

What's New with HP-UX?

Threads, 64-bits, 2000 and the Future

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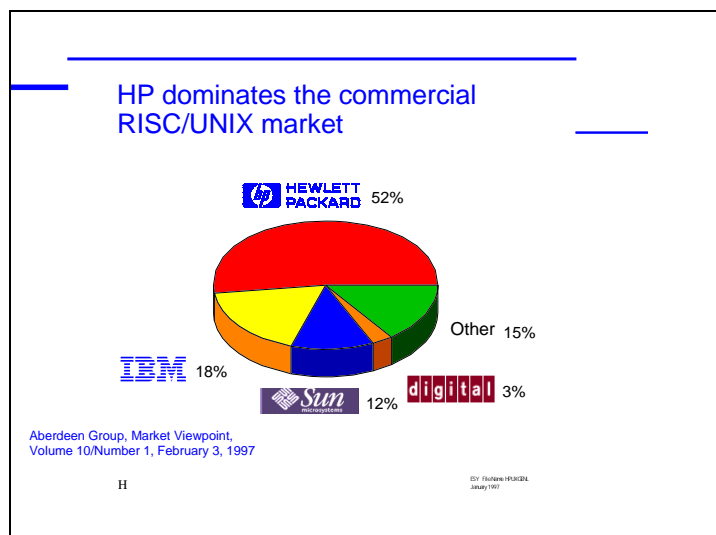
Executive summary¹

HP-UX is Hewlett-Packard's enterprise-class operating environment that leads the UNIX² market in many areas that are important to customers: performance and scalability, high availability, standards compliance, integration with the Internet and network operating systems, such as Novell Netware and Microsoft Windows NT, security and manageability.

This paper provides an overview of HP-UX, and describes selected current features and functionality. It then outlines HP's plans for future versions of HP-UX by providing a roadmap that describes mapping of hardware support and selected OS features for the next three to four years.³

Setting the stage: HP's presence in the UNIX market

HP's HP-UX-related revenues, covering server and peripherals hardware, networking products, HP-UX, and HP applications software amounted to more than \$9 billion in 1996. According to industry analyst Aberdeen Group, HP's share of the commercial RISC/UNIX server market was 52% in 1996, and its 34% revenue growth was 6 percentage points greater than that of the market overall.⁴



HP's commitment to UNIX

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² UNIX is a registered trademark in the United States and other countries, licensed exclusively through X/Open Company Limited.

³ The information contained in this paper presents both current aspects of, and future plans for, HP-UX. Such future plans are subject to change without notice.

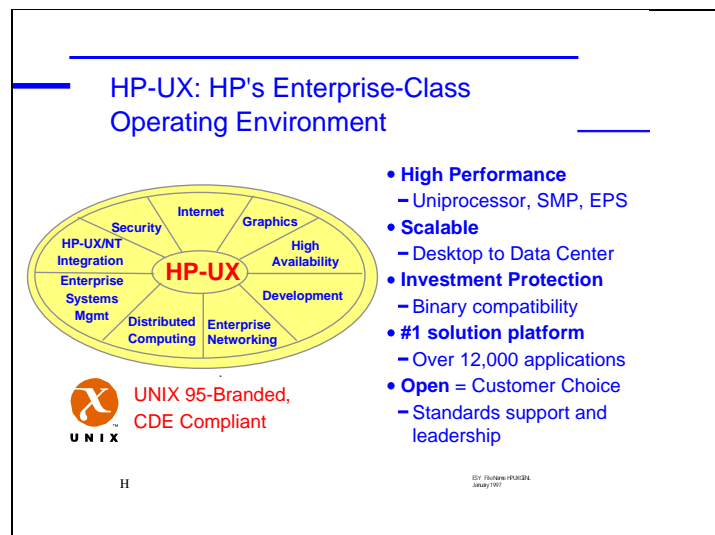
⁴ Aberdeen Group, *Market Viewpoint*, Volume 10/Number 1, February 3, 1997

HP's commitment to UNIX and HP-UX in particular is very strong indeed. Indicative of its commitment to HP-UX, HP spends several tens of millions of dollars annually on the development of HP-UX and related application software, and over a thousand software development engineers are devoted to this effort.

In addition to its own commitment to HP-UX, HP has strategic relationships in place with several industry partners for technology sharing and exchange with regard to HP-UX. These partnerships, with Hitachi, NEC, and SCO, have the aim of further extending HP-UX's strengths in the high end of the UNIX market.

Overview of HP-UX

The number and breadth of value-add services associated with HP-UX merit its being referred to as an enterprise-class operating environment rather than just an operating system.

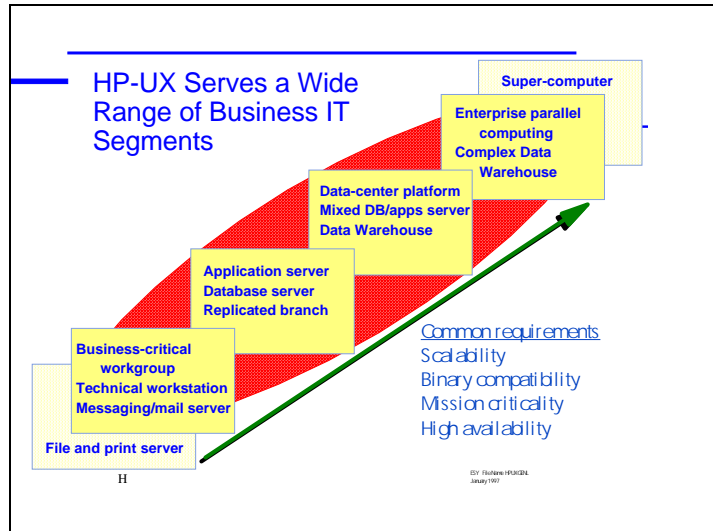


Key value-added features comprising the HP-UX environment include the following.

Extended HP-UX functionality	Specific elements
Security	B1- and C2-level security compliance; Praesidium: Authorization and Authentication server, Single Sign-On, Imagine Card, Virtual Vault
High Availability	MC/ServiceGuard, MC/LockManager, Journaled File System, Online JFS, Clusterview
Development Environment	SoftBench's fully integrated application development and HP's innovative optimizing compiler technology enable faster application performance.
Enterprise Networking	Ethernet, Token Ring, 100Base-T, 100VG-AnyLAN, FDDI, ATM, async, bisync, HIPPI, ISDN. TCP/IP, SNA, X.25, X.400, FTAM protocols. Advanced Server/UNIX, LAN Manager, NFS PV3, NIS+
Distributed Computing	Distributed Computing Environment (DCE)
Enterprise Systems Management	Industry-leading OpenView, Process Resource Manager (PRM), System Administration Manager (SAM), SD Software Distributor, Ignite/UX
HP-UX and Windows NT Integration	HP Colliance program provides smooth integration among HP-UX, Microsoft Windows NT, Novell Netware
Internet	HP-UX bundles Netscape FastTrack web server, Oracle's Web Application Server, Java (Virtual Machine, Developer's Kit, and Just-In-Time compiler), and Novell NDS. In addition HP-UX uses the most current standards for ELM, BIND, and SendMail.
Graphics	Industry-standard OpenGL, PHIGS

Performance and scalability

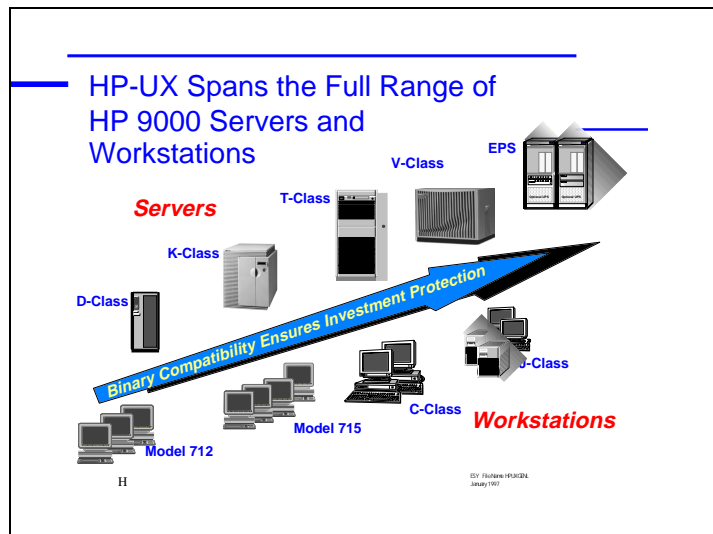
Beyond feature-specific attributes of the operating environment, HP-UX provides for considerable performance and scalability, from the single-user desktop to the main-frame-class Enterprise Parallel System (EPS). Evidence of HP-UX's scalability is its suitability for a broad range of business IT environments, from large NFS servers to very high-end computing environments, as shown by shaded rectangles.



HP-UX currently scales from 1 to 14 CPUs. HP-UX 10.20, the latest version shipping, has a number of prominent examples of scalability. It supports very large individual files and file systems up to 128GB, spanning numerous disks as necessary. It supports up to 2 billion user IDs, which can, for example, enable the assignment of a user ID to individual customers or part numbers.

64-bit HP-UX 11.00, discussed later in this paper, will enable vastly larger applications and data sets to reside in up to 4TB of RAM. Its heightened scalability will enable support of 16 CPUs, which will rise to 32 CPUs in HP-UX 11.0x.

In terms of specific hardware products, HP-UX spans HP's enterprise server and workstation product lines, as shown in the diagram below.



Investment protection

Investment protection has been a hallmark of HP-UX since it was first introduced in 1986. Over time, customers can spend up to twice as much on software as they do in hardware, in terms of people and dollars, and they want to be able to protect their substantial investments in applications software. HP-UX has the strongest record in the industry for providing application investment protection through forward binary compatibility, in which a fully-bound application developed on an earlier or current version of HP-UX is ensured to run smoothly on future versions of HP-UX. As a result, customers' investments in application software is protected by extending the useful life of that software across several versions of HP-UX.

Breadth of applications portfolio

HP-UX is the number one solutions platform in the UNIX market, with over 12,000 applications running on HP-UX developed by independent software vendors (ISVs). Customers can confidently choose HP systems, knowing that they have a breadth of business-critical applications available to apply to business needs throughout the enterprise.

It is impractical to show HP-UX's standing for all 12,000 of these applications. However, as the figure below shows, HP-UX is the overall leading platform for the three leading database vendors. It is the #1 platform for Oracle and Informix by a substantial margin, and is the second-highest platform for Sybase's sales.

HP-UX is the Overall Leading Platform for the Top 3 Database Vendors

Platform Share of Revenue (%)

HP #1 HP #1 HP #2

HEWLETT PACKARD Sun IBM digital SYBASE ORACLE Informix

Calendar year 1996 data, sourced from companies

HP

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HP's High Availability solution focuses on both increasing ROI and reducing the risks of loss of application availability and data corruption. HP's HA solution accomplishes these goals by clustering existing HP 9000 UNIX servers in end-users' IT infrastructure to provide application and data resiliency. A feature that is a standard part of HP-UX's robustness and memory fault tolerance, is called Memory Page Deallocation, which tests continuously for faulty physical memory. Should it detect same, it automatically prevents subsequent addressing, or use, of that failed RAM.

HP's clustering environment, MC/ServiceGuard, employs an auto-reboot facility for loosely coupled servers, so that if one server, which has been executing mission-critical applications, fails, several other production servers within the MC/ServiceGuard environment can pick up the extra workload.

Additionally, MC/ServiceGuard provides availability of mission-critical applications during hardware and software maintenance thus minimizing the need for unwanted planned down time. For example, operating system or processor upgrades for a server within a cluster can be done without having to bring down the cluster. Workload can be shifted to other clustered servers during these operations.

MC/ServiceGuard also monitors system processors, system memory, LAN media, LAN adapters, system processes and application processes, and it responds to failures in order to restore the application service to LAN-based clients in the matter of a few minutes. Other HA products from HP also ensure data availability, process management, on-line storage optimization, load balancing, etc.

HP's leadership in the UNIX clustered market is emphasized by services such as Critical Systems Support and Business Continuity Support, which are tailored to customers' availability needs. From availability of inventory to preventative maintenance, these services provide the proper level of responsiveness for customers' computing environments.

Standards

Openness and standards are the chief reasons for the growth of UNIX as a competitive alternative to proprietary mainframe computing environments. HP-UX leads the industry in the support and development of UNIX standards. It was the first UNIX to ship that is UNIX-95-branded⁵, as specified by The Open Group, the standards body⁶. HP-UX also complies with such industry standards as CDE, or Common Desktop Environment, HP-UX's windowing environment; POSIX; and over 70 others.

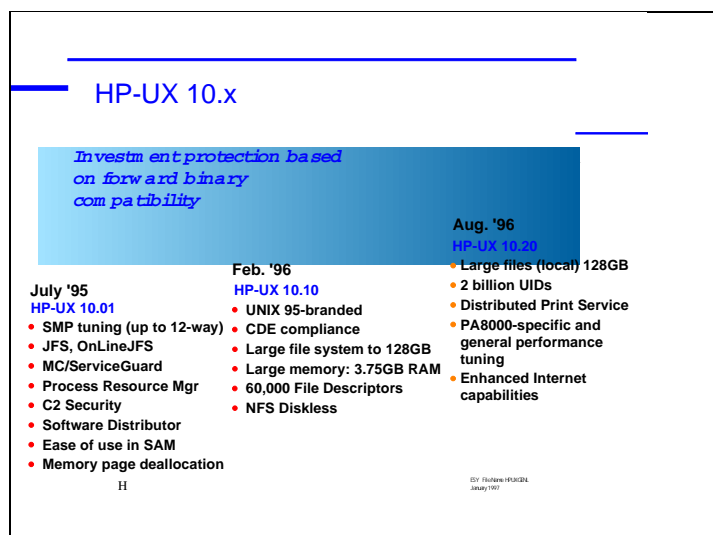
¹ ⁵HP-UX 10.10, released in February, 1996.

¹ ⁶See <http://www.xopen.org>

Beyond its commitment to standards adoption and compliance, by virtue of its leading presence in the UNIX server market, HP has played a significant role in the development of standards for 64-bit UNIX. HP's Software Distributor technology was the source of a new standard recently endorsed by The Open Group and other leading UNIX vendors that permits software platform replication and standardization.

Recent enhancements to HP-UX

During the past two years, HP has brought to market three new versions of HP-UX, comprising the 10.x family. Each is a functional superset of the previous, and all are forward binary compatible. The figure below highlights just a few key of the many new features of the indicated versions of HP-UX 10.x.



HP-UX 10.01

Released in mid-1995, HP-UX 10.01 introduced up to 12-way Symmetric Multiprocessing capabilities. Journaled File System (JFS), On-line JFS (OLJFS), Memory Page Deallocation, and MC/ServiceGuard provide for maximum high availability, a very desirable feature for mission-critical applications and environments. Process Resource Manager (PRM) allows a system administrator to allocate CPU resources to a given process. This is a capability unique to HP-UX that can contribute to greater performance.

HP-UX 10.10

Version 10.10 incorporated the important standards of UNIX-95 and Common Desktop Environment. In addition, it added the first installment of 64-bit functionality in an evolutionary manner, with large file system size of up to 128GB.

HP-UX 10.20

HP-UX 10.20 maximizes the performance of PA8000 and -8200 servers and advanced compilers. HP-UX 10.20 extends large file-system functionality introduced

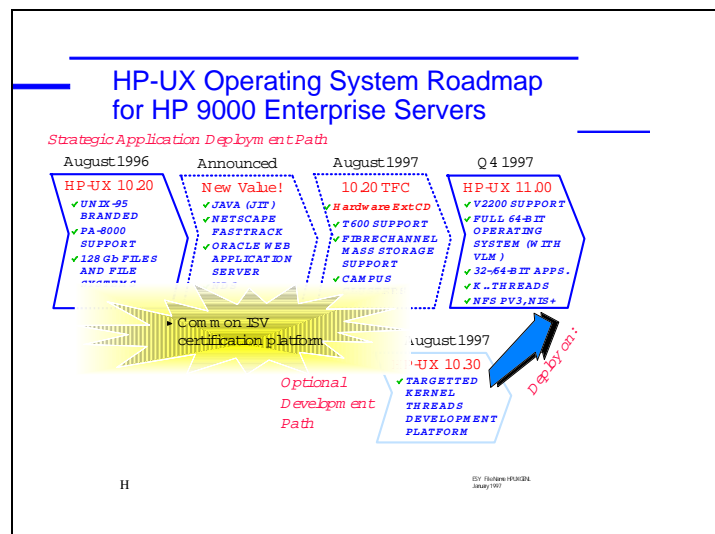
in HP-UX 10.10 to large single file size, also of 128GB. It also supports the industry's most advanced high-availability environment, and provides for strong HP-UX/NT integration. In addition, it extends PRM capabilities to control RAM resources among processes, which can contribute to performance gains.

Like its predecessor, HP-UX 10.20 is also UNIX-95-branded. Having been on the market since August 1996, it benefits from wide deployment in a large customer base and extensive portfolio of ISV applications. It incorporates standards-based Distributed Print Service, and enhanced Internet functionality, by virtue of its bundling of Java, Netscape FastTrack, and Oracle Web Application Server.

HP-UX 10.20 is an ideal strategic development environment for most (i.e., non-kernel threaded, 32-bit) applications. It also serves as HP's strategic deployment environment until 64-bit HP-UX 11.00 reaches the market in the fourth quarter of 1997.

HP's near-term plans for HP-UX

HP has ambitious plans for HP-UX's future. For convenience, we will split discussion of these plans into the near-term, i.e., through the end of 1997, and two to three years thereafter. Through the end of 1997, HP's plans for HP-UX are indicated in the figure below.



Extensions to HP-UX 10.20, Q397

HP will extend the functionality of HP-UX 10.20 to allow it to support the new T600 server and the new Fibre Channel information storage products. This change will make it easier for customers to take earliest advantage of the high-end performance of the T600 server and the dramatic bandwidth and performance improvements of Fibre Channel. Since the 10.20 release is already supported by a broad portfolio of ISV

applications and is in wide deployment at customer sites around the world, customers will be able to immediately leverage these products.

HP-UX 10.30, Q397

HP-UX 10.30 will be offered as an optional development path for the development and testing of kernel threads applications, with HP-UX 11.00 designed to serve as the strategic development and deployment environment for 32-bit threaded applications.

HP-UX 11.00, Q497

HP-UX 11.00 will be HP's first implementation of 64-bit HP-UX. As such, it will enable the processing of much larger applications and data sets, by virtue of the tremendous increase in scalability afforded by 64-bit computing.⁷

HP-UX 11.00 includes a full 64-bit kernel based on the *de facto* industry-standard LP64 data model. There is a full 32-bit and 64-bit development environment included within 64-bit HP-UX 11.00. Thus customers can keep their servers at the same (HP-UX 11.00) OS level, and can access new, non-64-bit, functionality. A 32-bit version of HP-UX 11.00 will also be available for customers who do not want to take advantage of the extensibility of 64-bits. 64-bit HP-UX provides support for significantly more than 16 GB of physical memory (RAM), 8 terabytes (TB) of shared memory (used for databases or thousands of client connections, for example), and 4 TB of per-process dataspace (used for large in-memory model manipulation, for example).

For heightened performance and scalability, HP-UX 11.00 will support HP's new high-end V-class server, based on the PA-8200 processor, and will support up to 16 processors in a symmetric multiprocessor (SMP) configuration. HP-UX 11.00 will support variable memory page size, which can result in a performance gain over fixed-size pages. In addition, 11.00 will support NFS PV3 and NIS+.

HP-UX 11.00 will serve as both the strategic development and deployment environment for both 32- and 64-bit applications. As outlined in the white paper cited earlier, HP-UX 11.00's ability to run 32- and 64-bit applications has the important dual benefits of investment protection of customers' 32-bit applications, and performance optimization.

The table below compares some of the features and specifications of the 10.x family of HP-UX with 64-bit HP-UX 11.00.

¹⁷ HP prepared a white paper on 64-bit computing and its strategies for 64-bit HP-UX, which is available at <http://www.hp.com/gsy/software/64bit/64bitwp.html>


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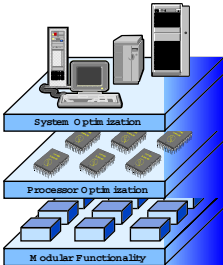
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January 1997

HP continues to rearchitect HP-UX with a unique, HP-developed three-dimensional architecture (3DA), with the goal of improving modularity, delivering full 64-bit scalability, ultra-high SMP, Non-Uniform Memory Access (NUMA), high-performance I/O, and optimization for the IA-64 architecture jointly developed by HP and Intel.

HP-UX's Unique UNIX Technology Architecture



A revolutionary three-dimensional architecture (3DA) which allows rapid innovation and extraordinary flexibility while maintaining compatibility.



The diagram illustrates the 3DA architecture as a three-dimensional structure with three distinct layers, each represented by a blue rectangular block. The top layer is labeled "System Optimization" and contains icons of a desktop computer, a monitor, and a printer. The middle layer is labeled "Processor Optimization" and contains icons of several microprocessors. The bottom layer is labeled "Modular Functionality" and contains icons of several modular components. The layers are stacked on top of each other, with the bottom layer being the base and the top layer being the highest. The entire structure is set against a white background.

HP-UX's Unique UNIX Technology Architecture

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Modularization entails separating the core operating system into basic building blocks, such as scheduler, memory management, and file system. These building

blocks or modules interact through well-defined internal interfaces. These interfaces ensure that modifications can be made to a module or that a module can be replaced without affecting other modules in the operating system. This makes possible much faster innovation and greater differentiation for products than for operating systems with monolithic kernels.

Processor optimization

The explosive growth in complexity and performance of micro-processor chip sets over the years is well known. Less well known is that most operating systems today seriously lag behind in exploiting the wealth of new features these chip sets offer. Typically, a new release of an operating system is optimized for one particular implementation of one chip set. That operating system may then remain unchanged for several years before a major new release takes advantage of the features in another, newer chip set. In addition, if the operating system must be portable across several different chip sets, the operating system may employ only the lowest-common-denominator features available in those chip sets.

The 3D architecture enables system designers to take full advantage of all of a processor's features, squeezing the maximum performance from the chip set. For example, functional modules may take advantage of new processor features such as frame buffer caching, on-chip audio/video hardware, or the Intel Merced's instruction parallelism. The operating system also can be quickly tuned to run on different chip sets. This ability to rapidly tap into the functionality of new chip sets will further encourage chip set designers to create even more innovative features. The result is increased functionality and value for end users.

System optimization

System optimization enables the functional modules to support specialized system topologies such as NUMA, loosely coupled clusters, or massively parallel architectures. It provides increased scalability and performance while maintaining application compatibility. Current architectures allow portability to these system topologies, but not optimization. With 3DA, users get both more choice due to portability and more performance due to cross-platform optimization.

Partnerships in force to enhance HP-UX

Beyond delivering 64-bit HP-UX, HP is teaming with other leading industry partners, such as Hitachi, NEC, and SCO, to bring exciting new features to HP-UX, while converging on a common standards-based set of APIs to ensure the broadest availability of applications.

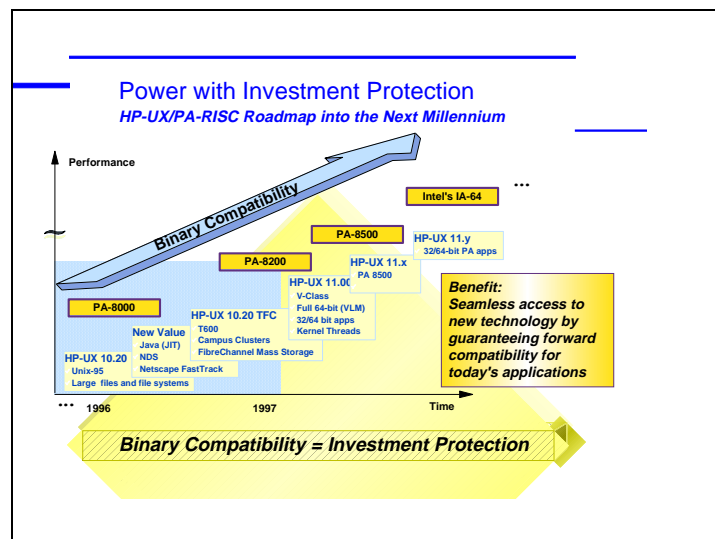
For example, HP and SCO are collaborating on the development of an extensive set of APIs, called the Lodi specification, that is intended to serve as a single target for applications developers. Roughly 4200 in number, the Lodi spec has been submitted

to X/Open for consideration as the basis for the anticipated UNIX 98 standard, an extension to UNIX 95.

The results of this and other partnerships will be versions of HP-UX that deliver even higher levels of scalability and performance by enabling configurations of up to 128 processors and beyond. These versions of HP-UX will also be more tightly integrated with the Internet and popular Internet applications, provide seamless interoperability with Windows NT, be more secure, and provide greater reliability and up time to meet the ever-increasing demands of organizations' mission-critical applications.

Longer-term plans for HP-UX

HP's longer-term plans for HP-UX, beyond version 11.00 (i.e., from 1998 on) are captured at a high level in the figure below.



Extensions to HP-UX 11.00 (2H 1998)

An extension to HP-UX 11.00 will be made to support PA-8500-based systems, in up to 16-way configurations. Most PA8x00-based HP 9000 enterprise servers will be upgradeable to the new PA-8500 processor.

HP-UX 11.0x (2H 1998)

This release will have a number of performance enhancements to improve online transaction processing (OLTP) and decision support systems (DSS), scalability and overall throughput by ongoing tuning to the various subsystems and compiler environments. HP is also planning to implement a first phase of NUMA in this release, to enable several systems to be clustered together and access a single shared memory image. Refinements to HP-UX included in this release include such high-availability enhancements as On-Line Addition/Replacement (OLA/R) of networking

and I/O cards, and the ability to install patches onto a running system dynamically, i.e., without bringing the system down and rebooting.

There are also plans to continue to add tools and utilities to HP's 1x1 kernel threads. SMP (Symmetrical Multi-Processing) will be extended to ensure smooth scalability to 32-way and beyond.

HP-UX and the year 2000

The year 2000 looms as a very significant IT issue, affecting the very core of organizations' computing systems. Fortunately, through 2000 -specific seminars and computer-related press, awareness of its importance has increased significantly during the past year.

Anticipating the need to properly address the year 2000, HP has implemented a series of strategies to assist customers in making a transparent transition to 2000 readiness. Beyond testing and verifying the 2000-readiness of HP9000 enterprise computer hardware for both workstations and servers, HP has updated three versions of HP-UX 10.x with patches to make them 2000-safe.⁸ Versions of HP-UX from 10.30 and thereafter will be year-2000-safe by design.

In addition, HP will make all of its applications software (such as Process Resource Manager, Online JFS, etc.) 2000-ready by year-end 1997. HP has prepared a white paper that describes its policies regarding the Year 2000; details the state of 2000 readiness of HP hardware and software products; and describes a comprehensive set of services HP has developed, called Cure 2000, to assist customers in making the year-2000 transition.⁹

Concluding remarks

HP-UX is the industry's leading UNIX, in terms of both present capabilities and planned future enhancements. In building next-generation UNIX technologies, HP and its partners are ensuring that customers' computing needs, ranging from the desktop to the data center, will be met well into the next century, with continued emphasis placed on performance and scalability, high availability, investment protection, and standards compliance.

¹ ⁸2000-readiness means that the software will correctly process dates after 1/1/2000. HP uses the X/Open standard for 2000 readiness, as described in X/Open's web page, <http://www.rdg.opengroup.org/public/tech/base/year2000.html>

¹ ⁹HP's Year 2000 white paper can be found at <http://www.hp.com/go/year2000>