 32-bit quantity called the byte offset. With eight space registers available in the CPU, simultaneous multiple spaces can be supported.

**Figure 4-6. Virtual memory organization**
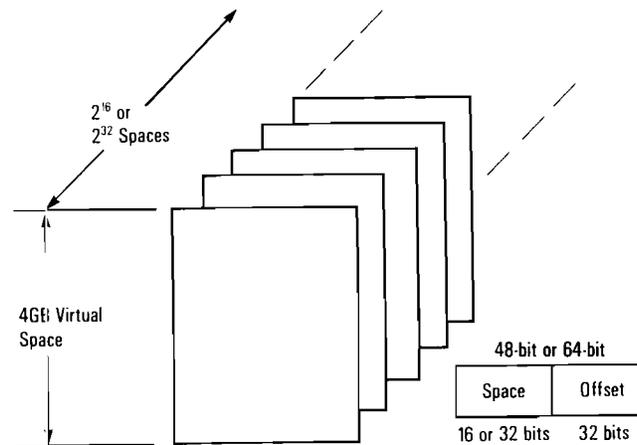


**Virtual address translation**

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 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.

**Figure 4-7. Virtual address translation**
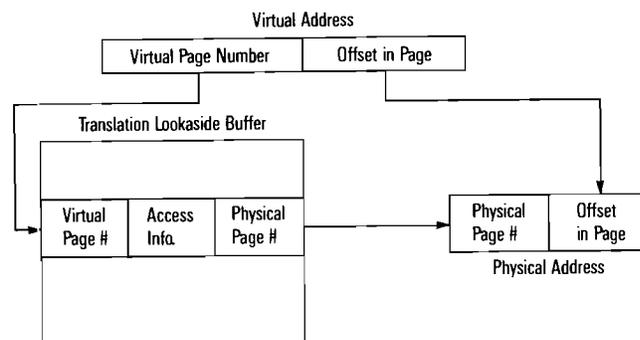
## Virtual memory access protection

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/Logical Instructions

Add
Add Immediate
Add Immediate Left
Load Immediate Left
Add Logical
Add and Trap on Overflow
Shift One and Add
Shift Two and Add
Shift Three and Add
Shift One and Add Logical
Shift Three and Add Logical
Shift One, Add, and Trap on Overflow
Shift Two, Add, and Trap on Overflow
Shift Three, Add, and Trap on Overflow
Add with Carry
Add with Carry and Trap on Overflow
Subtract
Subtract from Immediate
Subtract and Trap on Overflow
Subtract Immediate and Trap on Overflow
Subtract with Borrow
Subtract with Borrow and Trap on Overflow
Subtract and Trap on Condition
Subtract and Trap on Condition or Overflow
Inclusive OR
Exclusive OR

AND
AND Complement
Unit XOR
Unit Add Complement
Unit Add Complement and Trap on Condition
Decimal Correct
Intermediate Decimal Correct
Add Immediate and Trap on Overflow
Add Immediate and Trap on Condition
Add Immediate, Trap on Condition or Overflow
Compare Immediate and Clear
Variable Shift Double
Shift Double
Variable Extract Signed
Variable Extract Unsigned
Extract Signed
Variable Deposit
Variable Deposit Immediate
Deposit
Deposit Immediate
Zero and Variable Deposit
Zero and Variable Deposit Immediate
Zero and Deposit
Zero and Deposit Immediate
Divide Step
Compare and Clear

## System Control Instructions

Break
Return from Interrupt
Set System Mask
Reset System Mask
Load Space ID
Move to Space Register
Move to Control Register
Move from Space Register
Move from Control Register
Move to System Mask
Synchronize Caches
Probe Read Access
Probe Read Access Immediate
Probe Write Access
Probe Write Access Immediate
Load Physical Address

Load Hash Address
Purge Instruction TLB
Purge Instruction TLB Entry
Purge Data TLB
Purge Data TLB Entry
Insert Data TLB Address
Insert Data TLB Protection
Insert Instruction TLB Address
Insert Instruction TLB Protection
Purge Data Cache
Flush Data Cache
Flush Instruction Cache
Flush Data Cache Entry
Flush Instruction Cache Entry
Diagnose

## Special Function Unit Operations

Special Operation Zero
Special Operation One

Special Operation Two
Special Operation Three

## Coprocessor Loads and Stores

Coprocessor Load Word Short
Coprocessor Load Word Indexed
Coprocessor Load Doubleword Short
Coprocessor Load Doubleword Indexed

Coprocessor Store Indexed
Coprocessor Store Doubleword
Coprocessor Store Doubleword Indexed
Coprocessor Operation[1]
Coprocessor Store Word

[1] Floating-Point Operations Included

# Chapter 5                    HP 3000 Hardware Overview

**Introduction**

The HP 3000 family of computers spans a broad range of capabilities and capacities to meet specific application needs. All MPE/XL-based products are available in two configurations. A *multi-user system* can support many on-line users via terminals and PCs, and a *preconfigured server* can be utilized for PC-based client/server applications. The multi-user products are referred to with a "Series" prefix (for example, "Series 925"), while the application server products carry a "Server" prefix (for example, "Server 925"). This chapter focuses on the hardware composition of the entire HP 3000 family, and the capabilities and capacities of the individual systems.

**Figure 5-1.  HP 3000 System comparison**

| | Main memory standard/maximum (Mbytes) | CPU Cache (Kbytes) | Maximum workstations | Maximum disk storage (Gbytes) | Maximum tape drives | Relative performance |
|---|---|---|---|---|---|---|
| MICRO 3000LX | 2/4 | NA | 8 | 0.304 | 1 | 0.3–0.5 |
| MICRO 3000RX | 2/4 | NA | 24 | 2 | 4 | 0.3–0.5 |
| MICRO 3000XE | 2/8 | 128 | 56 | 4.5 | 4 | 0.3–0.5 |
| S922 | 32**/64 | 32 | 152* | 12 | 4 | 1.2 |
| S932 | 32/64 | 128 | 240 | 22 | 4 | 1.9 |
| S925 | 32/96 | 16 | 152 | 21 | 4 | 1 |
| S935 | 48/96 | 128 | 240 | 32 | 4 | 2 |
| S949 | 64/192 | 640 | 400 | 42 | 5 | 4 |
| S950 | 64/192 | 128 | 400 | 64 | 8 | 2.2 |
| S955 | 96/256 | 256 | 600 | 85 | 8 | 3.3 |
| S960 | 128/256 | 1024 | 600 | 85 | 8 | 4.4 |
| S980/100 | 192/512 | 1024 | ≥600 | 85 | 8 | 7.5 |
| S980/200 | 256/1024 | 2×1024 | TBD | 85 | 8 | Up to 14 |

*S/922LX supports 32 users, S/922RX supports 64 users
**S/922LX has 24 Mbytes standard memory

**HP MICRO 3000LX, 3000RX**

HP's MICRO 3000LX and 3000RX computers are complete, entry-level business systems that deliver exceptional performance for departmental, distributed branch office, and small business applications. They bring the power of transaction processing, text and graphics processing, data communication, and data management to the office in a small, unobtrusive package.

The MICRO 3000LX is a low-cost system for up to eight users, while the MICRO 3000RX supports up to 24 users with extended data storage and I/O options.

## MICRO 3000LX, 3000RX processor

At the heart of these new systems is an NMOS III VLSI processor
chip. This is the same hardware technology used in several
900 Series HP 3000 products and delivers both high performance and
high reliability. In fact, the CPU chip of the MICRO 3000 systems is the
most dense NMOS III chip HP has ever developed.

The chip comprises the CPU, 2000 words of control store (for the most
frequently executed microcode routines and boot code), a 256-word
register file, bank registers, Power Supply Monitor (PSM), and a mis-
cellaneous maintenance block.

The external support circuitry consists of the system clock generation
circuitry, the Time-of-Century (TOC) clock, a maintenance panel inter-
face, a special 8-volt power supply for the MICRO 3000 processor chip,
8000 words of "slow" Writable Control Store (WCS), and an additional
8000 words of EPROM micro-code storage.

**Figure 5-3. The HP MICRO 3000RX processor**
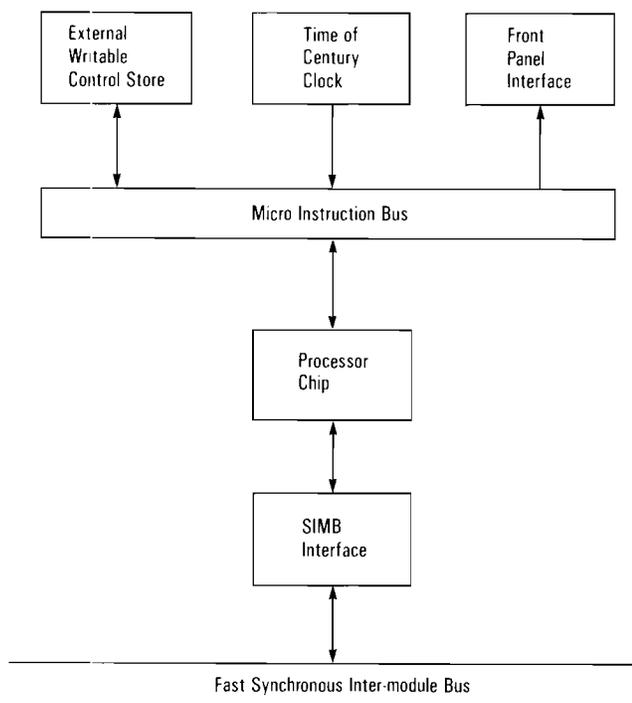
## Memory subsystem

The memory subsystem of the HP MICRO 3000LX, and 3000RX uses high-density, 1-Mbit RAM technology that, coupled with the VLSI implementations, allows memory, the CPU, and the PIC to be mounted on a single board. Data can be passed between the CPU and memory at a high speed using the 113-ns bus on the CPU board.

The 3000LX, and 3000RX come with 2 Mbytes of memory standard, and they can be upgraded to 4 Mbytes at the time of purchase or later, in the field.

## Subsystems

### Buses

The HP MICRO 3000LX, and 3000RX use a high-speed Synchronous Inter-Module Bus (SIMB) on the processor board to connect the CPU, memory, and the PIC. This on-board bus operates at 113 ns. A second SIMB (called the backplane SIMB, operating at 226 ns) serves as the connection to networks and to peripherals such as terminals and printers.

**Figure 5-4. HP MICRO 3000RX System structure**
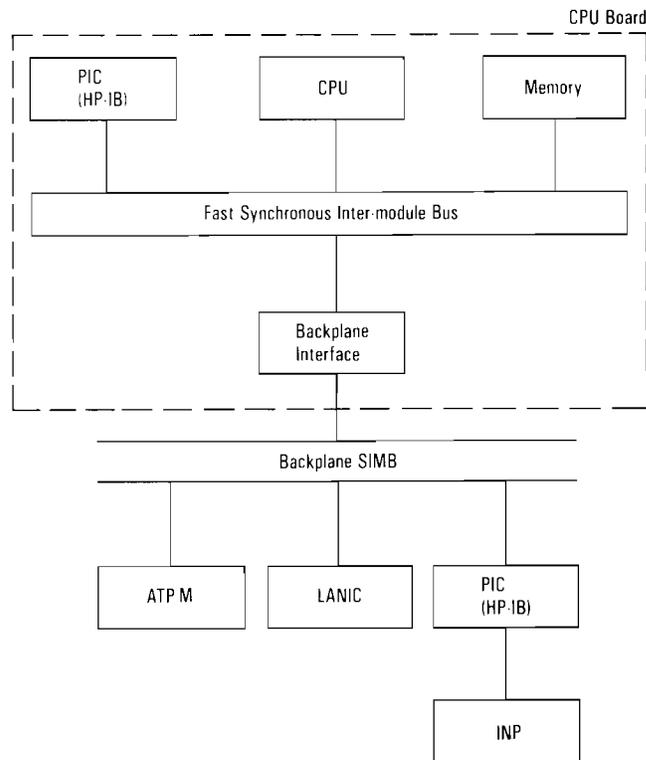
## System organization

The HP MICRO 3000XE utilizes an NMOS III VLSI CPU chip combined with a 128-Kbyte memory cache on the CPU board. This board works in conjunction with a 2- or 4-Mbyte memory board and supports a maximum of 8 Mbytes of memory. Communication is accomplished through the Synchronous Inter-Module Bus (SIMB) for all necessary bus control and data transfers. The microinstruction cycle time on the MICRO 3000XE is 113 ns.

The system also includes a Time-of-Century (TOC) clock, MPE timer, status display, and four 16-bit bank registers.

(See figure 5-7 for a diagram of the system structure.)

## HP MICRO 3000XE processor

At the heart of the MICRO 3000XE is an NMOS III VLSI processor chip. This is the same hardware technology used in several 900 Series HP 3000 systems and delivers both high performance and high reliability. The CPU chip of the MICRO 3000 systems is the most dense NMOS III chip HP has ever developed.

**Figure 5-6. The HP MICRO 3000XE processor**
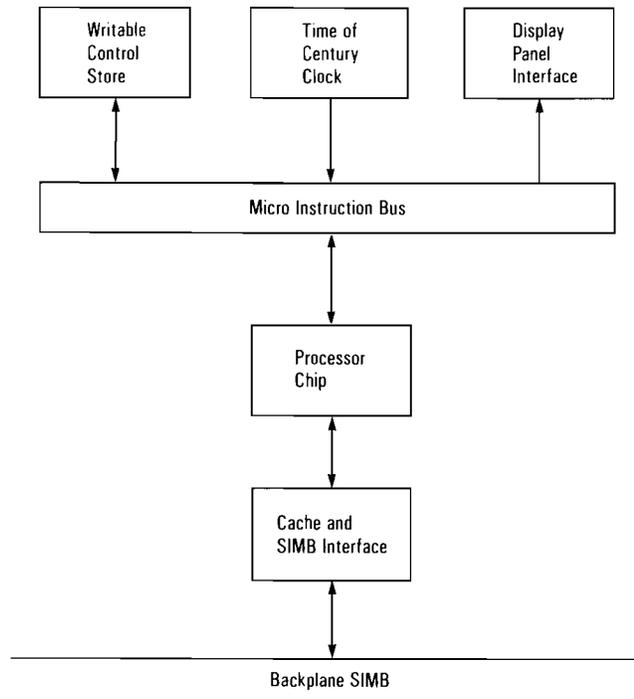
**Figure 5-5. The HP MICRO 3000XE**
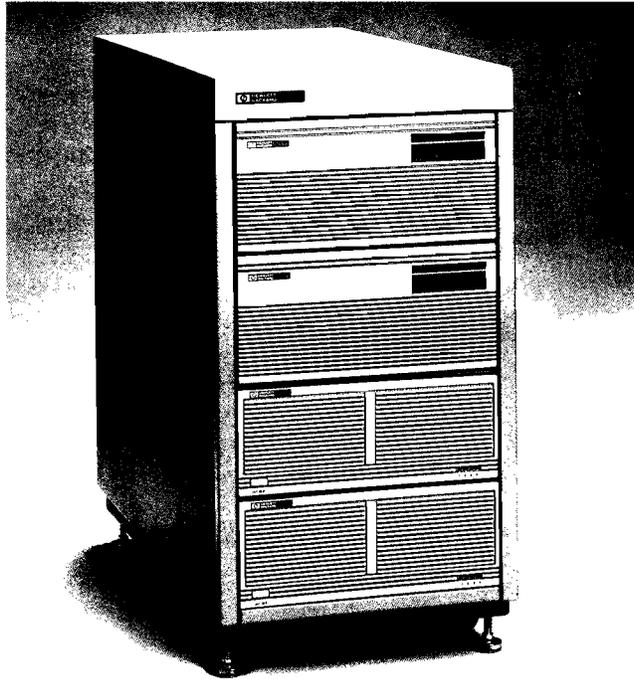


## Features

- High-performance MPE/V operating system
- 128-Kbyte memory cache
- 117-ns system clock cycle
- compact, quiet design for the office
- Power-fail recovery; 15-minute battery backup of system memory with automatic system recovery when power resumes
- Single-bus structure
- up to three synchronous lines for system-to-system communication plus one Local Area Network (LAN) for system-to-system and local workstation communication. HP StarLAN is also supported for local PC connections.
- network database standard; relational database supported
- AdvanceNet networking solution
- compatible upgrade path for future growth

**Configuration maximums**

| | |
|---|---|
| Memory | 2 Mbytes standard; expandable to 8 Mbytes in 2-Mbyte increments |
| Users | Up to 56 point-to-point (28 modem-capable) |
| Disks | Up to 8 disk drives, including support for 55-, 81-, 130-, 152-, 304-, 307-, 404-, and 571-Mbyte disk drives. Maximum of 4.5 Gbyte storage |
| Tape drives | Up to four ½-inch tape drives including support for 1600-, 800/1600-, and 1600/6250-bpi tape drives. Up to four ¼-inch cartridge tape drives and up to two ¼-inch tape cartridge autochangers |
| System printers | Up to 4 system printers including support for 300-, 600-, 900-, and 1200-lpm printers and intelligent page printers |
| Serial printers | Up to 8 serial printers including intelligent laser page printers, dot matrix, and daisywheel printers |

## Cache

The HP MICRO 3000XE CPU board includes a 128-Kbyte memory cache. The use of high-speed CPU caches significantly increases system performance by minimizing accesses to main memory. Cache access can be up to five times faster than main memory access.

The system automatically moves into cache from main memory the code and data that are most likely to be required based upon a "locality" algorithm. As a result, the required code and data are found in cache almost all the time. An access to main memory needs to be made only in the event of a cache miss. Since the CPU usually finds the required code or data in the cache, relatively slow accesses to main memory are minimized.

## Memory subsystem

The MICRO 3000XE comes with 2 Mbyte standard memory but can be expanded to 8 Mbytes maximum in increments of 2 or 4 Mbytes. The system uses both 256-Kbyte RAM and advanced 1-Mbit DRAM to expand main memory capacity.

Error Correcting Code (ECC) memory is standard on the MICRO 3000XE. 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.

## Subsystems

## Buses

**Figure 5-7. HP MICRO 3000XE System structure**
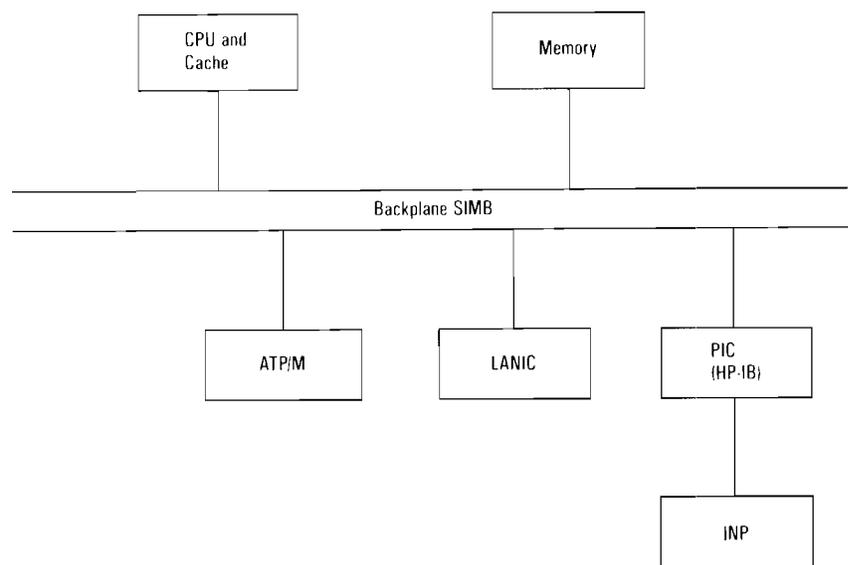
The HP MICRO 3000XE uses a single Synchronous Inter-Module Bus (SIMB) that operates at 170 ns. The SIMB is the backplane of the computer, into which all boards are plugged. This SIMB is the main communication vehicle for transferring data between the CPU/cache, memory, the HP-IB interface, Advanced Terminal Processors (ATPs), and Local Area Networks (LANs).

### Peripheral Interface Controller
The Peripheral Interface Controller (PIC) is a hardware input/output channel. The PIC interfaces with the SIMB. It provides the interface necessary to control and communicate with the Hewlett-Packard Interface Bus (HP-IB) peripherals. The channel is controlled by standard I/O instructions or by the execution of channel programs. The PIC is made up of three main blocks: the SIMB interface logic, PIC control logic, and HP-IB interface logic. Up to six HP-IB devices with I/O channel programs can be supported on a PIC.
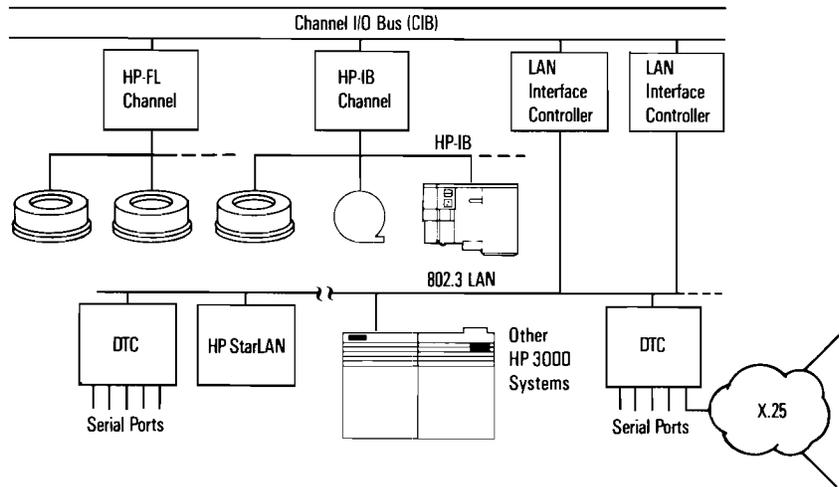
### Peripheral connections
Disks, tapes, and printers are connected via the PIC channel, which supports the 8-bit-wide IEEE-488 standard HP-IB. The PIC supports a maximum of six devices. The 3000XE will support up to three PICs (when the second I/O bay is purchased).

### Workstation and serial connections
The MICRO 3000XE will support up to 7 ATP/Ms with a maximum of 56 direct-connect ports, 28 of which are modem-capable. The 3000XE also supports PC connections over HP StarLAN or an 802.3 LAN.

### System-to-system data communication
The MICRO 3000XE supports local and wide area networks simultaneously. It can handle one LAN and up to three Wide Area Networks (WANs).

AdvanceNet-compatible local HP 3000-to-HP 3000 communication is supported via the LAN, with available services including Network File Transfer, Remote File Access, Virtual Terminal, and Remote Data Base Access to HP TurboIMAGE databases.

**Environmental specifications**

| | |
|---|---|
| Line voltage frequency (nominal) | 100-120 VAC (47-63 Hz) |
| | 200-240 VAC (47-63 Hz) |
| Input voltage tolerance: | ± 10% from nominal |
| Input current: | 6 amps @ 100-120 VAC, 50-60 Hz |
| | 4 amps @ 200-240 VAC, 50-60 Hz |
| Heat dissipation, maximum: | 3278 BTU/hr |
| Physical dimensions (system cabinet): | |
| – Height: | 720 mm (29 in) |
| – Width: | 375 mm (15 in) |
| – Depth: | 711 mm (28.5 in) |
| – Weight: | 33 Kg (73 lbs) |
| Operating temperature, system: | 10-40°C (50-104°F) |
| Relative humidity, system (operating): | 20-80% (non-condensing) @ 40°C |
| Altitude (operating): | Up to 4572 m (15,000 ft) |
| Battery backup time, minimum: | 15 minutes |
| Acoustics (inc. system cabinet): | 5.6 Bels sound power (A) |

## HP 3000 S922 and S932 processors

The HP 3000 S922 and S932 processors are implemented with VLSI semiconductor technology. The S922 is a single board processor with an 80-ns clock cycle, and the S932 is a single board processor with a 67-ns clock cycle. With hardwired control, the S922 and S932 are capable of executing one instruction every clock cycle. Separate instruction and execution units facilitate pipelining and allow for efficient parallel use of processor resources.

**Figure 5-9. The HP 3000 S922 processor**
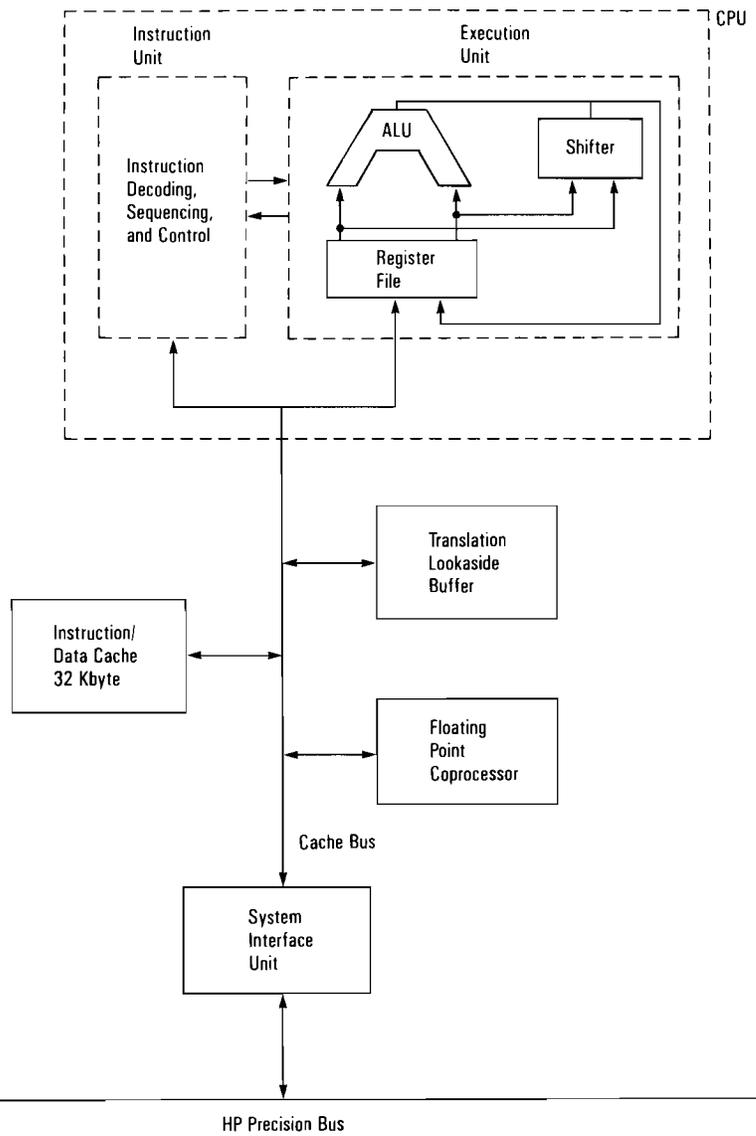
## Cache

The use of high-speed CPU caches significantly increases system performance by minimizing accesses to main memory. Cache access can be up to an order of magnitude faster than accesses to main memory.

The system automatically moves into cache from main memory the code and data that are most likely to be required based upon a locality algorithm. As a result, the required code and data are found in cache almost all the time. An access to main memory needs to be made only in the event of a cache miss. Since the CPU usually finds the required code or data in cache, relatively slow accesses to main memory are minimized.

One of the primary differences between the S922 and the S932 is the size of their CPU caches. The S922 has a 32-Kbyte cache, while the S932 has a 128-Kbyte cache to provide higher performance and support for more users.

Both the S922 and the S932 employ a combined cache for code and data that is two-way associative. The S922 cache is organized in two sets of 512 cache lines, and the S932 is organized in two sets of 2,048 cache lines. In both cases, the cache lines are 32 bytes each. Data modified in the cache is written to 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 power failure.

### Pipelining
Separate instruction and Execution Units help 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. It also generates the system's master clock.

The Execution Unit executes all instructions requiring data manipulation. It contains the 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 HP 3000 S922 and S932 use a three-stage instruction pipeline so that up to three machine instructions can be in operation simultaneously. Each stage is a CPU cycle. While one instruction is fetched, another instruction is executed, and the result of a third instruction is stored. The net effect is that, except for penalties such as cache misses (which occur infrequently), *one instruction completes (exits the pipeline) every CPU cycle.*

**Figure 5-10. Instruction pipelining**



| Instruction 1 | Fetch | Execute | Store | | |
|---|---|---|---|---|---|
| Instruction 2 | | Fetch | Execute | Store | |
| Instruction 3 | | | Fetch | Execute | Store |
| S922 | 80 ns | 80 ns | 80 ns | 80 ns | 80 ns |
| S935 | 67 ns | 67 ns | 67 ns | 67 ns | 67 ns |

Time

## Floating-Point Coprocessor

For scientific, engineering, and statistical applications that require high performance in floating-point calculations, the S922 and S932 come equipped with a hardware coprocessor that significantly accelerates floating-point calculations.

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 use floating-point calculations.

## Virtual memory management

Virtual addresses on the S922 and S932 are 48 bits in length, ensuring sufficient expandability to meet growing software needs. Virtual memory is divided into a set of 65,536 spaces, with each space 4 Gbytes in length. Spaces are further divided into fixed length, 2-Kbyte pages, with a given page holding data, code, or both. A single data structure can be up to 1-Gbyte or 4-Gbytes in length (compiler dependent), and code can span multiple spaces.

**Figure 5-11. Virtual memory organization**
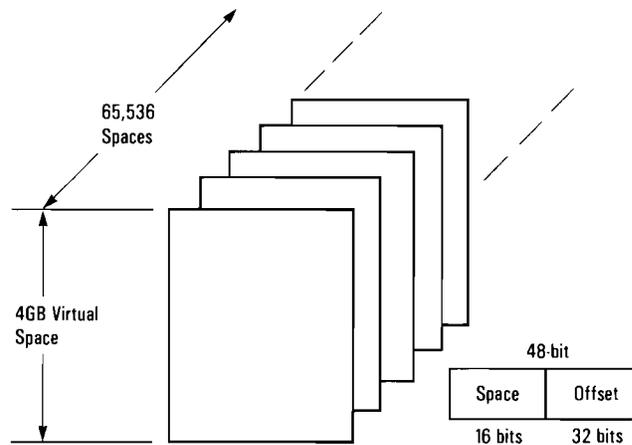


## Virtual address translation

Since the processor generates 48-bit virtual addresses, and memory access is via 29-bit physical (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. The S922 and S932 TLB holds translations for 4,096 virtual pages and is split into a 2,048-entry instruction TLB and a 2,048-entry data TLB.

Memory is divided into 2-Kbyte pages, with the access protection provided at the page level for all code, data, and I/O access. When a virtual-to-physical address translation occurs, the TLB checks whether the executing process can access the page and, if so, what type of access is allowed (read, write, execute, etc.).

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, then 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 S922 systems and the S932 are shown in the table below. The memory subsystem uses 1-Mbit Nibble-mode 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. This allows the operating system to be automatically restarted and processing to continue without data loss, upon a resumption of power.

Error Correcting Code (ECC) memory is standard on all 900 Series systems. The internal memory word size for the S922 and S932 is 72 bits: 64 bits for data and 8 bits dedicated to error detection and correction. Single-bit errors are automatically detected and corrected to ensure data integrity. Multi-bit errors are automatically detected, and a high-priority interrupt is sent to the system software for appropriate action.

| System | Standard memory | Maximum memory |
|--------|-----------------|----------------|
| S922LX | 24 | 64 |
| S922RX | 32 | 64 |
| S922 | 32 | 64 |
| S932 | 32 | 64 |

## Subsystems

### Buses
The S922 and S932 employ a two-level bus hierarchy for high-performance I/O throughput.

**Figure 5-12. HP 3000 S922 structure**
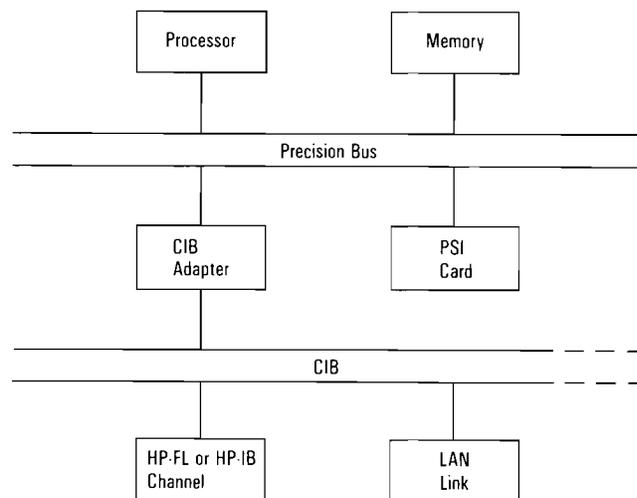


### Precision Bus
The Precision Bus is the communication path between the CPU, main memory, and the Channel Adapters. The Precision Bus provides a 32-bit data path, runs synchronously with an 8-MHz clock, and supports an average data transfer rate of 20 Mbytes/second.

In addition, the Precision Bus directly supports a Programmable Serial Interface (PSI) card to provide point-to-point, system-to-system communication between HP 3000 computers and communication to IBM systems via 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 Channel I/O Bus (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 S922LX, the S922RX, the S922 and the S932 include one Channel I/O Bus standard. The 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 and has an average data transfer rate of 5 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 increases system performance in I/O intensive applications.

### Peripheral connections

Disks, tapes, and printers are connected via an HP-IB channel, which supports the 8-bit wide, IEEE-48 standard HP-IB. Each HP-IB channel supports up to six peripheral devices. In addition, external disks can be connected via HP-FL, a high-speed fiber-optic link with a data transfer rate of up to 5 Mbytes/second. HP-FL and dual fiber optic disk drives are required for support of Mirrored Disk/XL, a redundant disk capability available with MPE/XL.

### Workstation and serial connections

Connections for workstations, serial printers, and other serial devices are provided via Datacommunications and Terminal Controllers (DTCs) for multi-user systems. DTCs are distributed over an IEEE-802.3 standard LAN. This flexible connection scheme allows DTCs to be situated in the department they serve, saving the cost and effort of running cables from each workstation back to the processor. Each DTC can support up to 48 direct-connect ports or 36 modem ports or a combination of the two. Both RS-232 and RS-422 interfaces are supported. In addition, PCs can be connected directly to a LAN or HP StarLAN.

**Figure 5-13. HP 3000 S922 I/O attachments**



## System-to-system data communication

HP 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 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.

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

## System packaging

The S922 systems and the S932 are each available in a compact, attractive cabinet measuring 0.7 meters high and 0.375 meters wide, comparable in size to a desk-high, 2-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 full compatible tape drive technology. The DDS backup unit integrated in the the S922 systems and the S932 system stores 1.3 Gbytes of data on a standard audio DAT cassette, measuring only 73 by 54 by 10.5 mm, slightly smaller than an audio cassette tape. 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:

- 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 5¼-inch form factor

**Figure 5-14. Photo of DAT cartridge (supports 1.3 Gbytes of data)**

### Disk storage

The S922 systems and the S932 take advantage of state-of-the-art disk storage devices by integrating up to four 5¼-inch 670-Mbyte disk drive units into the system. The S922 and S932 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 of over 100,000 hours)
- enhanced Small Device Interface
- 670-Mbyte formatted disk
- extensive use of HP's state-of-the-art VLSI processes

**S922 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 Class A computing device. Manufacturer's Declaration to German FTZ 1046. | | |
| AC power input voltage/frequency | Nominal | Range | Maximum Current |
| | 100-120V, 50/60Hz | 90-132 VAC/47-63 Hz | 12A |
| | 200-240V, 50/60Hz | 180-264 VAC/47-63 Hz | 6.3A |
| Power consumption | 1900 BTU/hr. | | |
| Physical dimensions | Height: 750 mm (29.5 in.) | | |
| | Width: 375 mm (14.8 in.) | | |
| | Depth: 710 mm (27.9 in.) | | |
| Weight | 110 kg (244 lbs) | | |
| Temperature | Operating: +5° to +40°C (41° to 104°F) | | |
| | Non-operating: -40° to +70°C (-40° to 158°F) | | |
| Relative humidity | Operating:20% to 80%, non condensing | | |
| | Non-operating: 5% to 80%, non condensing | | |
| Altitude (operating) | To 3.0 km (10,000 feet) | | |
| Battery backup time, minimum | 15 minutes | | |
| Acoustics | 5.8 bels (A) sound power below 30 C | | |
| Radiated susceptibility | 10 V/m 10kHz—1 G | | |
| Conducted susceptibility | 3 volts RMS 30 Hz—50 kHz | | |
| | 1 volt RMS 50 kHz—400 MHz | | |

**HP 3000 Series 925, 935, 949, and Servers 925, 935, and 949**

The HP 3000 Series 925, 935, 949, and Servers 925, 935, and 949 are midrange members of the HP 3000 family of business computers. These systems are based on HP Precision Architecture and use sophisticated VLSI technology to deliver super-minicomputer performance in a surprisingly small size and with low cost. The hardware performance of the S925, S935, and S949, combined with the enhanced MPE/XL operating system, provides excellent throughput and industry-leading price/performance in both On-line Transaction Processing (OLTP) and batch data processing environments.

The S935 provides up to 100 percent higher performance and greater configurability than a S925, and the S949 provides up to 100 percent higher performance and greater configurability than the S935, outperforming the S925 by about 4 times. You can move easily from a S925 to a S935 and then finally to a S949 via convenient, cost-effective, single processor board field upgrades.

The S925, S935, and S949 are available in a compact attractive cabinet with the capacity to rack mount an entire system. They can also be easily expanded to handle larger terminal and disk configurations. The S925, S935, and S949 are highly reliable, due to their low number of parts, and do not require a special computer room environment, making them ideal computing systems for small-to-medium-size businesses, departments, and remote office locations. And they are backed by the high standards of quality and support for which the HP 3000 is known.

Features

- 2 times S925 Performance (935), 4 times S925 Performance (949)
- MPE/XL operating system
- single-chip VLSI CPU
- HP Precision Architecture
- 48-bit virtual addressing
- Advanced Instruction Pipelining techniques
- Floating-Point Coprocessor
- battery backup and auto-restart standard
- terminal connection via IEEE 802.3 Local Area Network (LAN) HP StarLAN is also supported.
- HP AdvanceNet networking solutions
- low power and cooling requirements, compact packaging

**Features comparison**

|  | S925 | S935 | S949 |
|---|---|---|---|
| CPU cycle time | 80ns | 67ns | 33ns |
| CPU data cache | -- | -- | 128 Kbytes |
| CPU instruction cache | -- | -- | 512 Kbytes |
| Total cache | 16 Kbytes | 128 Kbytes | 640 Kbytes |
| Translation Lookaside Buffer | 2K-entry | 4K-entry | 16K-entry |

**Configuration maximums**

|  | S925 | S935 | S949 |
|---|---|---|---|
| Memory (Mbytes) | 32-96 | 48-96 | 64-192 |
| Users | 152 | 240 | 400 |
| Disks | 16 | 24 | 32 |
| Disk storage (Gbytes) | 20.8 | 31.2 | 41.6 |
| Tape drives | 4 | 4 | 5 |
| System printers | 4 | 8 | 8 |
| Serial printers | 8 | 32 | 32 |
| Intelligent laser printers | 4 | 4 | 4 |
| I/O Channel multiplexers | 1 | 2 | 2 |

**Figure 5-15. The HP 3000 S949**
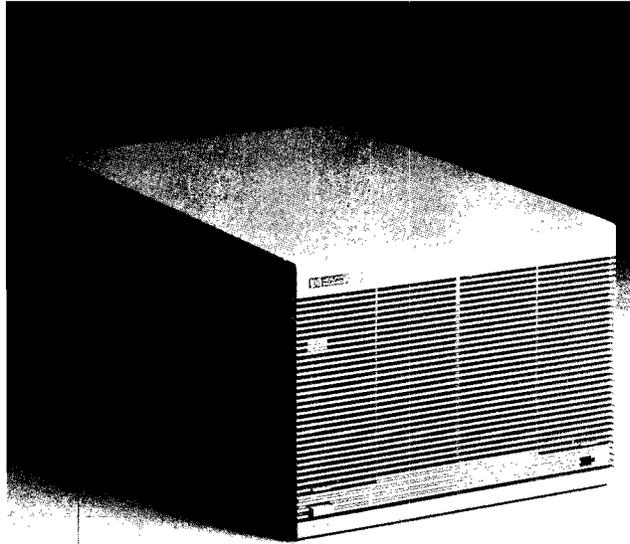


## System organization

The processor communicates with memory and I/O via the Central
Bus (CTB). The CTB provides a 32-bit data path and can support an
average data transfer rate of 22 Mbytes/second. The CTB is interfaced
to a separate 16-bit-wide Channel I/O Bus (CIB) via a Channel I/O Bus
Adapter (or Channel Adapter for short). The CIB supports I/O inter-
faces to peripheral devices and data communication links.

(See figure 5-19 for a diagram of the system organization.)

## HP 3000 S925, S935, and S949 processors

The S925, S935, and S949 processors are implemented with advanced
VLSI semiconductor technology. The S925 system processor is con-
tained on a single compact board that includes a CPU, a TLB Control
unit (TCU), two Cache Control Units (CCUs), a System Interface Unit
(SIU), a Math Interface Unit (MIU). On the S925, a second board, the
system board, contains the Floating-Point Coprocessor and the
Channel Adapter.

On the S935 and S949, the Floating-Point Coprocessor is located on
the processor board, and there are two Channel Adapters on the sys-
tem board.

With hardwired control, the S925 is capable of executing one instruction with every 80-ns clock cycle; the S935 can execute one instruction with every 67-ns clock cycle; and the S949 can execute one instruction with every 33-ns clock cycle. Separate instruction and execution units facilitate pipelining and allow for efficient parallel use of processor resources.

**Figure 5-16. The HP 3000 S935 processor**
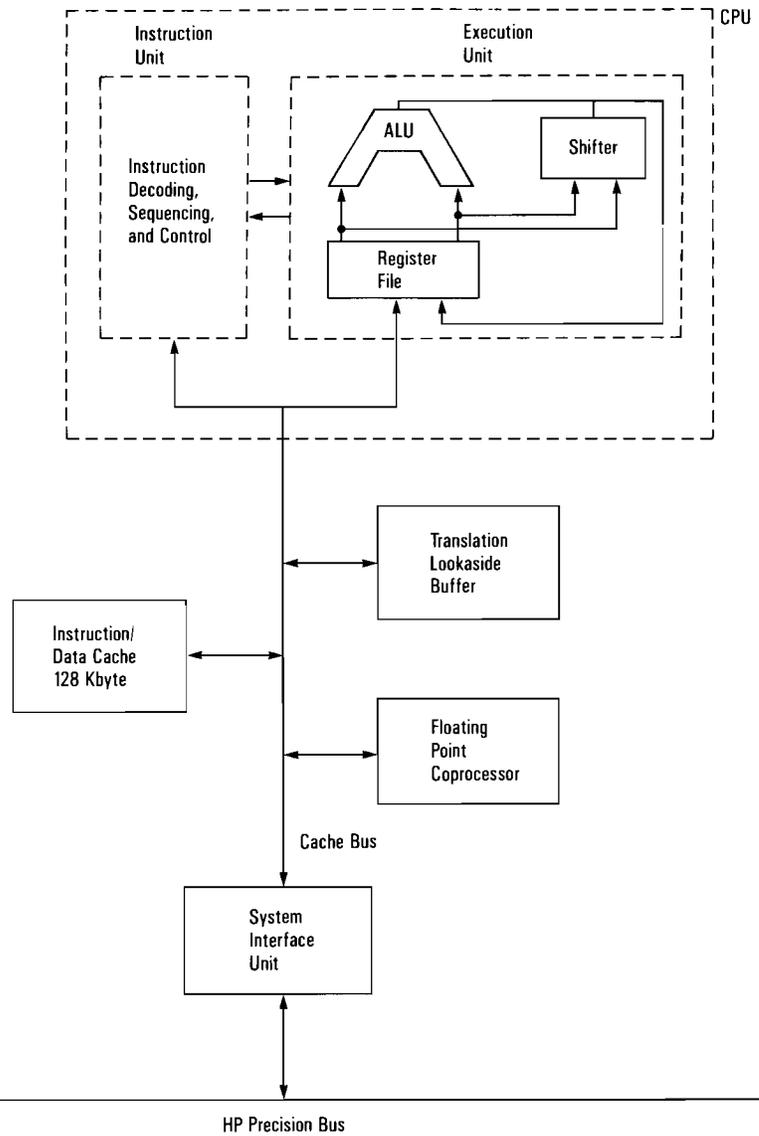
## Cache

The use of high-speed CPU caches significantly increases system per-
formance by minimizing accesses to main memory. Cache access can
be up to an order of magnitude faster than accesses to main memory.

The system automatically moves into cache from main memory the
code and data that are most likely to be required based upon a local-
ity algorithm. As a result, the required code and data are found in
cache almost all the time. An access to main memory needs to be
made only in the event of a cache miss. Since the CPU usually finds
the required code or data in cache, relatively slow accesses to main
memory are minimized.

One of the primary differences between the S925, the S935, and the
S949 is the size and organization of their CPU caches. The S925 has a
16-Kbyte cache, while the S935 has a 128-Kbyte cache to provide
higher performance and support for more users than the S925; and
the S949 has a 640-Kbyte cache to provide for higher performance
and support for more users than the S935.

Both the S925 and the S935 employ a combined cache for code and
data that is two-way associative. The S925 cache is organized in two
sets of 256 cache lines; the S935 cache is organized in two sets of
2,048 cache lines; and the S949 cache is organized in two sets of 8,192
instruction cache lines and two sets of 2,048 data cache lines. In all
three cases, the cache lines are 32 bytes each. Data modified in the
cache is written to 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 power
failure.

## Pipelining

Separate instruction and Execution Units help 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 instruc-
tions, maintains processor status, and handles traps and interrupts. It
also generates the system's master clock.

The Execution Unit executes all instructions requiring data manipula-
tion. It contains the 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 S925 and S935 use a three-stage instruction pipeline so that up to three machine instructions can be in operation simultaneously. Each stage is a CPU cycle. While one instruction is fetched, another instruction is executed, and the result of a third instruction is stored.

The S949 uses a five stage pipeline so that up to five instructions can be in operation simultaneously. The instruction pipeline consists of five 33 nanosecond stages. During the first stage, the instruction is fetched from cache. The specified 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 with the corresponding cache or internal result. The net effect for all three systems is that, except for penalties such as cache misses (which occur infrequently), *one instruction completes (exits the pipeline) every CPU cycle.*

**Figure 5-17. Instruction pipelining**

| Instruction 1 | Fetch | Execute | Store | | |
|---|---|---|---|---|---|
| Instruction 2 | | Fetch | Execute | Store | |
| Instruction 3 | | | Fetch | Execute | Store |
| S925 | 80 ns | 80 ns | 80 ns | 80 ns | 80 ns |
| S935 | 67 ns | 67 ns | 67 ns | 67 ns | 67 ns |
| S949 | 33 ns | 33 ns | 33 ns | 33 ns | 33 ns |

Time →

**Floating-Point Coprocessor**

For scientific, engineering and statistical applications that require high performance in floating-point calculations, the S925, S935, and S949 come equipped with a coprocessor that significantly accelerates floating point calculations.

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 provide a high level of performance for applications that use floating-point calculations.

On the S925, the Floating-Point Coprocessor consists of three NMOS VLSI chips attached to the CPU's processor interconnect bus. The S935 and S949 Floating-Point Coprocessor is implemented on two ECL VLSI chips which provide much faster floating-point performance than the S925 Floating-Point Coprocessor.

## Virtual memory management

Virtual addresses on the S925, S935, and S949 are 48 bits in length, providing sufficient expandability to meet growing software needs. Virtual memory is divided into a set of 65,536 spaces, with each space 4 Gbytes in length. Spaces are further divided into fixed length, 2-Kbyte pages, with a given page holding data, code, or both. A single data structure can be up to 1 Gbyte or 4 Gbytes in length (compiler dependent), and code can span multiple spaces.

**Figure 5-18. Virtual memory organization**
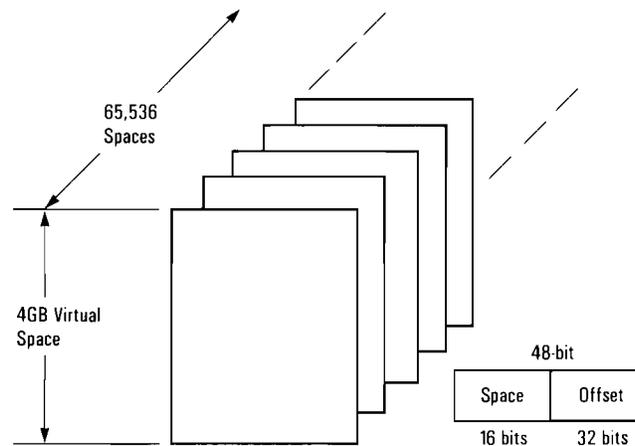


## Virtual address translation

Since the processor generates 48-bit virtual addresses, and memory access is via 28-bit physical (real) addresses on the S925 and S935 and 30-bit physical(real) addresses on the S949, 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. The S925 TLB holds translations for 2,048 virtual pages, the S935 holds translations for 4096 virtual pages, and the S949 holds translations for 16,384 virtual pages. In all three cases, the TLB pages are equally divided between instructions and data.

Memory is divided into 2-Kbyte pages, with the access protection provided at the page level for all code, data, and I/O access. When a virtual-to-physical address translation occurs, the TLB checks whether the executing process can access the page and, if so, what type of access is allowed (read, write, execute, etc.).

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, then 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 S925, S935, and S949 are shown in the table below. The memory subsystem for the 8- and 16-Mbyte cards uses 1-Mbit Nibble-mode Dynamic RAMs. The 32-Mbyte card uses 4-Mbit Nibble-mode 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. This allows the operating system to be automatically restarted and processing to continue without data loss, upon a resumption of power.

Error Correcting Code (ECC) memory is standard on all 900 Series systems. The internal memory word size for the S925, S935, and S949 is 72 bits: 64 bits for data and 8 bits dedicated to 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.

| System | Standard memory | Expansion increments | Maximum memory |
|--------|-----------------|----------------------|----------------|
| S925 | 32 Mbyte | 8, 16 & 32 Mbyte | 96 Mbyte |
| S935 | 48 Mbyte | 8, 16 & 32 Mbyte | 96 Mbyte |
| S949 | 64 Mbyte | 8, 16 & 32 Mbyte | 192 Mbyte |

### Subsystems

### Buses

The S925, S935, and S949 employ a two-level bus hierarchy for high-performance I/O throughput.

**Figure 5-19. HP 3000 S949 structure**
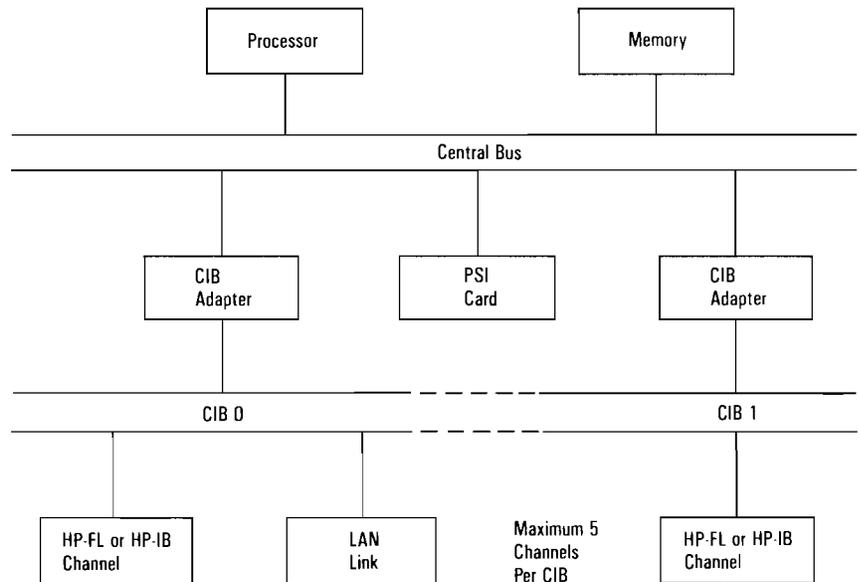


## Central Bus

The Central Bus (CTB) is the communication path between the CPU, main memory, and the Channel Adapters. The CTB provides a 32-bit data path and, on the S925, runs synchronously with a 8-MHz clock, supporting a data transfer rate of 22 Mbytes/second. The S935 and S949 CTB runs synchronously with a 10-MHz clock and supports a data transfer rate of 22 Mbytes/second.

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

## Channel I/O Bus Adapters

The S925, S935, and S949 Channel I/O Bus (CIB) 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-FL, HP-IB, 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.

### Channel I/O Buses

The S925, S935, and S949 include one Channel Adapter standard, and a second may be added. All three systems support up to two 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 and has a data transfer rate of up to 5 Mbytes/second.

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

### 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 increases system performance in I/O intensive applications.

### Peripheral connections

Disks are connected via 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/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 via 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 redundant disk capability available with MPE/XL.

### Workstation and serial connections

Connections for workstations, serial printers, and other serial devices are provided via Datacommunications and Terminal Controllers (DTCs), which are distributed over an IEEE-802.3 standard LAN. This flexible connection scheme allows DTCs to be situated in the department they serve, saving the cost and effort of running cables from each workstation back to the processor. Each DTC can support up to 48 direct-connect ports or 36 modem ports or a combination of the two. Both RS-232 and RS-422 interfaces are supported. In addition, PCs can be connected directly to to a LAN or HP StarLAN.

**Figure 5-20.  HP 3000 S925, S935, and S949 I/O attachments**



### System-to-system data communication

HP 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 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.

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

### System packaging

The S925, S935, and S949 are each available in two compact attractive cabinets: a 0.53-m and a 1.6-m cabinet. The 0.53-m cabinet is capable of holding the SPU and the optional CIB expander and is roughly the size of a desk-high 2-drawer file cabinet. The 1.6-m cabinet is roughly the size of a tall, 4-drawer file cabinet, and has been designed to hold an entire modular system in a very small area, maximizing the efficiency of office or computer room space. It is capable of holding the SPU, one DTC, a tape drive, and four disk drives. If desired, the CIB expander can be installed in the cabinet in place of two of the disk drives.

**S925, S935, and S949 Environmental specifications**

| | |
|---|---|
| Regulatory compliance | Safety compliant with UL 478, CSA 220, and IEC 380/435. |
| Electromagnetic interference | Complies with FCC Rules and Regulations, Part 15, Subpart J, as a Class A commuting device. Manufacturer's declaration verifies VDE level B. Registered as a VCCI Class I product. |

| AC power input voltage/frequency | Range | Tolerance | Maximum Current |
|---|---|---|---|
| | 100V | 90-110 VAC, 48-66 Hz | 9.5A |
| | 120V | 108-132 VAC, 48-66 Hz | 8.0A |
| | 240V | 180-264 VAC, 48-66 Hz | 5.3A |

| | |
|---|---|
| Power consumption | 600 watts, 2034 BTU/hr. |
| Physical dimensions | Height: 234 mm (9.21 in.)<br>Width: 325 mm (12.8 in.)<br>Depth: 500 mm (19.7 in.) |
| Weight | 22kg (51 lbs) |
| Operating temperature | 0 to 55 degrees C (32 to 131 degrees F) |
| Non-operating temperature | −40 to 71 degrees C (−40 to 159 degrees F) |
| Relative humidity | 15% to 95% at 0-40 degrees C, non condensing |
| Altitude (operating) | To 4.6 km (15,000 feet) |
| Altitude (non-operating) | To 15.3 km (15,000 feet) |
| Battery backup time, minimum | 15 minutes |
| Acoustics | 5.0 bels (A) sound power |
| Ventilation | Forced air cooling, air flows from front to back. |

**High-end systems**

The HP 3000 high-end systems, the S950, S955, S960, and S980 are all designed for high performance in On-line Transaction Processing (OLTP) I/O and overall system throughput. These systems provide mainframe class performance, support hundreds of on-line users, and are complemented by an operating system, MPE/XL, designed for high performance in OLTP and batch environments. MPE/XL is equipped with robust functionality while maintaining HP 3000 ease of use. MPE/XL offers powerful system management utilities, high availability options, tools for performance measurement and monitoring, and built-in features to ensure data integrity. The high-end systems take advantage of advanced technology to provide exceptional performance implemented with single chip CPUs and single board processors. Due to their powerful processors and advanced floating-point coprocessors, these systems are also very effective with computation-intensive applications.

The S950, S955, and S960 take advantage of Hewlett-Packard Precision Architecture (HP-PA) and NMOS VLSI semiconductor technology to provide high uniprocessor performance. The S955 offers 50 percent more processing power than the S950, and the S960 offers twice S950 performance. The S980/100 is a high capacity system providing up to three and one half times the performance of the S950, and is implemented with HP's advanced CMOS technology, which provides very high performance and exceptional reliability. The S980/200 is a fully symmetric multiprocessor comprised of two S980/100 processors. The reduced complexity of HP-PA allows these high-end

HP 3000s to fit in a meter-high, dual-bay, air cooled package, which is smaller and has significantly lower cooling and power requirements than typical systems in their performance class, today's water-cooled mainframes. You can move easily from the S950 to any of the intermediate high-end systems and finally to an S980/200 via convenient, cost-effective field upgrades.

Performance

• S950—2.2 times S925 Performance
• S955—1.5 times S950 Performance
• S960—2 times S950 Performance
• S980/100—3.4 times S950 Performance
• S980/200—up to 6.5 times S950 Performance

Common features

• MPE/XL operating system
• single chip VLSI CPU, single board processor
• HP Precision Architecture
• high-speed CPU cache for data and instructions
• advanced instruction pipelining
• Floating-point Coprocessor standard
• Translation Lookaside Buffer (TLB) for virtual to physical address translation
• battery backup, auto restart standard
• high-speed, average 100 Mbyte per second System Memory Bus (SMB)
• IEEE 802.3 Local Area Network (LAN) terminal connection; HP StarLAN also supported standard
• HP AdvanceNet networking solutions
• low cooling and power requirements; compact packaging

**Features comparison**

| | S950 | S955 | S960 | S980 |
|---|---|---|---|---|
| Virtual addressing | 48-bit | 48-bit | 48-bit | 64-bit |
| CPU cycle time | 73ns | 37ns | 37ns | 21ns |
| CPU data cache | — | 128 Kbyte | 512 Kbyte | 512 Kbyte |
| CPU instruction cache | — | 128 Kbyte | 512 Kbyte | 512 Kbyte |
| Total cache | 128 Kbyte | 256 Kbyte | 1 Mbyte | 1 Mbyte |
| Pipelining | 3-stage | 5-stage | 5-stage | 5-stage |
| Translation Lookaside Buffer on Chip (CPU) | — | — | — | 128-entry |
| External TLB | 4 K-entry | 16 K-entry | 16 K-entry | 8 K-entry |

**Configuration maximums**

| | S950 | S955 | S960 | S980/100 | S980/200 |
|---|---|---|---|---|---|
| Memory (Mbytes) | 64–192 | 96–256 | 128–256 | 192–512 | 256–1Gb |
| Users | 400 | 600 | 600 | ≥600 | TBD |
| Disks | 48 | 64 | 64 | 64 | 64 |
| Disk storage (Gbytes) | 64 | 85 | 85 | 85 | 85 |
| Tape drives | 8 | 8 | 8 | 8 | 8 |
| System printers | 8 | 8 | 8 | 8 | 8 |
| Serial printers | 32 | 32 | TBD | TBD | TBD |
| I/O Channel multiplexer | 4 | 4 | 4 | 4 | 4 |
| Intelligent laser printers | 4 | 4 | 4 | 4 | 4 |

Figure 5-21. The HP 3000 S95X, S960, and S980 system package
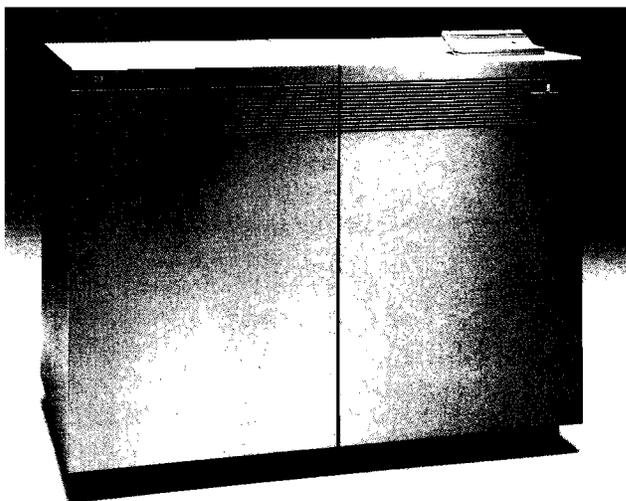


## System organization

The processor communicates with main memory via the 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) via separate Channel Adapters. The CIBs support I/O interfaces to peripheral devices and LAN links.

(See figure 5-26 for a diagram of the system organization.)

## HP 3000 S950, S955, and S960 processors

The entire S950, S955, and S960 processor, implemented with HP's advanced VLSI technology, is contained on a single board. The 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.

**Figure 5-22. The HP 3000 S950 processor**
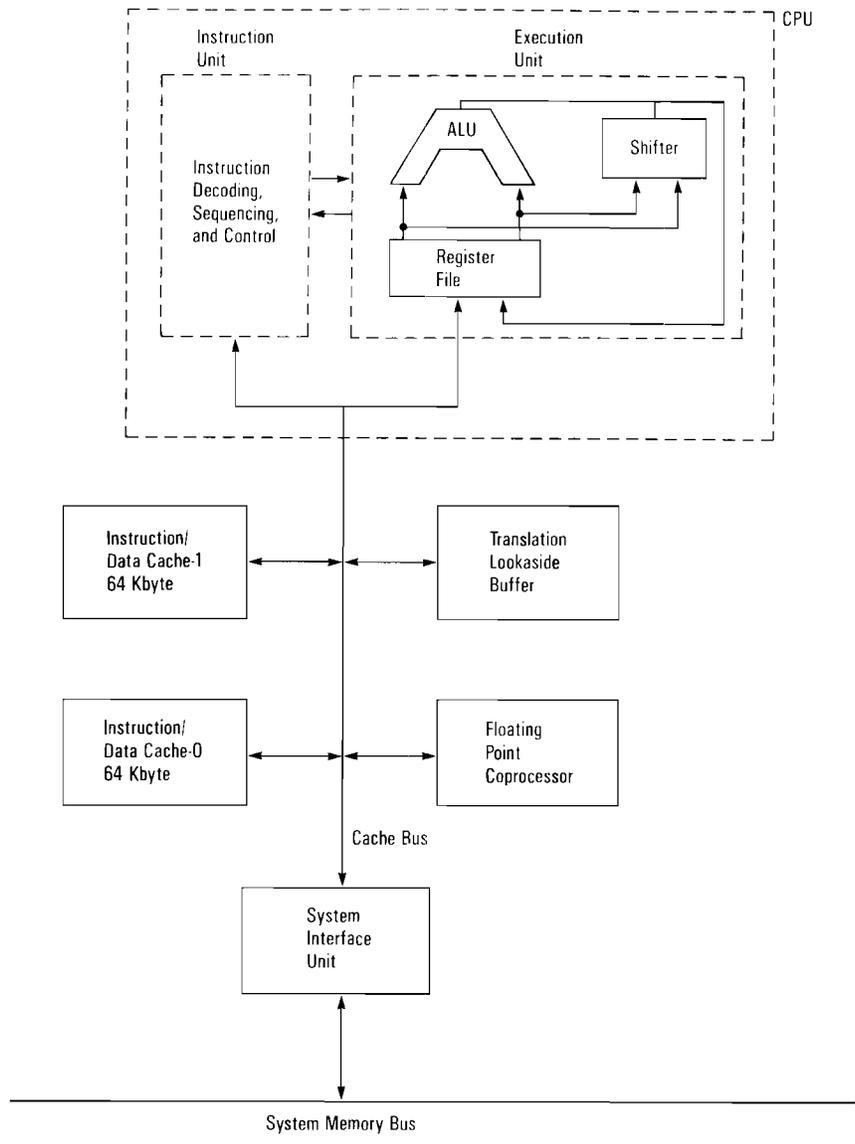
## HP 3000 Series 980 processor

The S980 processor, implemented with HP's advanced CMOS VLSI semiconductor technology, is also contained on a single board. This 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 (System Memory Bus) to Processor Interface (SPI) chip, and the Floating-Point Coprocessor (FPC). The very fast CPU instruction cycle time (21ns) is due to the advanced implementation of the CPU using submicron CMOS technology.

**Figure 5-23. HP 3000 Series 980 processor**
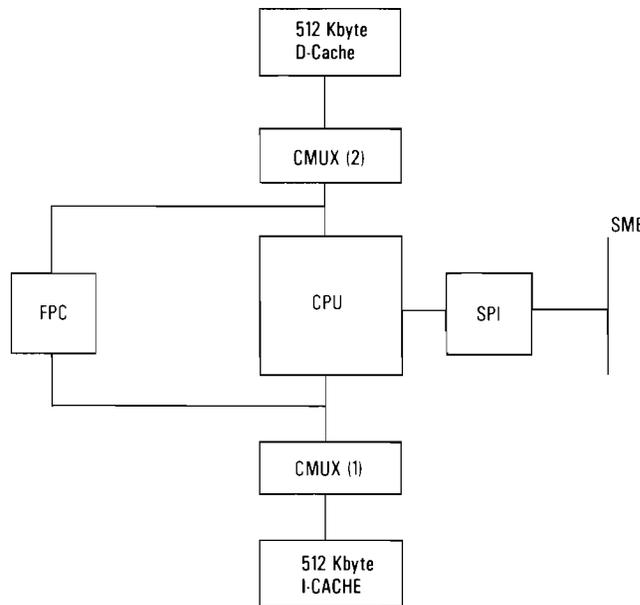


### Cache
The use of high-speed CPU caches significantly increases system performance by minimizing accesses to main memory. Cache access can be up to an order of magnitude faster than accesses to main memory.

The system automatically moves into cache from main memory the code and data that are most likely to be required based upon a "locality" algorithm. As a result, the required code and data are found in cache almost all the time. An access to main memory needs to be made only in the event of a cache miss. Since the CPU usually finds the required code or data in the cache, relatively slow accesses to main memory are minimized.

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.

There are some differences between the high-end members of the HP 3000 family in the organization and size of CPU cache. The S950 uses a 128-Kbyte combined cache for instructions and data. The cache on the S955 is divided into two separate caches for instructions and data, each 128 Kbytes in size. The S960 and S980 also have separate caches for instructions and data, each 512 Kbytes in size. The two caches on the S955, S960, and S980 operate in parallel, which further enhances processing efficiency. For example, data can be loaded from the Data Cache while the next instruction is fetched from the Instruction Cache.

| System | Total Cache Size | Instruction Cache | Data Cache |
| --- | --- | --- | --- |
| S950 | 128 Kbyte | — | — |
| S955 | 256 Kbytes | 128 Kbytes | 128 Kbytes |
| S960 | 1.0 Mbyte | 512 Kbytes | 512 Kbytes |
| S980 | 1.0 Mbyte | 512 Kbytes | 512 Kbytes |

**Pipelining**
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 S950 employs a three-stage instruction pipeline. While one instruction is being executed, others are being fetched, and the results of still others are being stored. The S955, S960, and S980 use a five-stage instruction pipeline. During the first stage, the instruction is fetched from cache. The specified 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 (which occur infrequently), one instruction completes (exits the pipeline) every CPU cycle.

**Figure 5-24. Instruction pipelining**
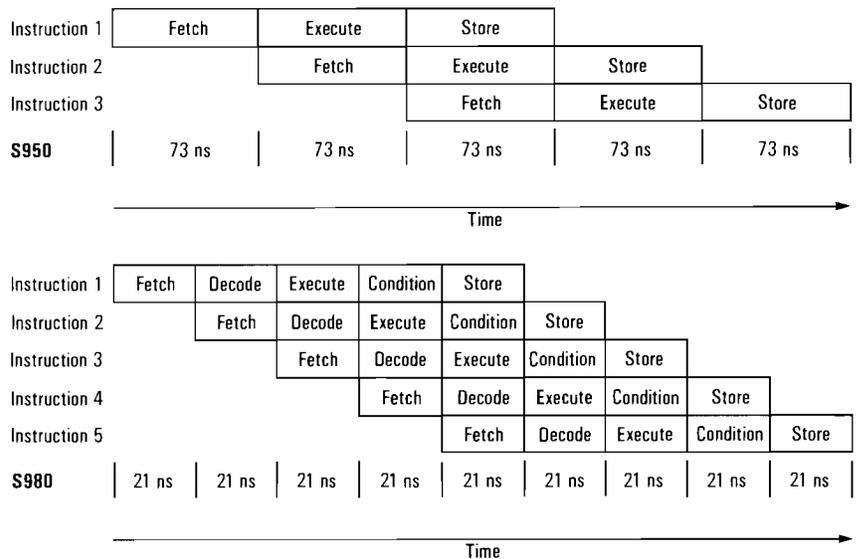
| Instruction 1 | Fetch | Execute | Store | | |
| Instruction 2 | | Fetch | Execute | Store | |
| Instruction 3 | | | Fetch | Execute | Store |

| **S950** | 73 ns | 73 ns | 73 ns | 73 ns | 73 ns |

Time →

| 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 |

| **S980** | 21 ns | 21 ns | 21 ns | 21 ns | 21 ns | 21 ns | 21 ns | 21 ns | 21 ns |

Time →

## Floating-Point Coprocessor

For scientific, engineering, and statistical applications that require
high performance in floating-point calculations, HP offers a coproces-
sor that significantly accelerates floating-point calculations.

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 par-
allel, with the CPU performing integer calculations and other func-
tions while the coprocessor performs floating-point calculations. This
parallel operation helps provide a high level of performance for appli-
cations that use floating-point calculations.

A Floating-Point Coprocessor is standard on the S950, S955, S960, and
S980. It consists of twelve 64-bit-wide registers for operands and is
implemented on three NMOS VLSI chips on the S950, two high-speed
ECL chips on the S955 and S960, and two very high-speed ECL chips
on the S980. The S955 and S960 provide higher floating-point perfor-
mance than the S950, and the S980 provides higher floating-point per-
formance than the S955 and S960. In all cases, the Floating-Point
Coprocessor is attached to the CPU's cache bus.

## Virtual memory management

Virtual addresses on the HP 3000 S950, S955, and S960 are 48 bits long, and virtual addresses on the S980 are 64 bits in length. This greatly extended address space provides tremendous expandability for large applications. The virtual memory on the S950, S955, and S960 is divided into a set of 65,536 spaces, with each space 4 Gbytes in length. S980 virtual memory is divided into a set of 4 Billion spaces, with each 4 Gbytes is length. Spaces are further divided into fixed-length, 2-Kbyte pages, which hold data, code, or both. A single data structure can be up to 1 Gbyte or 4 Gbytes in length (compiler-dependent), and code can span multiple spaces.

**Figure 5-25. Virtual memory organization**
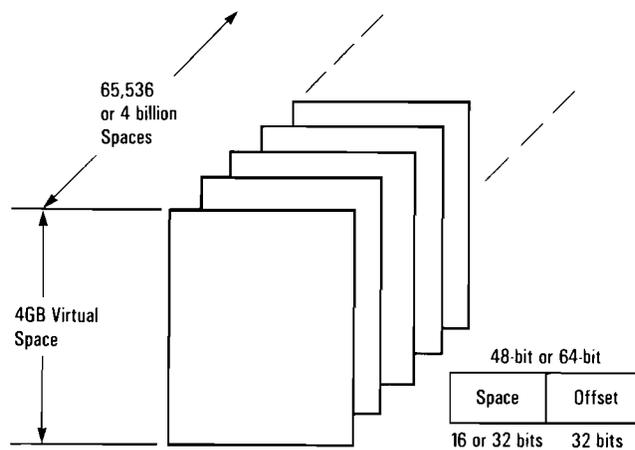


## Virtual Address Translation

Since the processor generates 48-bit (S950, S955, and S960) and 64-bit (S980) virtual addresses, and memory access is via 32-bit physical (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.

Memory is divided into 2-Kbyte pages, with access protection provided at the page level for all code, data, and I/O access. When a virtual-to-physical address translation occurs, the TLB checks whether the executing process can access the page and, if so, what type of access is allowed (read, write, execute, and so forth).

The needed address is found in the TLB more than 99 percent of the time. If the address is not in the TLB, a software scheme that involves hashing 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, then 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 S950, S960 and S980 systems are listed in the table below. The memory subsystem uses 1-Mbit, nibble-mode dynamic RAMs for the 16-Mbyte array and 4-Mbit, nibble-mode dynamic RAMs for the 64-Mbyte array.

| System | Standard Memory | Maximum Memory | Expansion Increments |
|--------|-----------------|----------------|----------------------|
| S950 | 64 Mbytes | 192 Mbytes | 16 Mbytes |
| S955 | 96 Mbytes | 256 Mbytes | 16 Mbytes |
| S960 | 128 Mbytes | 256 Mbytes | 16 Mbytes |
| S980/100 | 128 Mbytes | 512 Mbytes | 16 or 64 Mbytes |
| S980/200 | 192 Mbytes | 1024 Mbytes | 16 or 64 Mbytes |

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. This 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 these high-end 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 S980/200 uses the memory subsystem to implement cache-line interleaving. This improves performance by increasing aggregate bandwidth for usable memory. 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 5-26. HP 3000 Series 980 System structure**

```
┌ ─ ─ ─ ─ ─ ┐     ┌───────────┐        ┌──────────┐   ┌──────────┐
│ Processor │     │ Processor │        │  Memory  │   │  Memory  │
└ ─ ┬ ─ ─ ─ ┘     └─────┬─────┘        └────┬─────┘   └────┬─────┘
    │   1 or 2 CPUs
─────────────────────────────System Memory Bus─────────────────────
              ┌──────┴──────┐                    ┌──────┴──────┐
              │    CTB      │                    │    CTB      │
              │   Adapter   │                    │   Adapter   │
              └──────┬──────┘                    └──────┬──────┘
─────── Central Bus 0 ────────         ─────── Central Bus 1 ───────
   ┌─────┬────────┬──────┐                 ┌─────┬────────┬──────┐
┌──┴──┐ ┌──┴──┐ ┌──┴──┐             ┌──┴──┐ ┌──┴──┐ ┌──┴──┐
│ CIB │ │ PSI │ │ CIB │             │ CIB │ │ PSI │ │ CIB │
│Adapter││Card │ │Adapter│           │Adapter││Card │ │Adapter│
└──┬──┘ └─────┘ └──┬──┘             └──┬──┘ └─────┘ └──┬──┘
   CIB 0  ─ ─ ─   CIB 1               CIB 0  ─ ─ ─   CIB 1
```

| HP-FL or HP-IB Channel | LAN Link | Maximum 5 Channels Per CIB | HP-FL or HP-IB Channel | HP-FL or HP-IB Channel | HP-FL or HP-IB Channel | Maximum 5 Channels Per CIB | HP-FL or HP-IB Channel |
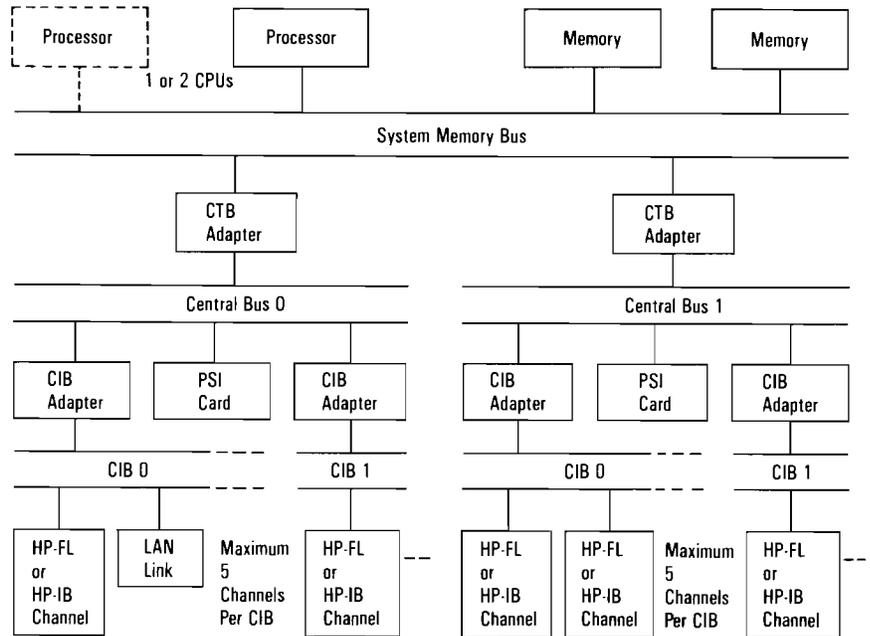
## System Memory Bus

The System Memory Bus (SMB) is the communication path between the CPU, 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 CTBs. 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, system-to-system communication between HP 3000 computers and communication to IBM systems via 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 standard; a third and fourth may optionally be added.

## 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 and has a data transfer rate of up to 5 Mbytes per second.

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

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 are connected via 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/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 via 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 redundant disk capability available with MPE/XL.

**Figure 5-27. HP 3000 S95X, S960, and S980 I/O attachments**
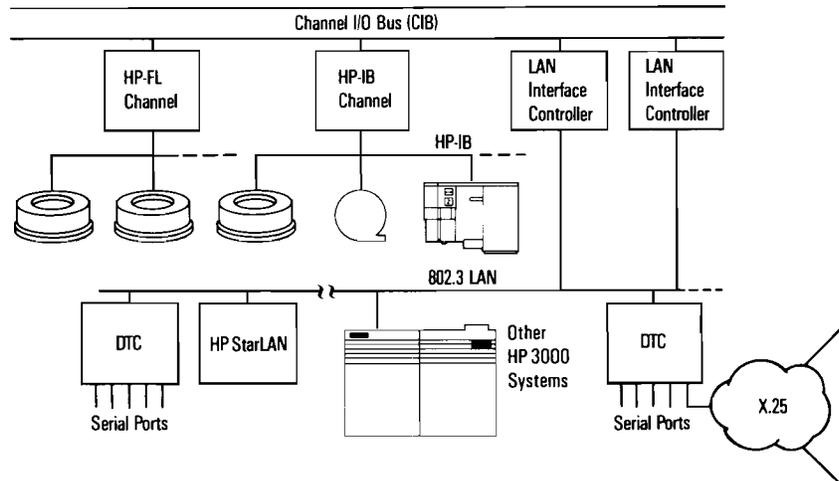


## Workstation and serial connections

Connections for workstations, serial printers, and other serial devices are provided via 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. Each DTC can support up to 48 direct-connect ports or 36 modem ports or a combination of the two. Both RS-232 and RS-422 interfaces are supported. In addition, PCs can be connected to a LAN or HP StarLAN.

## System-to-system data communication

HP 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 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.

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

**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 lbs) |
| **Operating temperature, system** | 20–25.5°C (68–78°F) |
| **Relative humidity, system (operating)** | 40–60% (non-condensing) |
| **Altitude (operating)** | Up to 4572 m (15,000 ft) |
| **Battery backup time, minimum** | 15 minutes |
| **Acoustics** | 7.3 Bels sound power (A) |

# Chapter 6    **Networks**

**Overview**

**HP AdvanceNet strategy**

The data communication capabilities of the HP 3000 systems fit under the umbrella of HP AdvanceNet. HP AdvanceNet is a family of hardware and software communication products that enable HP systems to communicate with each other and with equipment made by other vendors. HP AdvanceNet 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 AdvanceNet product design. HP also offers products for batch and interactive communication to IBM mainframes in SNA and bisynchronous environments.

**Figure 6-1. HP AdvanceNet strategy**
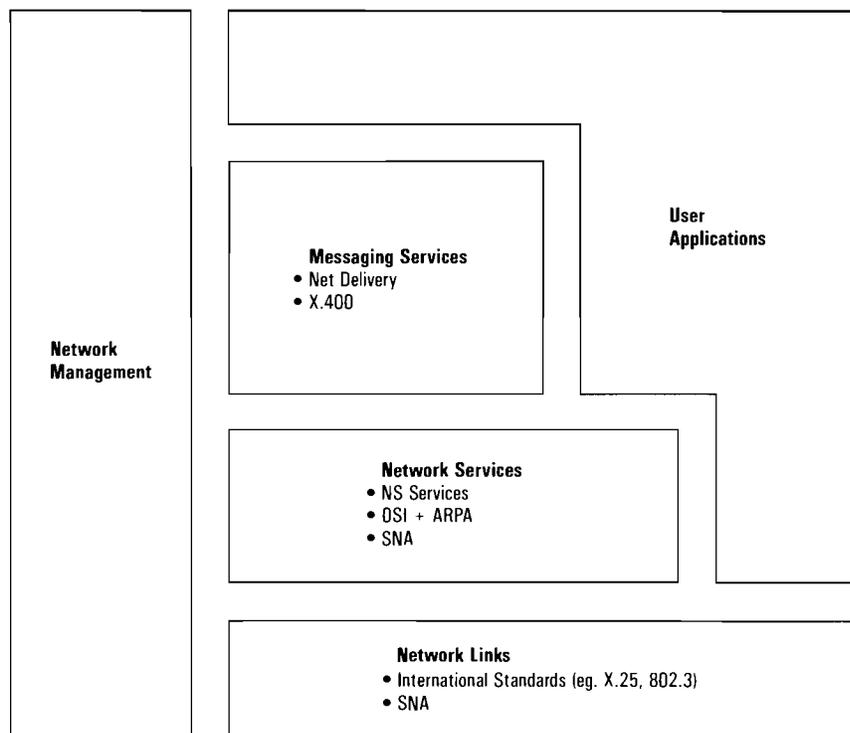


Because HP AdvanceNet products are based on industry standards, they provide a foundation for the development of applications that span multiple vendors' equipment.

This chapter summarizes the HP AdvanceNet products that provide the communication capabilities of the HP 3000 systems. These products provide solutions for the primary business areas of service and manufacturing companies, covering both internal automation environments (LAN) and external site communication needs (WAN). These products are grouped in five broad categories:

* workstation-to-system
* system-to-system
* HP-to-IBM systems
* HP Network Management
* messaging services

## Workstation-to-system communication

By workstations, we refer to the terminals, personal computers, and serial printers that are connected to an HP 3000 system. On 900 Series systems, terminal-to-system communication is provided by the *Datacommunications and Terminal Controller (DTC)*. MPE/V workstation-to-system communication is handled by the Advanced Terminal Processor (ATP).

Personal computers can also be connected to HP 3000 systems directly through the LAN or through a DTC via terminal emulation.

### Terminal Access

HP 2345A Datacommunications and Terminal Controller (DTC) / Terminal Access is a modular and flexible LAN-based controller which provides asynchronous connections for terminals, PCs in terminal emulation mode, and serial printers to 900 Series HP 3000 systems.

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

As connectivity needs grow, the DTC can evolve into a powerful Datacommunications and Terminal Controller, providing an integrated communications server for both multiple system terminal access (terminal switching) and X.25 communications. Through the use of a PC-based OpenView Windows Workstation, asynchronous and X.25 connections can be managed by a single operator. OpenView Windows provides an easy-to-use advanced graphical user interface which simplifies the management of multiple DTCs. For more details on X.25 communications on the DTC, please refer to the "Remote Communication" section.

DTCs are typically placed in an EDP room, or they can be located throughout a building on the LAN cable. Using HP 92223A Repeater Kits and HP ThickLAN cable, an HP 2345A controller can be up to 1500m (5000ft) from the system that controls it.

**Figure 6-2. DTC/Terminal access**
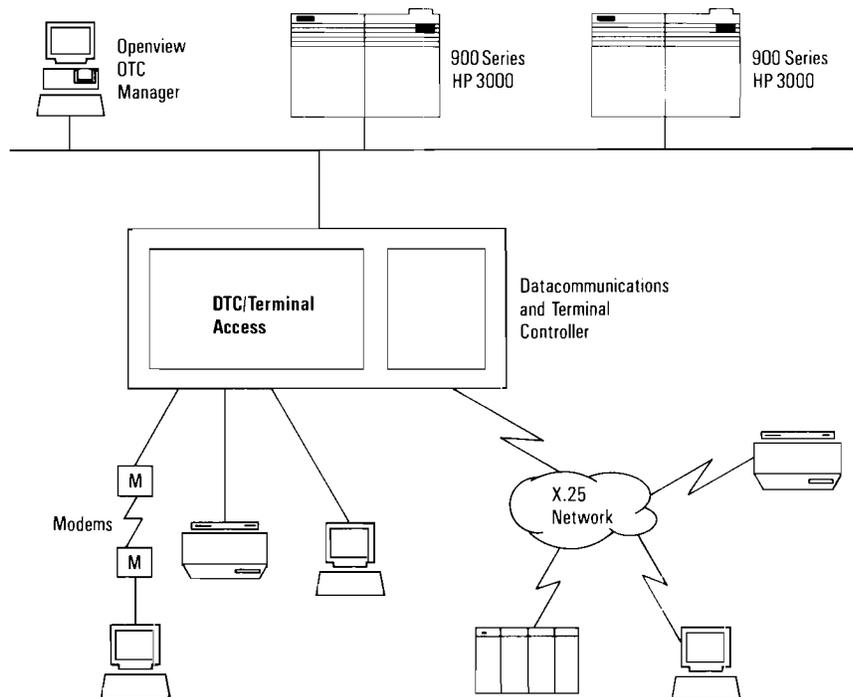


The HP 2345A DTC provides

- either single or multiple system access depending on the network management option chosen
- six slots, each offering a choice of
  - eight local connections at up to 15m (50ft) with the HP Type 232 option, or to 1220m (4000 ft) with the HP Type 422 option
  - six remote connections, with the RS-232-C option, for devices connected over full-duplex modems
- connection to the 900 Series system over either HP ThinLAN (Type 10Base2) cable or HP ThickLAN (Type 10Base5) cable
- transfer of data at rates of 300, 1200, 2400, 4800, 9600, and 19200 bps
- speed and parity sensing
- support of full-duplex modems and spooled serial printers
- powerfail session recovery
- type ahead utility

## Non MPE/XL access

DTC back-to-back support will allow users connected to a DTC to access a non-MPE/XL system. The non-MPE/XL system must be connected via RS-232 connections to a second DTC on the same LAN (see diagram). Back-to-back configurations for MPE/V systems will be supported first, followed by back-to-back support for HP 9000 Series 800 systems.

**Figure 6-3. DTC Back-to-back configurations**



DTC Back-to-Back Configurations
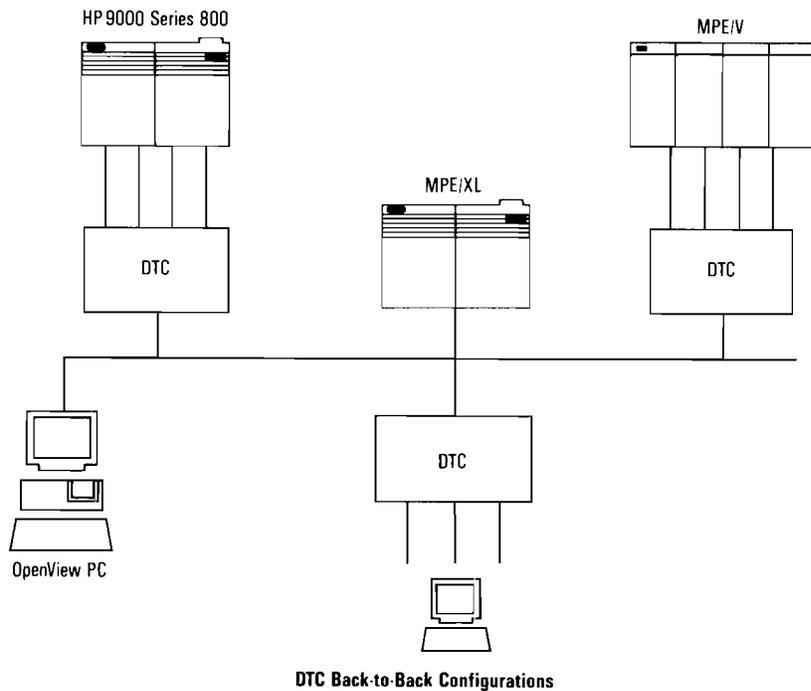
## Advanced Terminal Processor

The Advanced Terminal Processor (ATP) is designed to interface asynchronous workstations to the MPE/V-based HP 3000 systems in a point-to-point configuration. Interfaces are available to allow workstations to be connected either directly (for local communication) or through full-duplex modems (for remote communication).

The Advanced Terminal Processor Model M (ATP/M) is a communication interface designed for the MICRO 3000 systems. It provides connections for up to eight asynchronous workstations (personal computers, terminals, and printers with a serial interface) in a point-to-point configuration. Workstation ports come integrated with the MICRO 3000LX and RX but are based on the same ATP/M hardware.

Both the ATP and ATP/M allow workstations to transmit and receive in either character or block mode at speeds up to 19.2 Kbps.

Local workstations can be connected to the system via RS-232C direct-connect ports, modem ports, or RS-422 direct-connect ports. Remote workstations can be connected via RS-232C modem ports with full-duplex asynchronous modems or with HP 2334A statistical multiplexers and full-duplex synchronous modems. (Note: The MICRO 3000LX and RX do not support RS-422.)

### PC integration

For connecting PCs, 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 multitasking, background file transfer, and cut and paste.

HP AdvanceNet offers a full, standards-based family of networking products and a range of computing software for cooperative computing. HP NewWave Office on the HP 3000 provides full application and data access as well as resource sharing and program-to-program communication to PC users. In addition, HP will be adding the emerging LAN Manager standard to the HP 3000.

Novell is recognized as a de facto standard for PC networks, and to meet the needs of Novell customers, HP provides the NS LAN Gateway. The Gateway provides Novell/HP 3000 integration through LAN-to-LAN connectivity between their Novell networks and the HP 3000. Apple PC to HP 3000 connectivity is provided by the HP AdvanceLink product.

## System-to-system communication

For system-to-system networking within the HP family of computers, the HP 3000 provides the following HP AdvanceNet products: HP Network Services, HP NS LAN Link, HP NS Point-to-Point Link, and HP NS X.25 Link.

### Network Services

NS, which corresponds to OSI layers 5 through 7, provides powerful networking services. It is used in conjunction with the NS LAN Link, NS Point-to-Point Link, and NS X.25 Link to provide Virtual Terminal, Network File Transfer, Remote File Access, Remote Database Access, Network InterProcess Communication, and Remote Process Management.

The HP Networks Services are used for system-to-system communication between HP 3000 computers and between the HP 3000 and other HP computers (HP 9000 and HP 1000).

The network services include:

### 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 you to log onto any system on the network as easily as logging onto your "home" system.

### Network File Transfer

Network File Transfer is a file copy utility that lets you easily copy files from one HP system to another. The transfer can be done interactively or programmatically.

**Figure 6-4.  NS functionality**

• Virtual terminal

• Network file transfer

• Remote file access
• Remote data base access

• Remote peripheral access

• Network interprocess communications
• Remote process management
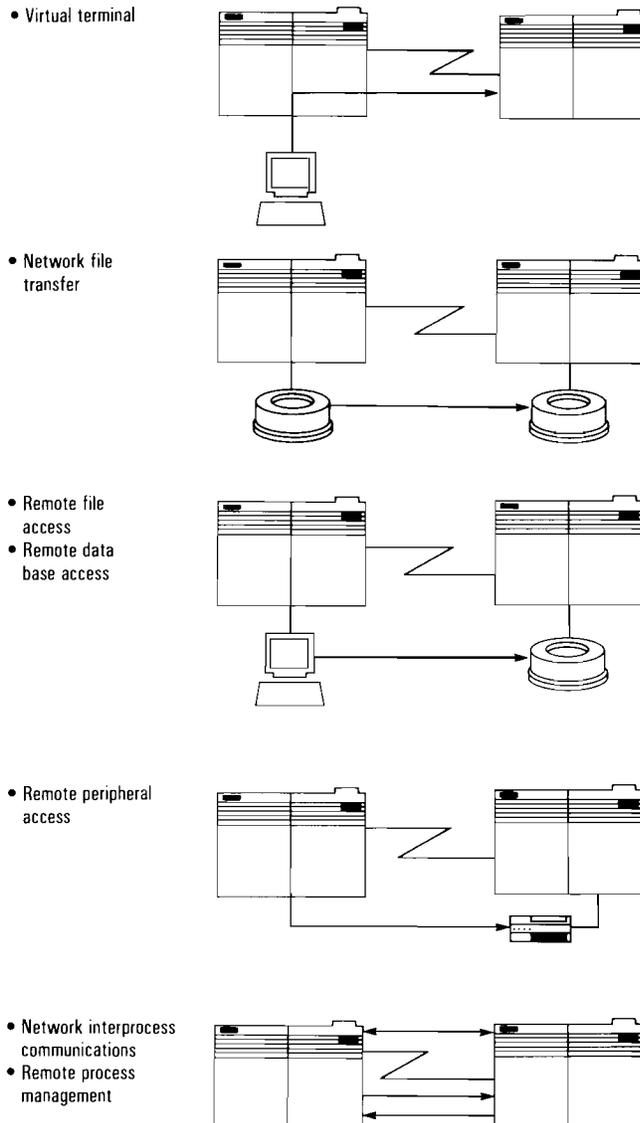
**Remote file and peripheral access**

This service gives you access to the files and peripherals of other HP 3000 systems in the network. Access can be interactive or programmatic. The MPE operating system contains intrinsics for file manipulation. Since MPE treats peripherals similarly to files, the same intrinsics can be used for peripheral operations. NS3000 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. It provides powerful access either interactively or through application programs. This is the first step in HP's strategy to provide distributed databases.

Through Remote Database Access, HP TurboIMAGE databases can be accessed on different HP 3000 systems in the network. Access can be interactive (through Query/3000) or through application programs.

Remote Database Access 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 Network IPC calls, allowing an entire distributed application to be controlled from a single system.

**Security**

NS honors the security provisions of the MPE operating system and the database management systems. Beyond this, NS 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.

## Multivendor networking

In addition to networking capabilities within the HP family of computers, HP 3000s support a variety of networking capabilities to allow them to interoperate with other vendors' computers. HP 3000 systems support industry and de facto standards like TCP/IP, Open Systems Interconnect (OSI), and IBM's SNA. The HP 3000's SNA networking capabilities are covered in the "HP 3000-to-IBM Communication" section.

All of the HP 3000 Link products implement industry-standard protocols. For instance, the NS LAN Link supports IEEE 802.3 as well as Ethernet, and NS X.25 Link is based on industry-standard X.25. In addition, all of the HP 3000 Link products use an industry-standard TCP/IP transport and as a result, are able to interoperate with other vendors' systems.

ARPA Services are provided for HP 3000 MPE/V systems from an independent software vendor and are under development within HP for the 900 Series. The ARPA Services include Telnet (Virtual Terminal), File Transfer Protocol (FTP), and Simple Mail Transfer Protocol (SMTP).

Probably the most widely implemented OSI networking capability is 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 which is described in more detail in the "Messaging Services" section. HP will also be providing the OSI File Transfer, Access and Management (FTAM) capability on the HP 3000.

If your HP 3000 networking needs include the ability to communicate with another vendor's system, HP will have a solution to meet that need.

## Local area networking

### NS LAN Link

NS LAN Link provides the hardware and communication software needed to connect HP 3000 systems to a network for system-to-system communication. It includes a Local Area Network Interface Controller (LANIC) and transport software that perform the functions specified in layers one to four of the OSI reference model. The NS LAN Link is used in conjunction with NS or with ARPA Services.

The same LAN cable used for workstation communication can be used for system-to-system networking.

Features of HP's NS LAN Link

- integrated node management software is provided for on-line configuration, diagnostics and logging
- any node may be attached or removed while the network is still active
- carrier-Sense Multiple Access with Collision Detection (CSMA/CD) protocol controls network access. There is no centralized control; all nodes have equal access
- the data transfer rate is up to 10 Mbits per second, depending on the application
- transport-level protocols are based on the Defense Advanced Research Project Agency and Transmission Control Protocol/Internet Protocol (DARPS TCP/IP)
- support of IEEE 802.3

Figure 6-5. NS3000 over a LAN
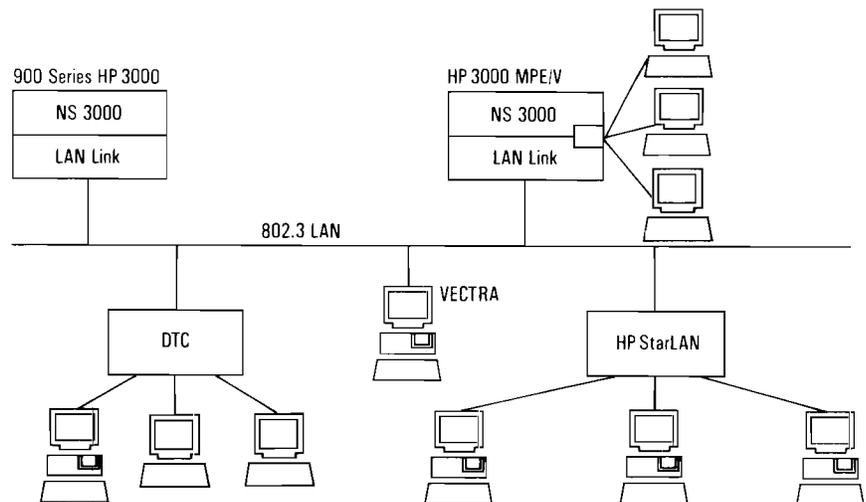


## Remote communication

### NS Point-to-Point Link

The NS Point-to-Point Link provides the network connection to allow an HP3000 system to communicate with another remote HP3000. It includes an Intelligent Network Processor (INP) for MPE/V systems or a Programmable Serial Interface (PSI) for MPE/XL systems as well as transport software that perform the functions specified in layers one to four of the OSI reference model.

NS Point-to-Point Link, in conjunction with NS Services, allows systems to communicate over wide areas via modem connections.

Features of HP's NS Point-to-Point Link include

- support of dial, leased line, X.21, and digital phone network modems
- a programmable microprocessor-driven line controller that reduces the HP 3000 overhead associated with communication-link handling
- support of RS-232C up to a line speed of 19.2 Kbps and CCITT V.35 up to a line speed of 64 Kbps

**Figure 6-6. NS over a wide area network**
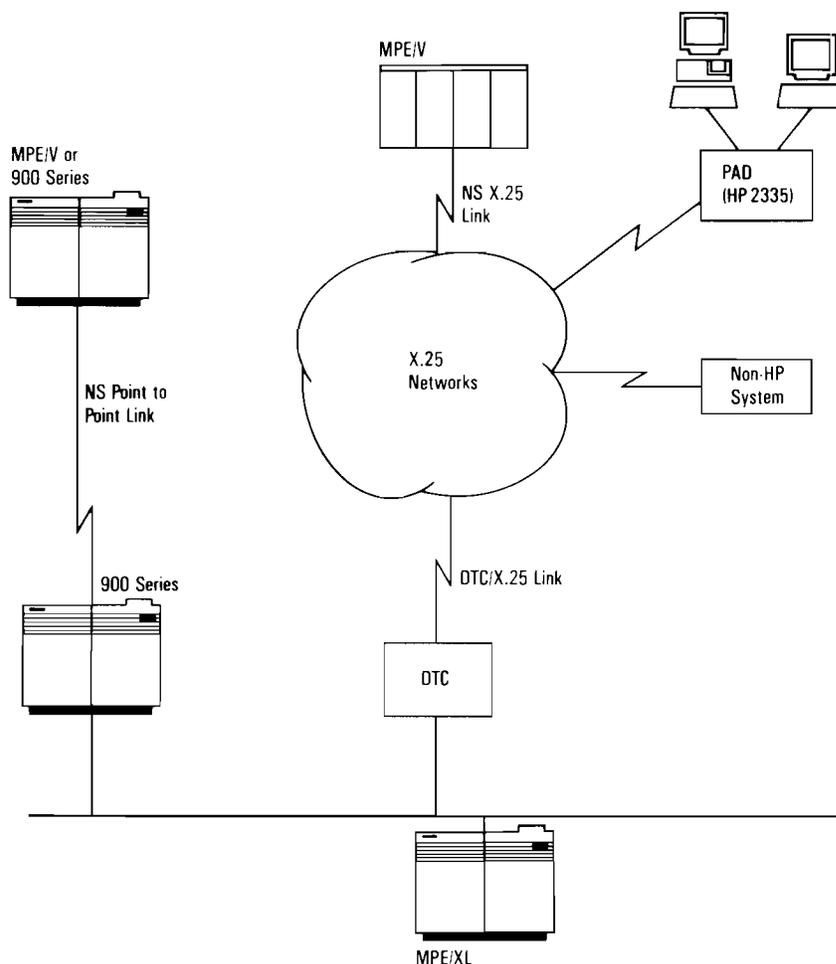


### NS X.25 3000/V Link

The NS X.25 Network Link for MPE/V-based systems provides the network connection on HP 3000 systems to private and public X.25 Packet Switched Networks (PSN). The NS X.25 3000/V Link can be used in conjunction with NS3000/V (or ARPA Services) for higher-level user services such as network file transfer, virtual terminal, and remote database access. In addition, NS X.25 3000/V Link provides programmatic access to protocol at level 3 or level 4. This allows you to develop your own protocol and services for communication with remote HP or non-HP systems over an X.25 network.

The features provided by HP NS X.25 3000/V Link include

- industry-standard DARPA TCP/IP protocols
- full support of NS3000/V Network Services
- remote terminal connections over X.25 networks, using the HP 2335A X.25 multiplexer at the remote locations
- programmatic access to X.25 and transport layers for the development of multivendor or customized applications
- packet routing and gateway capability for transparent access over multiple nodes and between networks
- extensive X.25 user facilities
- integrated node management software for on-line configuration and logging

## DTC/X.25 XL Network Link

**Figure 6-7. DTC/X.25 XL Network Link product components**



DTC/X.25 XL Network Link
Product Components
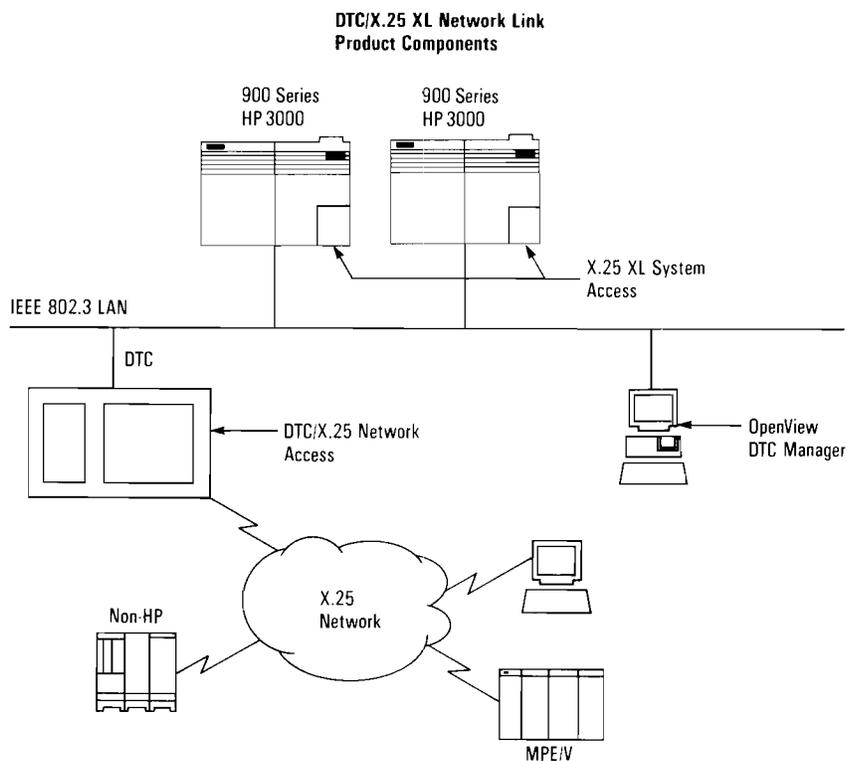
The DTC/X.25 XL Network Link for 900 Series HP 3000 computers is a high performance networking solution which provides Hewlett-Packard customers with access to public and private X.25 packet-switching networks. It features extensive communications capabilities with remote HP 3000 hosts and asynchronous PAD (Packet-Assembler/Disassembler) devices. For communication with non-MPE processors, the link provides programmatic access to protocol at level 3 or level 4.

The DTC/X.25 XL Link is a modular and flexible solution. The link works in conjunction with the Datacommunications and Terminal Controller (DTC), providing access to remote devices. The same DTC being used for PAD and system-to-system communication may be used for terminal server connectivity, providing customers with an integrated communications solution.

The DTC/X.25 XL Network Link is comprised of the following components:

- DTC/X.25 Network Access—A dedicated VLSI processor card for X.25 data communications, which resides in the DTC
- X.25 XL System Access—900 Series host software, providing an application interface across the LAN to the DTC/X.25 Network Access card and LAN/WAN routing via TCP/IP
- OpenView DTC Manager—PC-based software, running under Open-View Windows, used to configure and manage one or more DTCs

The features provided by the DTC/X.25 XL Network Link include

- full support of NS Services for communications to remote HP 3000 computers across public and private X.25 networks
- remote terminal connections over X.25 networks, using the HP 2335A X.25 multiplexer at the remote locations
- programmatic access to X.25 level 3 and TCP level 4 for program development of special applications such as HP to non-HP communications
- Open Systems Interconnect (OSI) layered architecture
- standard CCITT 1984 version of X.25, and 1980 versions of X.3/X.28/X.29, and Defense Advanced Research Projects Agency (DARPA) TCP/IP protocols
- high system connectivity with up to 11 X.25 Network Interfaces (NI) and 1024 virtual circuits per 900 Series HP 3000 host
- line speeds up to 64 kbps
- reduced CPU overhead due to X.25 and PAD protocol processing on the DTC

**HP 3000-to-IBM mainframe communication**

An HP 3000 or a subnet of HP 3000s can communicate in batch, interactive, or programmatic mode with an IBM mainframe. In addition, the HP 3000 can communicate to the IBM host in either an SNA or Bisync (BSC) environment, and can send and receive electronic mail to PROFS and/or DISOSS residing on the IBM mainframe.

**SNA communication**

For SNA communication, there are gateway or stand-alone solutions available. The SNA stand-alone products (that is non-gateway products) are HP SNA Interactive Mainframe Facility (IMF) for interactive communication, HP SNA Network Remote Job Entry (NRJE) for batch communication, HP SNA Distributed Command Facility (DHCF), and HP LU6.2 Application Programming Interface (API) for program-to-program communication. SNA IMF, SNA NRJE, and SNA LU6.2 API are available for both MPE/V and MPE/XL. SNA DHCF is available for MPE/XL only. These products 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 support all SNA services.

SNA IMF allows access to 3270 applications on the IBM mainframe such as TSO, CICS, and IMS via programmatic or PassThru mode. In programmatic mode, application programs on the HP 3000 emulate IBM 3270 terminals and printers, exchanging data with the host via 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 devices.

SNA NRJE allows HP 3000 users to submit large batch jobs and transfer files between the IBM mainframe and the HP 3000 system. In addition, 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, disks, and printers. Similarly, jobs can be input through any standard input device such as terminals, card readers, or disk. Reverse NRJE allows a user connected to an IBM mainframe to start a job on the HP 3000. SNA NRJE emulates an IBM 8100 DPPX/RJE workstation.

LU6.2 API will allow third parties and end users to develop HP 3000 applications that use the LU6.2 protocol to communicate program-to-program with LU6.2 applications running on IBM systems elsewhere in the SNA network.

SNA DHCF/XL allows users with IBM 3270 terminals to interactively access many applications on an HP 3000 Series 900 system through their SNA network. SNA DHCF/XL is supported with both TTY-line-mode and HP VPLUS block-mode applications. SNA DHCF/XL can support up to 120 concurrent sessions.

**Figure 6-8. SNA communication**
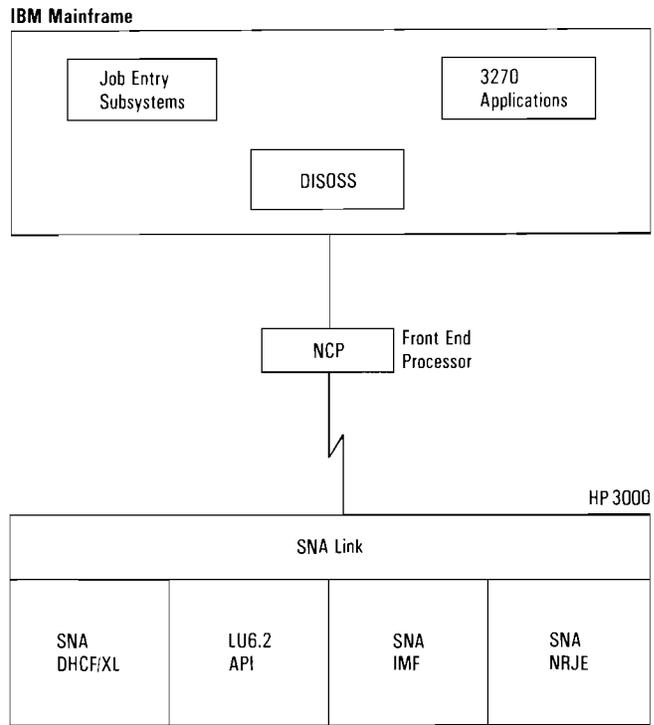


## E-Mail office communication

HP Office Connect to DISOSS and HP Office Connect to PROFS allow
multiple HP DeskManager users on different HP 3000s in an HP Desk-
Manager network to exchange, file, and convert electronic mail
between their HP 3000 system and an IBM mainframe running
DISOSS and PROFS, respectively.

HP OC DISOSS and HP OC PROFS are available for MPE/V only. An
MPE/V system with HP OC DISOSS or HP OC PROFS can serve as an
electronic mail gateway for an HP DeskManager network.

In the future MPE/XL systems will support SNA Distributed Services
(SNADS) connection to an IBM mainframe running DISOSS and other
future IBM office products.

## BSC communication

HP also provides a batch product for IBM bisynchronous connections. Remote Job Entry (RJE) permits single-user remote job entry using 2780/3780 BSC protocol. BSC RJE is available for both MPE/XL and MPE/V systems.

**Figure 6-9.  BSC communication**

**IBM Mainframe**
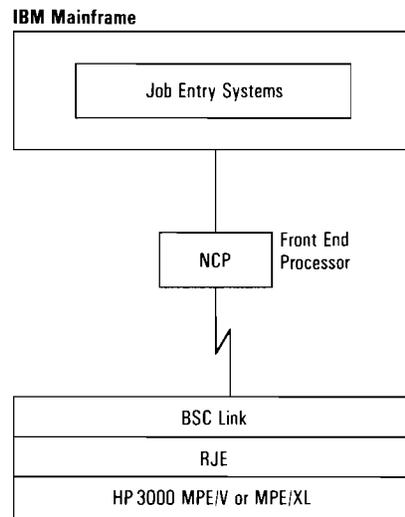


## Future directions

Hewlett-Packard currently has an entire research and development facility working on the development of new products that will enable you to communicate within IBM environments. Committed future directions include:

- the ability to utilize an SNA backbone network for HP 3000 to HP 3000 communication via HP Network Services (NS)
- support for IBM's PU2.1 protocol
- support for IBM's SNA Distribution Services (SNADS)
- support for management of the HP-IBM Links and Services from IBM's Netview product
- SNA-to-X.25 conversion software allowing SNA communication between the 900 Series system and the IBM mainframe over an X.25 network

**HP OpenView network management**

The cornerstone of HP's network management is a family of applications, tools, and services called HP OpenView. It can cut your costs and improve network uptime by providing integrated, centralized management of multivendor networks and networked HP 3000 systems.

HP 3000, 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 which Hewlett-Packard is helping develop as a co-founder of the OSI/Network Management Forum and participation 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 our experience with customers.

HP's full line of network management support services completes the HP OpenView offering, assisting your organization at all stages of the network life cycle: planning, implementation, operation, and maintenance. Support services can be tailored to your requirements, helping you manage your network-related operating costs.

**Networked system management**

**OpenView DTC Manager**

The OpenView DTC Manager software provides centralized and integrated network management for both local terminal connectivity and X.25 network. The OpenView DTC Manager downloads software to, configures, monitors, diagnoses, and controls DTCs. From a single PC running OpenView Windows, an operator using OpenView DTC Manager can centrally manage local and remote terminal connections and remote system-to-system communications across multiple DTCs on the LAN.

**INCS/3000**

An HP special product, Integrated Network Console Support (INCS/3000), provides the capability for centralized management of networked HP 3000 computers. INCS can be used in a local, remote, or mixed network environment. In a local environment, such as a data center, INCS eliminates the need for multiple system consoles. In a distributed network environment, the central management node controls and monitors all remote HP 3000 systems, eliminating the need for operators at remote sites.

An HP OpenView product based on enhanced INCS functionality is currently under development for future release.

## 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 allows you to reduce troubleshooting time and effort of networked HP 3000s, and reduces the need for remote operators.

### Performance management

HP LaserRX/MPE and HP GLANCE provide detailed information about network node activity—the system and application processes that generate load on the network. These tools provide important insights for network performance management and are described in detail on pages 44–45 in chapter 2.

### Security Monitor/V

HP Security Monitor/V can be ordered as a separate product when greater security is needed. It is a fully integrated system security program that protects both system resources and sensitive data from unauthorized access. Building on the strong security of the HP 3000 systems, it allows improved password protection, stricter audit trails, and tighter terminal security. Some of its key features are:

- password encryption and aging
- terminal passwords
- terminate idle sessions
- log selected commands, file opens and closes
- disable selected commands

HP Security Monitor/V is available now for MPE/V-based systems, and will be available in the future for MPE/XL-based systems.

### Network configuration management

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 data communication products on the network to determine their operating characteristics.

## Local area network management

### LanProbe

The LanProbe distributed analysis system tackles three major concerns of network managers—the maintenance, management, and planning of LANs. It enables the monitoring of all critical aspects of both remote and local LANs, including problems related to the cable, communications software, traffic load, equipment malfunction, and user error. The LanProbe system's centralized, graphical user interface displays the network map, segment maps, and statistical charts of real time and accumulated traffic patterns.

### HP OpenView BridgeManager

The HP OpenView BridgeManager provides central monitoring and control of the HP StarLAN-to-10Mbit/s Bridge and the HP 10 Mbit/s-to-10 Mbit/s LAN Bridge. Capabilities include configuration, collection, and logging 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. As the network grows in complexity and importance, up-to-date information on the status of the network is needed to effectively manage the network resources and detect problems. Bridges are in an excellent position to provide information about the network and its operation.

### Network Diagnostics

The LAN Node Diagnostic (LANDIAG) is an on-line diagnostic tool that verifies the LANIC components by running the LANIC self-test as well as a series of diagnoses as far into the LAN as possible, dependent upon the equipment connected to the LANIC. LANDIAG testing includes a Remote Node Test which sends and receives test frames between nodes.

## Wide area network management

### HP OpenView Data Line Monitor

HP OpenView Data Line Monitor automatically monitors leased point-to-point analog lines while they continue to work normally and detects lines that are performing outside preset alarm limits. The HP OpenView network map changes color when an alarm is detected. The Data Line Monitor improves network availability by enabling performance and fault monitoring, and speeding up repair of faulty lines. It is easy to learn and use and works on multivendor networks.

**HP OpenView Developers Kit**

HP OpenView Developers Kit provides a complete solution for building an integrated, end-to-end network management system. This developer's environment offers a choice of protocols (SNMP/CMOT, TCP/IP, and OSI) and operating systems (DOS and HPUX). It provides a toolkit for quick and cost-effective development of an integrated network management system for multivendor network devices and equipment based on the HP OpenView platform.

**Messaging services**

**NetDelivery**

NetDelivery utilizes NS Services and any NS Link and provides a reliable, asynchronous application messaging service. This allows transparent background delivery of messages and files within a network. NetDelivery can send data between two nodes which are not directly connected and without requiring a synchronous connection between the two nodes.

NetDelivery can be used to send large amounts of data from one location to another. For example, sales information from regional offices can be consolidated and sent to the corporate headquarters of a company. NetDelivery can also be used to distribute applications throughout a network.

NetDelivery will save messages on disk for the remote node in the event that the node is unavailable or the link between the nodes is down. It will try to deliver the data again when the node or link becomes available.

NetDelivery utilizes static, incremental routing. You can specify when message transfer will take place between nodes. Because NetDelivery is an asynchronous or background service, it allows an application to continue without waiting for the data transfer to finish.

With NetDelivery, the sender only needs to know the recipient's destination name and not the node name on which the recipient resides. This provides the ability to reconfigure the network or move applications without requiring any application changes.

NetDelivery has two components—a programmatic interface and an interactive interface. The programmatic interface is provided through the NetDelivery Intrinsics. You can write applications that call these intrinsics. The NetDelivery Utility is an interactive program that operators and system administrators run to control, configure, maintain, and diagnose NetDelivery.

## HP X.400

HP X.400 for the HP 3000 offers standards-based multivendor connectivity for MPE/V and MPE/XL computers. With HP X.400, users of HP DeskManager can exchange electronic mail messages throughout their multivendor environments or with public messaging services.

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 both MPE/XL and MPE/V 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.

# Chapter 7        **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.

HP 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 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.

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 storage, and industry-leading reliability. High-density data storage and compact size provide the ideal storage systems for a wide range of multi-user computer systems.

HP's open-reel and cartridge tape drives are technological leaders offering ideal backup solutions for systems of all sizes. In addition to providing secure data storage, they save valuable floor space and improve operator efficiency.

Figure 7-1 is a guide to the suggested use of peripherals for each HP 3000 system.

**Figure 7-1. HP's Peripheral family**
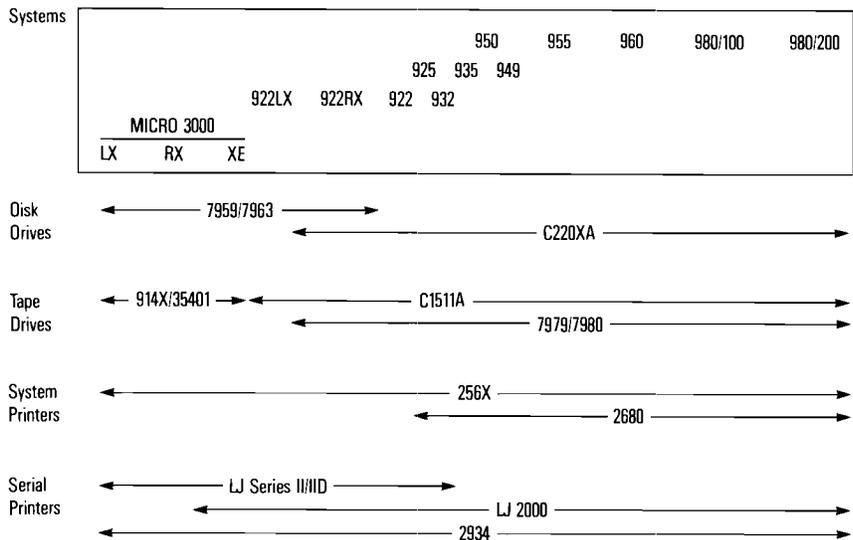
**Peripheral connection**

## HP-FL channels

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

The HP-FL interface is a CPU-resident card providing 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 Pbus 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.

Disk drives can also be connected via HP-IB, although HP-FL is the recommended solution for disk connection on high-end 900 Series systems. HP-FL is required for Mirrored Disk/XL, a redundant disk capability available with MPE/XL.

## HP-IB channels

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

Disk drives can also be connected via HP-IB although HP-FL is the recommended solution for disk connection on high-end 900 Series systems.

HP-IB is a cost-effective solution that allows customers to continue using many of the peripheral devices they already have when upgrading from one HP system to another.

An HP-IB Channel consists of an HP-IB cable connected to an HP-IB interface card. The interface card, which is connected to the system's backplane, performs protocol translation between the CPU and HP-IB. Up to six devices can be connected to a single HP-IB Channel.

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

**Workstation connections**

The Advanced Terminal Processor (ATP) is used to connect worksta-
tions to MICRO 3000 systems in a point-to-point configuration. On the
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 6:
Networks.

**Disk drives**

**HP C220X Series disk drives**

The HP C2200 family of disk drives, using thin-film media, combine
compact size with high-density data storage to provide the ideal stor-
age system for a wide range of multi-user computer systems.

The HP C2204A provides 1.34 Gbytes of formatted data storage on
sixteen 5¼-inch platters and is an ideal product for high-end mass
storage. The HP C2201A, C2202A, and C2203A use eight platters for
670 Mbytes of storage and are well suited for entry-level through large
systems. The HP C2200A uses 4 platters for 335 Mbytes of storage and
provides a low cost disk subsystem for smaller systems. HP's complete
range of disk drive products offer low cost-per-megabyte storage for
all HP 3000 systems.

The compact size of HP's family of disk drives allows up to eight
drives to be stacked in a single cabinet. (A four-drive cabinet is also
available.) In addition, it is possible to rack-mount HP disk drives in
the mid-range system cabinets. Modular design offers great flexibility
in rack mount and cabinet configuration 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 manufactured
thin-film media.

Technical details

- 1.34 Gbyte (formatted), HP C2204A (HP-FL)
- 670 Mbyte (formatted), HP C2201A (HP-FL), HP C2202A (HP-IB with
  cache), HP C2203A (HP-IB)
- 335 Mbyte (formatted), HP C2200A, (HP-IB)
- 2.35 Mbyte per second internal burst data transfer rate
- 17 ms average seek time
- high reliability (Mean Time Between Failures (MTBF) greater than
  100,000 hours)
- efficient use of floor space
- low power consumption

Figure 7-2. The HP C22XX Family
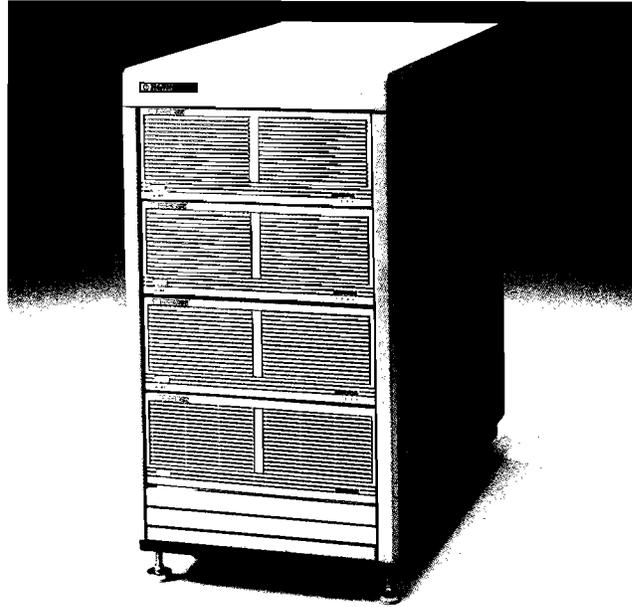


**Magnetic tape drives**

## HP 7979A/7980A/7980XC ½-inch tape drives

The HP 7979A, 7980A and 7980XC ½-inch tape drives are designed to save valuable floor space and improve operator efficiency for mid-range and high-end systems.

The HP 7980XC high-performance tape drive is best suited for systems with greater than 2 Gbytes of disk storage. The data compression feature of the HP 7980XC allows up to a 5 to 1 compression ratio which saves backup time by reducing the number of tapes loaded and handled. The HP 7980XC also offers ANSI standard PE (1600 bpi) and GCR (6250 bpi) formats.

The HP 7980A is the perfect backup solution for systems with 400 Mbytes to 2 Gbytes of disk storage. This high performance tape drive 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.

The HP 7979A follows the same design as the HP 7980A but offers 1600 cpi density only. It is best suited for systems with 100 to 500 Mbyte of disk storage. When your system grows, you can upgrade your HP 7979A on-site to an HP 7980A with a field upgrade kit.

## HP 9144A/9145A ¼-inch cartridge tape drives

The HP 9144A ¼-inch cartridge tape drive is the low-cost, convenient backup solution for MICRO 3000 systems with up to 152 Mbyte of disk storage. This drive accepts 16- and 67-Mbyte-capacity cartridges. The 9144A features immediate READ-after-WRITE, automatic error correction on READ, and a 2-Mbyte-per-minute transfer rate. The HP 9145A offers higher performance with a 4-Mbyte-per-minute transfer rate and the ability to accept 133-Mbyte high capacity tape cartridges. The HP 9145A also has the ability to read tapes produced by the HP 9144A and HP 35401A.

Technical details

- supported by MPE/V-based systems
- backup 67 Mbytes in 45 minutes (HP 9144A), 134 Mbytes in 45 minutes (HP 9145A)
- HP-IB interface/CS80 protocol
- streaming devices with gentle tape handling
- 16 track cartridge tape (HP 9144A), 32 track cartridge (HP 9145A)

## HP 35401A Autochanger ¼-inch cartridge tape drive

The HP 35401A Autochanger ¼-inch cartridge tape drive provides cost-effective, unattended backup for HP MICRO 3000 systems with up to 536 Mbytes of data. Media and format are compatible with the HP 9144A ¼-inch cartridge tape drive, so you can move up to the HP 35401A when your backup needs grow without losing archived data or having to change media.

Technical details

- supported by MPE/V-based systems
- 2-Mbyte-per-minute transfer rate
- Design Plus cabinet, stand-alone, or 19-in EIA rack mount
- Autochanger handles up to eight cartridges
- sequential and selective modes of operation
- immediate READ-after-WRITE and automatic error correction on READ

**System printers**

## HP 256XB Family of dot matrix printers

The HP 256XB 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

The HP 256X family is composed of the:

- HP 2562C—a 300-lpm industrial printer built to provide fast and reliable performance for high-volume printing.
- HP 2563B—a 300-lpm printer that comes standard as a 55-dBA unit with quietized cabinet, sound enclosure, and passive paper stacker. A 65-dBA desktop model is also available without the cabinet, sound enclosure, and passive paper stacker.

**Figure 7-5. The HP 2566 line printer**
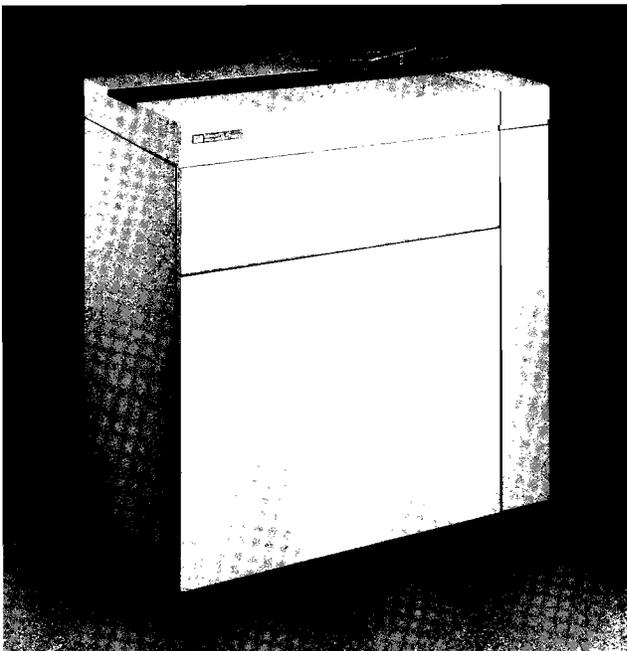
- HP 2564B—a 600-lpm printer that comes standard as a 55-dBA unit with quietized cabinet, sound enclosure, and passive paper stacker. A 65-dBA cabinet model is also available without the sound enclosure and passive paper stacker.
- HP 2566B—A 900-lpm printer.
- HP 2567B—a 1200-lpm printer. The speed of this printer can be increased to 1600 lpm with an optional sparse character set.

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 utilizes the powerful and easy-to-use QMS Magnum programming language.

In addition to being HP-IB devices, the 256X family can also be connected serially through an RS-232 or RS-422 interface.

### HP 2680A laser page printer

The HP 2680A laser page printer offers advanced laser scanning technology and printing capabilities.

The HP 2680A prints 45 pages per minute and is designed for the high-volume EDP environment. It provides 180 dots per inch resolution and uses continuous-feed paper in a variety of sizes including 8½ by 11 inches. The HP 2680A is designed to print 300,000 to 800,000 pages per month. Bar code and OCR-A/B character sets are optionally available.

Besides its speed and laser-technology reliability, this printer does jobs that traditionally have required retyping, cut-and-paste work, reformatting, and photo reduction. As a result, it provides significant cost savings and productivity improvement.

Technical details

- high-quality output
- more than 200 predefined character sets
- more than 60 predefined forms
- Forms Design software (PSP) lets users create their own electronic forms
- up to 32 fonts on any page
- portrait or landscape orientation
- 2 to 1 and 4 to 1 reduction
- capability to merge graphics and text in printed output
- microprocessor controlled
- sophisticated self-diagnostic hardware
- prints on label stock

**Figure 7-6.  The HP 2680 laser printer**
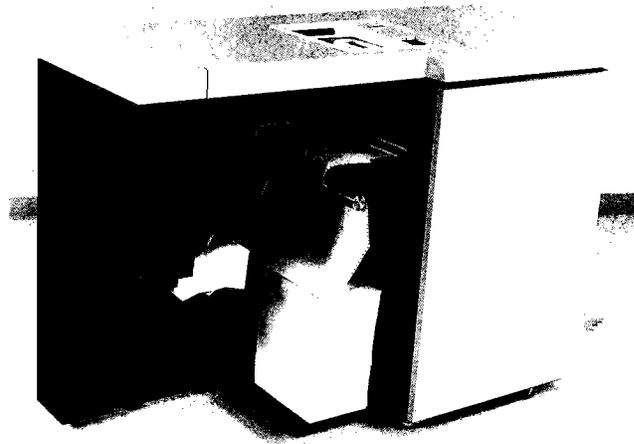


**Printers connected serially**

**HP LaserJet Series II and LaserJet IID**

The HP LaserJet Series II and HP LaserJet IID printers are the second-generation desktop laser printers from Hewlett-Packard. Both printers print 8 pages per minute at up to 300 dots per inch (dpi) resolution. The LaserJet IID provides automatic duplex (two-sided) printing at up to four pages (8 images) per minute.

The LaserJet Series II comes with 6 internal fonts, 23 symbol sets, and an easy-to-use front control panel. The LaserJet IID comes with 24 fonts, greater paper capacity, and an optional envelope feeder. Both printers are completely compatible with the HP LaserJet PLUS, so all software, font cartridges, and soft fonts that work with the original LaserJet PLUS printer will work with the LaserJet Series II and IID.

### HP 700/94 high-performance 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 communication.

- selectable 80- or 132-column display modes
- printer port standard
- detachable adjustable keyboard with 8 shiftable function keys
- block-mode operation

## 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 utilizing 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.

### The HP Vectra Personal Computers

HP Vectra Personal Computers present a broad range of price/performance choices (illustrated in figure 7-9) for the user who needs the local computing capability of PCs together with terminal access to the host computer.

**Figure 7-9. HP workstation family**
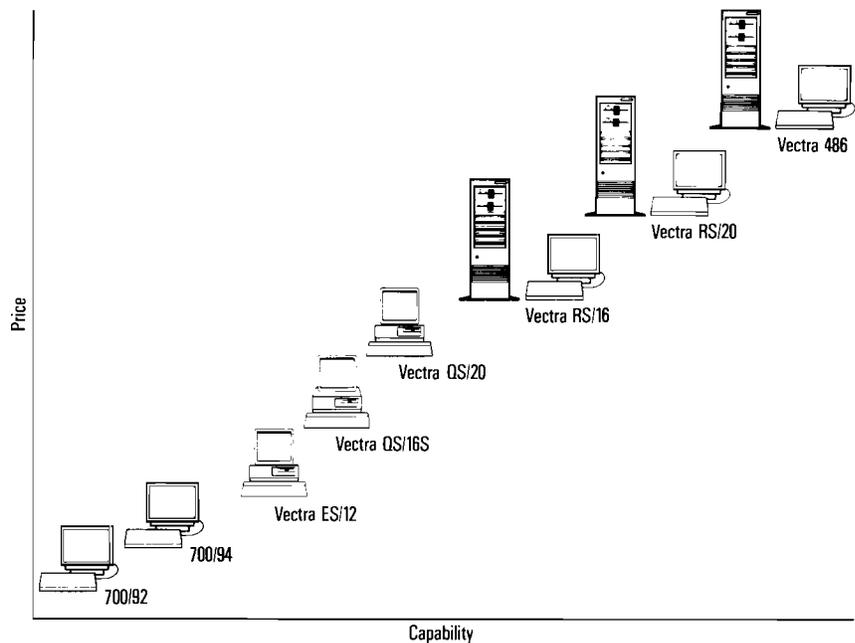


Vectra PCs can be integrated with HP 3000 systems to take full advantage of HP 3000 data and peripherals while offering complete PC-based office functionality.

AdvanceLink and 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 HP Touch, HP Mouse, 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 available on HP Vectra PCs. These same packages and accessories are also supported on Extended Industry Standard Architecture (EISA) PCs, such as the Vectra 486 PC. In addition, accessories which take advantage of EISA's advanced capabilities are fully supported by the Vectra 486 PC.

**Figure 7-10. The HP Vectra ES/12**



## The HP Vectra ES/12 PC

The HP Vectra ES/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, 7 accessory slots, 3 half-height mass storage shelves, 640 Kbytes of RAM, a 1.2-Mbyte flexible disk drive, and serial/parallel ports. Options include additional disk drives, (1.2-Mbyte flexible disk or 20- or 40-Mbyte hard disk), color and monochrome monitors, and expanded RAM up to a total of 16 Mbytes.

## The 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; 3 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.

## The 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, 8 accessory slots; 6 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.

## The 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; 8 EISA accessory slots; 6 half-height mass storage shelves, 2 Mbytes to 64 Mbytes of 32-bit memory; two serial ports and 1 parallel port; 360-Kbyte, 1.2-Mbyte, and 1.44-Mbyte flexible disk drives; and up to 1.3 Gbytes of internal hard-disk storage.

**Figure 7-11. The HP Vectra 486**

# Chapter 8

# Commitment to Your Success

**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. These services fall into the following general categories:

- hardware maintenance programs provide various levels of hardware support for systems, workstations, and office products
- a comprehensive program of network support services
- 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 service

HP customer support is delivered by a worldwide network of Systems Engineers (SEs), Customer Engineers (CEs), and 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**

On-site warranty for 90 days is included for 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, while giving you the flexibility to choose response time and coverage periods that meet your service needs.

When you purchase an HP support agreement for your HP 3000, a CE is assigned to your account to personally manage your maintenance program. Your Account CE will perform preventive maintenance on a regularly scheduled basis and, if necessary, will adjust or replace parts to ensure a continued high level of performance. Your CE also will install equipment, update your system with engineering improvements, monitor your site environment, and maintain a current system log.

HP remote support is included with HP hardware support for your HP 3000 system. A communications link via phone line and an HP-provided Support Link modem enable specialists in the HP Response Center to access your system in order to remotely run tests and diagnose functional problems.

HP Predictive Support is also included with hardware support for HP 3000 systems. HP Predictive Support provides early warning of potential problems in HP disk drives, magnetic tape media, and system memory. This allows you to avoid unscheduled downtime and increase system availability.

Should your system require troubleshooting, your CE has the training and materials to rapidly resolve most problems. The CE will stay 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 plan that enlists all the HP resources necessary to provide a solution.

Features included in HP 3000 support agreements are detailed in figure 8-1:

**Figure 8-1. HP SuccessLine Service features**

**Features**

| | |
|---|---|
| Account-assigned CE | HP Predictive Support |
| Work to completion | Remote support |
| Escalation Management Program | Preventive maintenance |
| Response Center network | Engineering improvements |
| Local parts inventory | Site environment survey |
| | Warranty enhancement |
| | Installation of add-ons |

HP SuccessLine Service offers you the flexibility to choose from four service levels:

**Priority Plus support**
If your applications are extremely critical and call for maximum availability, this service level 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 this service level will meet your needs. On-site assistance is available for several business hours beyond the standard business day, and HP will respond to your service request as quickly as possible. This coverage is provided during the normal workweek.

## Next-Day support

If your application allows for service delivery on the following business day, then this service level 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

This 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 alternate 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.

**Figure 8-2. 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 additonal low cost alternative. This service offers support for situations where your applications are not critical and service economy is a priority. With HP Customer Return, you return the product to an HP Service Center for repair. Within three days of its arrival, the repaired unit will be shipped (prepaid) back to you via normal land carrier.

Selected non-HP terminals and PCs and multivendor PC LANs can also be fully supported by HP.

## HP Multivendor Network Support Services

### The network life cycle: successful network management goes beyond the initial purchase

HP 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, 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.

**HP Multivendor Network Support Services: integrated, flexible assistance throughout the life cycle**

HP'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 network support program integrates services so that they work logically together 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 Multivendor Network Support Program**

**HP Network Consulting**
HP provides experienced network consultants who develop a custom network design that can best support your business needs.

In addition, HP Network Consulting offers you a comprehensive range of service modules that you can customize to help your organization achieve successful network implementation and operation.

**HP WireTest**
HP evaluates the suitability of your existing cabling prior to implementing a new or upgraded network.

**HP CableSite**
HP takes responsibility for the design and installation of the cabling infrastructure needed for information transport over LANs.

**HP Network Startup**
HP coordinates the installation and testing of your HP and multivendor network to ensure it operates as designed.

**HP NetAssure**
HP provides you with a single point of contact for trouble shooting and managing resolution of faults 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 new software support services are designed to provide you with the level of support that best meets your individual 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.

Figure 8-3. HP Commercial Software support programs



**HP TeamLine**
- Assigned support consultant
- Personalized assistance
- Support management reviews
- Software release planning
- HP TREND

**HP ResponseLine**
- Software problem resolution
- Product usage assistance
- Escalation management
- HP SupportLine
- HP PowerPatch
- HP Startup ResponseLine service

**HP BasicLine**
- Right-to-use updates
- Support information databases

**HP Custom Support Plan**
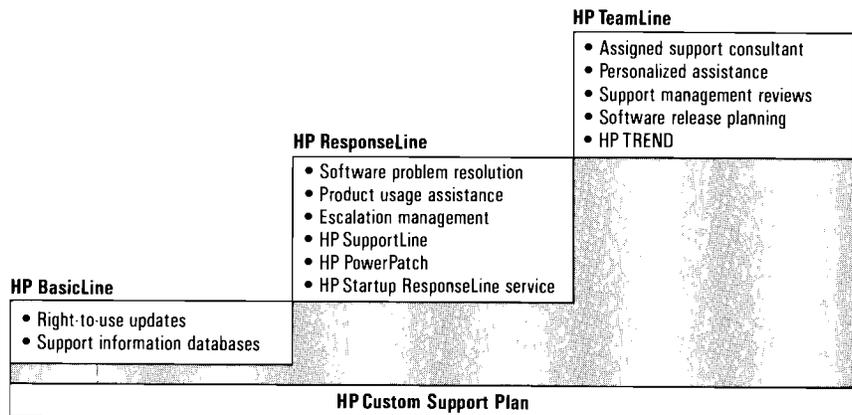
### HP TeamLine software support

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 to improve your system's productivity and maximize the effectiveness of your people.

In addition to personalized assistance, HP TeamLine software support provides the full benefits of complete software maintenance support with access to the HP Response Center and HP SupportLine electronic database, plus the right to use software updates.

### HP ResponseLine software support

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, an electronic support information service, preventive software maintenance, and problem escalation management. The HP Response Centers bring together the worldwide resources of Hewlett-Packard into a single network for software maintenance. 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 the full benefits of HP ResponseLine software support.

### HP BasicLine software support

HP BasicLine software support service delivers current, comprehensive support information by providing electronic access to support information and the right to use updates to your Hewlett-Packard software. 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 add 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's Custom Support Plan is designed for customers who need tailored software support. Built on top of HP TeamLine, HP Response-Line or HP BasicLine, the HP Custom Support Plan is unique to you. The services included depend entirely upon your needs and can incorporate anything from performance analysis and multiple site coordination to additional reviews and consulting services.

Because the Customer Support Plan is developed by you and HP, 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 ensure that your software and documentation are kept current and that you benefit from any fixes or enhancements that become available. Hewlett-Packard continuously enhances HP software products through periodic updates. Updated software includes known defect repairs and may include additional functional and performance improvements.

With the HP LaserRelease MPE/V media option, you save money on the price of updates, as well as reduce error rate and gain improvements in system uptime during updates. The HP LaserRelease program incorporates CD-ROM (compact disk read-only memory) technology to distribute operating system and all subsystem software for HP 3000 MPE/V computers.

## Optional services

In order to provide the complete solution, HP also offers you many optional features to enhance your standard support contracts.

- Additional SE support provides incremental time with your SE for HP TeamLine software support.
- Additional HP Response Center Caller provides authorization for one additional person to call HP's Response Center.
- Software Update Installation provides installation for one operating system or subsystem update at your site.
- Off-Hours Update Installation provides installation for one operating system or subsystem update during specified times outside of normal working hours.

**Figure 8-4. HP 3000 Software Support Program features**

| Features | HP TeamLine | HP ResponseLine | HP BasicLine |
|---|---|---|---|
| Account-Assigned SE | S | | |
| Support Management Review | S | | |
| Software Release Planning | S | | |
| HP TREND | Y | 0 | |
| HP Platinum Book | S | | |
| Additional Support Management/Technical Reviews | 0 | | |
| Access to HP Response Center | S | S | |
| HP Remote Support | S | S | |
| Software Problem Verification | S | S | |
| Software Patch | S | S | |
| HP PowerPatch | S | S | |
| HP SupportLine | S | S | |
| Extended Hours HP RC Service | S | S | |
| Problem Escalation | S | S | |
| Additional RC Caller Service | 0 | 0 | |
| Right-to-Use Updates | S | S | S |
| Electronic Database Access | S | S | S |
| Software Update Installation | 0 | 0 | |
| Off-Hours Update Installation | 0 | 0 | |

Legend: S–Standard    0–Additional (optional) service    Y–MPE/V only

**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.

Lastly, HP HelpLine service is available should your support needs call for a per-call service.

**Consulting services**

HP offers a comprehensive set of consulting services to help you obtain the most productive use possible of your HP 3000 system throughout its life cycle. Consulting is available in standard service packages offering defined results and fixed prices, or on a time-and-materials basis.

**Migration Consulting—FastLane 3000**

Migrating applications from your current MPE/V-based HP 3000 system to a 900 Series system is straightforward, but proper planning is bound to accelerate the process. Proper planning will ensure that the migration is efficient and does not interfere with daily operations.

An HP consulting service that concentrates on planning, FastLane 3000 is a powerful yet cost-effective way to streamline the migration process and help you make the most effective use of your time and resources.

FastLane 3000 is delivered by a specially trained HP systems engineer who will work with your migration project team on the planning of your migration. The service, which is customized to fit your needs, consists of two components:

• System Planning provides a system-level migration perspective of your data processing environment and helps you develop an overall migration strategy
• Application Planning guides your project team through the development of a complete migration plan for one of your applications

The components of FastLane 3000 can be put together in many different ways—and consultation on a time-and-materials basis can be added to FastLane 3000—to structure the service that perfectly fits your needs.

## HP Performance Consulting

HP's Performance Consulting is designed to maximize the performance and return on investment of your current systems.

These services help you determine your system's current resource utilization levels, identify performance bottlenecks and tune your system and applications for improved response time and transaction throughput.

The situations where these services can be of most benefit are when you have system slowdowns, problems with turnaround on one or more applications, difficulties in scheduling batch jobs, or a wish to proactively manage your system's performance in order to prevent performance problems occurring.

## HP SNAPSHOT

HP SNAPSHOT is a performance consulting service for customers who have specific system performance concerns and require consulting assistance on an individual request basis. HP Performance Specialists provide this service, which includes identifying specific problem areas and making tuning recommendations.

## HP Capacity Planning Consulting

HP's Capacity Planning Consulting helps you plan for business and system growth. They provide a forecast of your system's performance as your users, applications and system configuration change and grow.

The HP Performance Specialist will use sophisticated software tools to build a model of your system based on accurate measurement of your system's current performance. The specialist will then use analytic modeling and other techniques to predict your system's performance under a number of different scenarios. These scenarios will be determined in consultation with you, and will match your future business requirements.

These services can be of most benefit to you when you need to determine future system resource requirements to meet your predicted business changes and growth. This type of capacity planning can assist in your business and budget planning process.

## HP CAPLAN

HP CAPLAN is a capacity planning service performed by HP Performance Specialists. This service answers your "what if" questions by providing information on how system performance will be affected by capacity increases (such as the addition of more memory, peripherals, or on-line terminals), and how to best plan for capacity increases. HP CAPLAN services can also provide performance projections for the migration of MPE/V-based applications to compatibility mode and native mode operation on a 900 Series system.

## HP Custom Performance Consulting

For large multi-faceted performance consulting or consulting requirements which cannot be met by one of the structured consulting projects, HP Custom Performance Consulting is tailored to meet your needs.

## Time-and-materials assistance

When the content and duration of the assistance you need is difficult to determine, HP can provide consulting on a time-and-materials basis. This way, you can take advantage of HP's consulting expertise in an ad hoc manner that best fits your needs.

Additionally, HP consulting on an ad hoc basis is available for new system installations. This gives you personalized help in customizing a new system for your needs and planning for long-term operational success.

**Customer education**

Hewlett-Packard offers a full range of courses to meet your need 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.

See figure 8-5a and figure 8-5b for a diagram of customer training courses offered by HP.

**Figure 8-5a. Customer training**

**Electronic Mail**

**HP DESK Users**

```
┌─────────────────┐        ┌─────────────────┐
│ HP DeskManager IV│───────▶│ HP DeskManager IV│
│ New User         │        │ Experienced User │
│ HP 27538A        │        │ HP 27539A        │
└─────────────────┘        └─────────────────┘
```

**HP DESK Administrators**

```
┌─────────────────┐
│ HP DeskManager IV│
│ Administration   │
│ HP 27537A        │
└─────────────────┘
```

Note: HP 27545 = HP 27538A
                 + HP 27539A

**Network General Knowledge**

```
                              ┌─────────────┐
                         ┌───▶│ LAN         │
                         │    │ HP 50747A   │
                         │    └─────────────┘
                         │
                         │    ┌─────────────┐      ┌───────────────────┐
                         ├───▶│ WAN         │─────▶│ X.25 Packet       │
┌─────────────┐          │    │ HP 50748A   │      │ Switching Network │
│ Introduction│          │    └─────────────┘      │ HP 50752A         │
│ to DataCom  │──────────┤                         └───────────────────┘
│ HP 35051B   │          │    ┌─────────────┐
└─────────────┘          ├───▶│ Network     │
                         │    │ Management  │
                         │    │ HP 50749A   │
                         │    └─────────────┘
                         │
                         │    ┌─────────────┐
                         └───▶│ Approaches to│
                              │ Network Design│
                              │ HP 50750A    │
                              └─────────────┘
```

**Figure 8-5b. MPE/XL customer training**

**MPE/XL for New 900 Series HP 3000 Users**   **Experienced MPE/V User**

**System Operators**

900 Series HP 3000 System Operation Skills HP 31120A

MPE/V to MPE/XL Getting Started *HP 30367-60002 → Moving from MPE/V to MPE/XL System Operator HP 31117A

**System Managers**

900 Series HP 3000 System Operation Skills HP 31120A → 900 Series HP 3000 System Management Skills HP 31119A

MPE/V to MPE/XL Getting Started *HP 30367-60002 → Moving to MPE/V to MPE/XL System Manager HP 31110B

HP SQL for MPE/XL and HP-UX HP 36217AN

VPLUS/3000 for Programmers HP 22830C → HP Business Report Writer HP 36070BB

**Programmers**

900 Series HP 3000 Programmer Skills HP 31118A → TurboIMAGE DBMS/3000 HP 35053B → Database Design for TurboIMAGE HP 30606A

MPE/V to MPE/XL Getting Started *HP 30367-60002 → Moving from MPE/V to MPE/XL System Operator HP 31117A

HP Pascal— Advanced and System Programming HP 31113A → TRANSACT/3000 HP 35014B

900 Series HP 3000 Programmer Skills II HP 31128A

**System Administrator (Run Only Application Environment)**

MPE/XL System Administration for Application Users HP B1677A

**General Users**

Using the 900 Series HP 3000 Fundamental Skills *HP 31126A 001 → Using the 900 Series HP 3000 Advanced Skills *HP 31126A 002

*Self-paced course

All HP courses are taught by experienced professionals knowledgeable about HP products. Training is available at 45 HP Education Centers around the world or, 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**
HP 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.

**Advanced programmers**
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 IMAGE or HP SQL, HP offers courses that cover topics such as accessing, reporting on and maintaining data, transaction management, backup and recovery, programming basics, security and locking strategies, and much more.

**Customer documentation**

HP 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 manuals are written from the users' point of view. They identify the actual tasks users perform, supply clear explanations, and make frequent use of examples and illustrations. The manuals have been extensively tested by users for appropriate content, organization, readability, and ease of use.

The manuals 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 manuals provide more than just HP-specific information; they provide general discussions about topics such as database design and structured programming techniques.

Included with all system shipments is the System Management Core manual set. With the larger systems, the S93X, S949, S95X, S960 and S980 systems, also included is the System Management Core Plus manual set. The manuals are orderable as sets from the local Hewlett-Packard sales office or as individual manuals from the Direct Marketing Division (DMK).

**Figure 8-6. Manual structure**

**Manual sets shipping with MPE XL systems**

| System Management Core | Ships with: S922LX S922RX S922 S925 |

| System Management Core / System Management Core Plus | Ships with: S932 S935 S949 S950 S955 S960 S980 |

**Manual sets purchased by product number**

| Programming Core | Programming Core Plus |
| HP System Dictionary/XL | HP ALLBASE |
| General Usage | Migration |
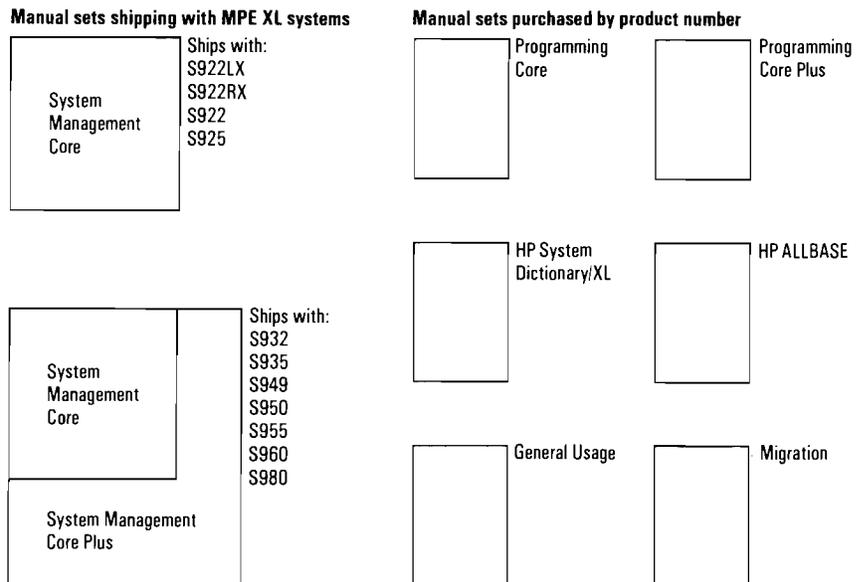
The available manual sets are:

**System Management Core 36367A**
These manuals allow for efficient operation of an MPE/XL system. All of the necessary information to operate an MPE/XL system is included.

**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.

### Programming Core 36369A

Designed for basic programming environments, this manual 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 manuals for larger more advanced programming environments.

### System Dictionary Set 36371A

This manual set helps programmers use the HP System Dictionary/XL product.

### ALLBASE Set 36372A

These manuals are designed for programmers who will use ALLBASE, 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- 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 manuals, 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 (part number 5952-0258).

**HP Disaster Recovery program**

## HP Disaster Recovery Planning

HP Disaster Recovery Planning provides you with the knowledge and tools necessary to develop a disaster recovery plan designed for your HP 3000 environment. It is designed to assist you in preparing contingency plans to protect against the disastrous loss of computer resources. HP Disaster Recovery Planning helps you:

• 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

## HP Backup service

HP Backup service minimizes the risk to your business should a disaster occur. It gives you the hardware, technical support, the customized communications capabilities you need to keep your critical applications up and running after a disaster strikes. HP Backup provides subcribers:

• access to fully operational HP 3000 hardware—S58, S70, and S950 systems, recovery facility, and telecommunications
• resources and expertise of HP's Worldwide Customer Support Organization standing by 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

HP Disaster Recovery Services provides you with a total recovery solution, from up-front planning and documentation to hardware backup and recovery of your disaster site. With HP Disaster Recovery Services, you can rest assured that when disaster strikes, your critical business applications are safe.

Chapter 9         **Office Information Products**

**HP NewWave Office**

**Figure 9-1. HP's Office Framework**
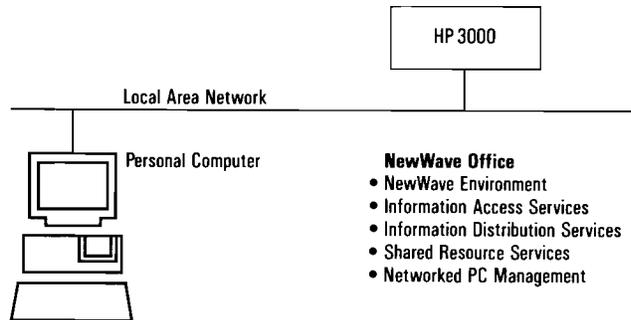


HP NewWave Office software provides powerful communication, decision support, and information sharing services. HP NewWave Office offers organizations unparalleled flexibility to manage the flow and use of information. It empowers departments and ad hoc teams to share information and improve decision making. HP's implementation represents the industry's best solution for integrating PC applications and tapping into diverse corporate information sources.

HP's NewWave Office software breaks down technology barriers, empowering organizations to use information to their fullest advantage.

* NewWave Office extends HP's leadership in PC integration. People can integrate the PC software of their choice from HP and other vendors. They can establish meaningful links among their favorite PC applications that were not originally designed to work together.
* People can create flexible, open information systems that bridge islands of corporate information from micros to larger host systems that hold company data.
* Smart services called "agents" can learn sequences of tasks and repeat them on request, improving productivity; a consistent user environment makes the system easy to use and reduces training time.
* PCs are linked into a network that offers consistent capabilities across a full range of platforms (MPE, UNIX, OS/2) and can grow as needs change.
* NewWave Office automates the management and control of networked PCs with centralized software distribution/updating and simplified installation processes. HP was the first major vendor to offer this automated approach to networked PC management.

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 you to choose the combination of services your organization needs today with the ability to add services incrementally as needs grow.

* the HP NewWave or traditional MS-DOS PC environment
* Information Access Services
* Information Distribution Services
* Shared Resource Services
* Networked PC Management

HP NewWave Office supports industry-standard PCs, and UNIX and Apple Macintosh workstations (in terminal emulation mode). You can choose from a variety of local area networking options or asynchronous connections. In all, Hewlett-Packard's NewWave Office gives you the flexibility to build an information system your way.

**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 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 on-line help facility, and a consistent and predictable graphical user interface for ease of learning, use, and access to the full range of HP NewWave Office services.

HP NewWave Office offers you flexibility and choice for your PC environment. Using an industry-standard PC, your favorite MS-DOS and Microsoft Windows/286 applications are easily integrated into the HP NewWave environment, and you'll be able to add future applications without worrying about compatibility.

A non-NewWave interface is also provided for HP NewWave Office customers who wish to operate in the traditional MS-DOS environment.

## Key capabilities

The first thing a user sees when starting NewWave is the Office window. It is modeled after a real office for ease of use and is the starting point from which the user can create, file, copy, delete, and rename objects.

The Object Management Facility (OMF) is one of the key technology contributions of HP NewWave. The OMF links data to applications to create objects and then represents them as icons. The OMF makes it easy to create and revise objects in compound documents by keeping this document/application linkage. It also allows the user to show the same information in multiple places on the personal computer.

In the first release of HP NewWave, an Agent can automate Information Access and AdvanceLink tasks by executing command files which have been written for these products. In the second release of HP NewWave, the Agent can record 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 be edited. MIS departments can use this sophisticated Agent facility and task language to create advanced Agent tasks which can be given to users and run on individual personal computers. For example, an Agent task could start a database access application, download information from a remote source into a spreadsheet, generate a graph of the data, combine the graph with a document, and mail the document.

**Figure 9-2. HP NewWave screen**
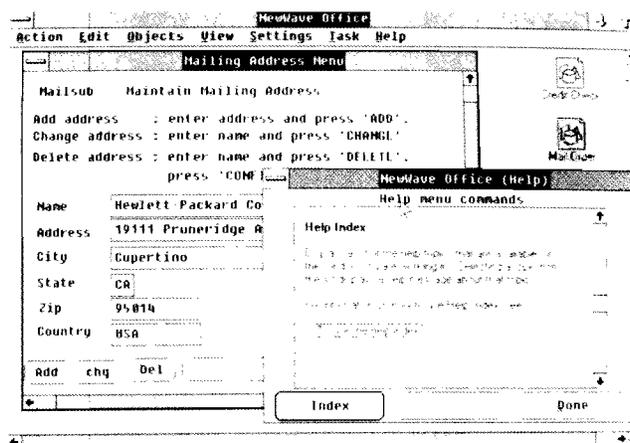
## Information Access Services

Information Access Services of HP NewWave Office allow users to select a broad range of data sources on their HP 3000 or PC and 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 workstation and a data server on the HP 3000. With Information Access, decision makers spend less time gathering data and more time analyzing and solving business problems.

On the PC, an interactive, query-by-example interface allows users to join, select, sort, summarize, and convert data (from a variety of data sources) in either the HP NewWave or MS-DOS environment. This data can then be used in popular PC applications. Additionally, 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 and executable by the NewWave Agent within the NewWave environment.

On the HP 3000, administration functions are provided to control access to the database information. For non-relational data (TurboIMAGE databases, KSAM, and MPE files) a soft-key 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 their database management system. In either case, database administrators can satisfy their user needs for data while maintaining central security and control of the data sources.

## Information distribution services

### HP DeskManager
Hewlett-Packard's HP DeskManager provides the information distribution and messaging services of HP NewWave Office. HP DeskManager provides your organization with a cost-effective communications server. Users can distribute any information, whether this is a simple message, a file created on a personal computer, or data processing information.

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

HP DeskManager integrates with a range of complementary applications to add to its benefits. AdvanceMail and NewWave AdvanceMail 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 parts of Hewlett-Packard's leadership PC integration.

*HP Schedule*

HP Schedule extends the time management facilities of HP DeskManager by providing a comprehensive meeting scheduler and resource management tool. With HP Schedule, you can organize meetings with other HP DeskManager users, even if they are on different computers, and at the same time schedule any resources you might need, from meeting rooms to corporate jets.

To schedule a meeting, HP Schedule examines the relevant electronic calendars and comes up with a list of potential meeting times within a specified range of dates. Select a time, and HP Schedule sends appointment requests to all those concerned. Features such as reply tracking and automatic conflict reporting mean that you always know whether attendees have received the request, and you are automatically notified if someone schedules a meeting that clashes with yours before all details are finalized.

HP Schedule accommodates non-calendar 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 In Tray, so they can either respond personally or by generating an HP DeskManager message.

*HP File/Library*

HP File/Library brings community filing and archiving into the HP DeskManager environment. HP File/Library provides electronic indexing of documents held both inside and outside HP DeskManager. Now the entire workgroup can share documents and access the information they need to do their jobs.

The HP DeskManager Library Area contains one or more shared or individually owned Catalogs, where documents are indexed by up to eight attributes: Subject, Creator, File Type, Status, Create Date, Keywords, Author Name, and Comments. You can add Keywords and Comments to provide a unique description of an item to help speed things up when you want to find it. For example you could use the Keyword "Hazardous Chemicals" to describe documents concerned with environmental pollution.

To find a document in a Catalog simply specify as many details as you wish about it. Each Catalog contains an automatically maintained Keyword Dictionary to remind you of which Keywords have been used. Search specifications can be saved to avoid retyping when looking for a frequently used document.

**External Connections—HP OfficeConnect**
Hewlett-Packard has long been committed to the multivendor environment. This is especially important where office automation is part of company-wide information networks. Communications between HP DeskManager and other office systems can be achieved using HP OfficeConnect to X.400, HP OfficeConnect to PROFS, and HP OfficeConnect to DISOSS. This allows you to share critical information between users in a multivendor environment.

HP OfficeConnect to PROFS provides a communications link between HP DeskManager and IBM's Professional Office System (PROFS) electronic mail systems. HP OfficeConnect to DISOSS provides comparable services for IBM's DISOSS. HP OfficeConnect to PROFS and DISOSS products demonstrates HP's commitment to multivendor environments, giving customers more flexibility to choose the solutions which best fit their needs, while protecting their existing investment.

**HP NewWave Mail/HP AdvanceMail**
HP NewWave Mail is a fully integrated NewWave PC-based application for mailing services. HP AdvanceMail is the non-NewWave PC information distribution service. NewWave/AdvanceMail allows the choice of applications and consistent performance you expect from a PC while providing a transparent link to network wide communications through HP DeskManager. NewWave Mail/AdvanceMail's electronic mail services are available for both HP Vectra and IBM PC users.

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

NewWave Mail/AdvanceMail has the rich set of PC mailing functions you would expect from a leading supplier of information systems solutions. In addition to the ability to send and receive any object by any user, NewWave Mail/AdvanceMail provide automatic, background transfer messages, full distribution list checking, forward and reply capabilities, priority mailing, new mail notification, automatic conversion and mail filters.

HP NewWaveMail and HP AdvanceMail save host connection time by allowing the user to perform many functions such as message creation, reading, printing, and editing without ever making a connection to the host computer. The only time you need to make the connection is to send or receive mail.

Your PC investment is protected and enhanced through the support of a wide range of file types which allows you to send, receive and even convert files from your existing PC applications. These file types include Binary, Text, AdvanceWrite, Executive MemoMaker, VisiCalc® DIF, VisiCalc VC, RFT/FFT DCA, HP Word/PC, Graphics Gallery, Lotus 1-2-3® NewWave Object and other WP file types. Additionally, NewWave Mail/AdvanceMail enhances your investment by letting you integrate your favorite word processor into NewWave Mail/ AdvanceMail.

NewWave Mail, HP DeskManager, and 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 you can add NewWave users to your existing system and at the same time protect your investment in existing hardware and software.

*Quick and easy connections for NewWave Mail/AdvanceMail*
Making that connection to the HP 3000 can be done quickly and easily by means of connection files configured in AdvanceMail or NewWave Mail. This built-in flexibility is available whether you are directly connected to the host computer via a LAN or by RS-232 or remotely connected via modem, X.25, or multiplexer. AdvanceMail and NewWave Mail support standard RS-232 and CCITT X.25 communications. Additionally, they support OfficeShare, ThinLAN, StarLAN, and StarLAN Local Area Networks which are based on OSI standards.

NewWave and non-NewWave users can connect to other systems using the capabilities available in HP DeskManager. These connections include IBM's PROFS and DISOSS, and other external systems by means of X.400 and telex via HP Telex.

**HP DeskMon**
Hewlett-Packard's DeskMon is an add-on software product which monitors the status of HP DeskManager systems throughout an entire network. The primary functions of the product are to oversee the HP DeskManager system and to report exceptions to the system administrator. HP DeskMon is able to check your HP DeskManager network as often as required, automatically initiating the monitoring process at preconfigured times. The system administrator will be notified of exceptions through a message output to a nominated console or printer, or the system can be configured to automatically send that information to a designated HP DeskManager user.

Minimal overhead is required on the host machine to take advantage of these benefits, without having to make changes to the existing HP DeskManager configuration of databases. HP DeskMon reduces the time that an administrator spends monitoring an HP DeskManager node. The administrator's only responsibility is to configure HP Desk-Mon to monitor what they wish and then to ensure that reported errors are either corrected or noted. This leads to lower administration costs and efficient use of administration resources.

## Shared Resource Services

With the HP NewWave Office Shared Resource Services, available in the local area network (LAN) environment, workgroups have easy access to HP 3000 peripherals from their PC environment. Using shared disks, a workgroup can easily access and work on a common document, making workgroups 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.

Users can protect their PC files in two ways: 1) using PC Backup and 2) through normal system backup. The PC Backup capability allows users to back up their PC hard disk to a tape on the HP 3000 server. Files saved on system shared disks will automatically be stored to tape during system backup.

In the HP NewWave environment, full backup is necessary and provided with PC Backup. For traditional MS-DOS users, full/partial backups and restores are available.

## AdvancePrint

AdvancePrint is a serial alternative PC software product that provides non-NewWave, low-cost shared printing for PC users. It lets HP Vectra, IBM, and HP 150 users share printers and plotters connected to an HP 3000. With AdvancePrint, PC users can print to shared devices with the same functionality as if the printers or plotters were directly attached to their PC, including full graphics support. AdvancePrint lets you leverage your PC printing investment to give PC users the best PC output capabilities possible.

### Networked PC management

HP NewWave Office management tools simplify the installation of PC applications and PCs in an HP 3000 LAN environment so your organization can quickly benefit from HP NewWave Office capabilities with minimized effort. The HP NewWave and MS-DOS applications offered with the system can be installed from the HP 3000 to all hard disk PCs in the workgroup. With enhancements, other HP PC applications can be centrally distributed. With the software update service, PC users can load updated HP NewWave Office applications automatically. This is much faster than with flexible disks, and all users are assured of using the same application version.

### Terminal emulation

The new AdvanceLink family of terminal emulation and file transfer solutions provides full integration of your personal computer into your workgroup. Whether you are using an HP Vectra, IBM compatible PC, or an Apple Macintosh, Hewlett-Packard has the connectivity solution to meet your needs.

The AdvanceLink family now supports three of today's popular personal computing environments.

AdvanceLink for MS-DOS is a comprehensive data communications package which incorporates alphanumeric, monochrome, block mode, and color graphics terminal emulation, in addition to state-of-the-art file transfer and an extensive command language that allows task automation.

AdvanceLink for Windows emulates the HP 2392 block mode terminal. It provides alphanumeric terminal capabilities under Microsoft Windows and HP's NewWave, together with file transfer and basic scripting capabilities.

AdvanceLink for the Macintosh offers three choices of terminal emulation for the Apple Macintosh: AdvanceLink/Text for HP 2392 alphanumeric, AdvanceLink/Graphics for HP 2393 monochrome graphics and AdvanceLink/Color Graphics for HP 2397 color graphics terminal emulation. All versions offer file transfer.

VT3K (Virtual Terminal to HP 3000) is a product that runs on HP 9000 Series 300 and 800 systems under HP-UX. It provides virtual terminal capabilities over local area networks into HP 3000s from HP 9000s. VT3K works in combination with the block mode emulation of HPTERM on an HP 9000 to run HP 3000 block mode applications in an X-Window on a 9000 with a bit-mapped display. It will also work with block mode terminals that are direct-connected to a multiuser Series 800 to run HP 3000 block mode applications. In addition, VT3K will work with non-block mode HP 3000 applications.

Hewlett-Packard is committed to the future development of terminal emulation solutions. Future releases will incorporate expanded terminal emulation and task automation capabilities. In addition, HP intends to extend the multiple connections capabilities offered today to allow multiple local area network sessions to be run simultaneously. HP also intends to develop emulation solutions for non-HP terminals, supporting users in mixed vendor environments.

Our goal is to extend the next generation AdvanceLink family to additional graphical environments, in particular HP NewWave and OS/2 Presentation Manager. As the AdvanceLink family evolves, users will find the power at their fingertips to access information on their networks from their industry-standard workstations of choice, whatever environment they operate in.

**Application development tools**

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

**Cooperative Services**
The Cooperative Services development tool helps software designers create cooperative processing applications between personal computers and an HP 3000 minicomputer. 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 minicomputer. 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 that of the HP 3000 environment. Developers use the equivalent of HP TurboIMAGE or MPE 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 Microsoft 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 their applications. Personal computers may be connected to the HP 3000 over either the HP OfficeShare family of networks or basic serial connections. Up to ten concurrent connections are allowed from a single PC application when the PC is used in a LAN networking configuration. When a basic serial networking configuration is used, only one connection per PC is allowed. The application can be designed so that the PC is connected to the HP 3000 at all times, or connections can be established only as required.

**NewWave Developer's Kit**
The 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 will be 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 Application Program Interface, 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 environment application in the HP NewWave environment. Appendices include utilities descriptions and a set of Data Interchange Standards, 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 New-Wave 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 on how to approach the writing tasks. It includes a definition of what is included in each document and how they work together. Appropriate writing style and terminology is also introduced.

# Index

**HEWLETT PACKARD**