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Compaq Computer Corporation

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Compaq Leadership in Server Innovations

Executive Summary

With Compaq's long history of innovations in the industry standards marketplace, it's easy to see why Compaq is the number one server for customers' needs. Compaq provided **more than twice** as many servers in the worldwide market than the nearest competitor in the first three quarters of 1997. Within seven years after server sales began, Compaq produced its one-millionth server. **This far surpasses volumes of x86 servers shipped by IBM, Hewlett-Packard, and Digital combined.** [1] These accomplishments illustrate that what customers require in industry standard servers, Compaq gives to them.

Compaq's server innovations began in 1989 with the Compaq Systempro, the server that was the prototype for Compaq's family of enterprise-based servers built on industry standards. Compaq's innovations continue with the current ProLiant server family, the first in the industry to integrate the latest technology, including PCI Hot Plug on selected models. Some major examples of innovations, which Compaq introduced to the standard-based server marketplace and have been widely adopted by customers include:

- **Compaq Insight Manager**
- **Compaq SmartStart**
- **PCI Hot Plug**
- **Intelligent Hot-Pluggable Power Supply**
- **Virtual Interface Architecture**
- **Fibre Channel**
- **I_2O Readiness**
- **Compaq Recovery Server Option**
- **RAID**
- **Redundant NIC Technology**
- **ECC Memory**
- **Next Generation Microprocessor and 8-way processor support**
- **Rack-Mount Design**[2]

Unlike commodity-based providers, Compaq offers flexible computing platforms today by driving the adoption of useful innovations for higher performance and higher availability into industry-wide standards. Compaq delivers systems that provide total value to the customer, unprecedented design and engineering technology, key management solutions, and strategic partnering to provide seamless integration. This approach is exactly what the customer demands from a world-class company. And this approach is exactly what the customer receives from Compaq.

[1] As of November 19, 1996 for x86 servers shipped 1994-1996. Source: IDC Report.

[2] Compaq technologies continue to evolve to maintain industry standards

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COMPAQ

OVERVIEW

Compaq is number one in providing customers solutions which match their needs. Compaq accomplishes this by providing servers which "innovate within the standard", providing advantages of standards-based computing with value-added enhancements. One way Compaq shows its commitment to innovation includes its involvement in technology. An example is Compaq's patent growth for 4Q97, which was over 32%.

Customers have recognized and rewarded Compaq's superior innovations by buying one million servers after seven years of server sales **far surpassing volumes of x86 servers shipped by IBM, Hewlett-Packard, and Digital Equipment Corp. combined as of November 19, 1996.**[3] These server sales illustrate Compaq's leadership in delivering server products that best meet customer requirements.

COMPAQ SERVER EVOLUTION: THE COMPAQ SYSTEMPRO TO THE COMPAQ PROLIANT

Compaq has historically focused on the growing demands for client/server technologies and their benefits to customers. In 1989 the Compaq Systempro, the first standards-based multiprocessing server, led the growing client server revolution for the enterprise environment. Building on its technical expertise and customer focus, Compaq's creative server innovations continued in 1992 with the SystemPro XL and ProSignia families and in 1993 with the Compaq ProLiant families. The SystemPro XL was the world's fastest PC server and the ProSignia family set a new price:performance standard for the PC server industry. The ProLiant servers, a class of database and application servers, were the first of their kind to provide customers with a tested, proven, and optimized database platform.

Progressing with industry standards, in 1996 Compaq introduced the Compaq ProLiant 5000 family of servers that included dual-peer PCI bus architecture and redundant Ethernet fail-over (NIC) technology on industry-standard architecture. The two current ProLiant servers, ProLiant 6500 and ProLiant 7000, offer the newest in industry standards including the PCI Hot Plug and Intelligent Hot-Pluggable Power Supplies. The ProLiant family focuses on a common set of architectural consistencies including Compaq Insight Manager and SmartStart that guarantee ease of operation, service, and training, and other benefits which result in value for the customer. These consistencies were developed in 1993 and have been built upon through today.

Since the beginning, Compaq focused on driving innovations to meet customer requirements. The following chart illustrates Compaq's historical progression of industry standards:

[3] Numbers correspond to x86 servers shipped 1994-1996. Source: IDC Report

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Compaq Innovations Timeline

	PERFORMANCE	HIGH AVAILABILITY	MANAGEMENT TOOLS/TCO
1989	Multiprocessing x86 server on multiple OS's EISA as a standard I/O bus in servers	32-bit Intelligent drive array controller	
1990	486 SMP		Software management tools for x86 servers
1991			First standards-based x86 server management tool – Compaq Insight Manager Remote hardware management board for x86 servers
1992	Pentium SMP TriFlex and DataFlow Manager	Pre-Failure Warranty Automatic Server Recovery Dual-channel array controller designed for x86 servers	Integration of Insight Agents with third party management consoles SNMP-Compliant
1993		One of the first with hot-pluggable drives in x86 servers	SmartStart bootable CD-based OS and server integration tool
1994	X86 servers with 1GB memory Server-optimized PCI architecture	Redundant power supplies	SmartStart support for database software integration and tuning Advances in Insight Manager – Asynchronous Management and VersionControl Rack Mount Servers and Rack Builder
1995	Modular 10/100 NIC Pentium Pro-based servers Published the first 4-way Intel TPC-C (OLTP) benchmark Published the first NT TPC-C benchmark	Industry-standard clustering in x86 servers Redundant NIC	Intelligent Manageability became standard for desktops, portables SmartStart Replicated Install
1996	Support for 4GB memory in x86 servers Dual-peer PCI Only company to publish TPC-C benchmarks for all 4 major database vendors on NT		Integration Server for software management support Insight for OpenView/TME10 NetView – "plug-in application for enterprise management consoles Integrated hardware for remote management (IRC) Remote Insight Board
1997	First TPC-D results for a system under $1,000,000 First to publish a 100GB TPC-D (DSS) on NT First to publish a 100GB TPC-D with total system cost under $500,000 Highest TPC-C benchmark perform. ever achieved in a four-way x86 SMP under $40 First to break $100 per TPC-C Highly Parallel System Architecture	PCI Hot Plug Redundant, hot-pluggable fans	Servers with in-chassis upgradability to next generation Intel Architecture Info Messenger - Customized, proactive web-based notification of Compaq support software updates Integration modules for management of Compaq servers and clients with leading management software

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HOW COMPAQ INNOVATIONS PROVIDE CUSTOMER BENEFITS TODAY AND IN THE FUTURE

Compaq, not content to rest on its accomplishments, commits to continually enhancing its servers to meet evolving customer needs today and in the future. Compaq first marketed and built upon industry standards. Compaq's integration labs, testing facilities, and design criteria also provide expertise that drives development of highly reliable, innovative server platforms that best meet customer requirements. In addition, Compaq conducts operating system certification for Compaq servers and workstations. From these engineering proficiencies, Compaq has a multitude of innovations that give customers what best meets their requirements.

The following examples include major technological innovations that provide Compaq customers with key advantages. These innovations will serve as a foundation for tomorrow's cost-effective, standards-based computing infrastructure:

- **Compaq Insight Manager** - is Compaq's system management tool that addresses three critical server management needs: configuration, performance monitoring, and fault prediction.

  Key Benefits - Insight Manager 3.50 combines outstanding scalability with the most robust features set in the industry to allow administrators greater control and flexibility. Compaq's Insight Manager 3.50 consists of two components: a Windows-based console application and server- or client-based management data collection agents.

  Compaq Advantage - Insight Manager 3.50 provides several configuration reporting options including Insight Version Control that compares the systems' drivers, firmware, and utility versions on a server to a reference platform that is constantly upgraded with the most up-to-date version available from Compaq. Insight Manager's examples of real-time performance monitoring and graphing include CPU, PCI, and EISA bus utilization as well as NIC throughput. And Insight Manager's predictive parameters, coupled with its trend analysis capabilities, can predict impending failures of many components such as NIC cards, the CPU, memory, and SCSI drives. In addition, Insight Manager uses SNMP to provide full management functionality for Compaq servers and can communicate with any management platform, including HP's OpenView, BMC's Patrol, and TME 10 Netfinity.

- **Compaq SmartStart -** is Compaq's intelligent integration tool that simplifies the process by automatically installing and configuring Compaq systems. SmartStart assists users and resellers in successfully setting up new servers by incorporating the integration knowledge gained through thousands of hours of testing Compaq hardware with its partners' software products. [4]

  Key Benefits - This tool offers the shortest path to a proven and tested server configuration. SmartStart efficiently deploys new systems based on internal standards and proven, reliable server configurations, and ensures software compatibility. Another key benefit is Replicated Install, a powerful new tool that reduces the time required to install and configure software across multiple servers, saving customers time and money when deploying Compaq systems.

- ***Compaq Advantage*** - SmartStart benefits offer superior cost and performance benefits compared with others companies' software management tools. Automated installation means rapid deployment. Customers can also have confidence that their system is installed and configured correctly.

[4] Refer to White Paper *Compaq SmartStart*, Doc. No. 703a/0297 for more information.

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- **PCI Hot Plug -** an industry standard technology of which Compaq led the development, allows a systems administrator to change a PCI peripheral board in a server without interrupting user service by powering down the server. The systems administrator can replace existing PCI Boards with the same or with new versions of the board and driver software, or can add new, previously uninstalled, board and driver software while the server is running.[5]

  Key Benefits - Increased data availability without having to purchase new server hardware. By bringing this technology to the industry as a standard, Compaq has made PCI Hot Plug accessible to a much broader customer base. Intel and others have also licensed Compaq's implementation of the PCI Hot Plug hardware, which once again demonstrates Compaq's technology leadership of useful innovations in the computing industry.

  Compaq Advantage - Compaq is the first company to market PCI Hot Plug as an industry standard. Other companies' systems without PCI Hot Plug technology may result in costly downtime.

- **Intelligent Hot-Pluggable Power Supply (IPS)** - enables a server to communicate more intelligently with the power supply, providing much more pertinent status information. In addition, an IPS allows the system administrator to troubleshoot more effectively when problems arise, and, in some cases, prevent problems or downtime from occurring at all. In addition, an IPS automatically performs several key functions that ensure the most efficient use of resources.[6]

  Key Benefits – Increased reliability due to self-test and load balancing, increased availability due to N + 1 redundancy and hot plug capability, longer life due to load balancing, greater and easier manageability, flexibility of configuration, and flexibility of shut-down sequence.

  Compaq Advantage – In servers with traditional power supplies, power switches connect directly to the power lines. As a result, if the switch is accidentally turned off, power immediately disconnects from the system, which could disrupt functions and cause loss of critical information. With Compaq's exclusive IPS, the power switch connects to a microcontroller, which ensures a proper shutdown of the system.

- **Virtual Interface (VI) Architecture -** is a distributed messaging specification that provides an open architecture promoting clustered computing with a transport layer and Application Programming Interface (API) for message passing. This specification can be utilized by software and hardware vendors to provide high speed and low latency communications between servers in a System Area Network (SAN).

  Key Benefits - VI Architecture is designed to be hardware independent and compatible with current network protocols such as Ethernet, ATM, and ServerNet. This ability to rely on existing communications adapters and media will help migrate existing protocols to VI Architecture. Since VI Architecture is also processor independent, it will allow the architecture to be implemented into silicon, therefore further improving communication performance. VI Architecture also reduces or removes the protocol stack(s) for send/receive and read/write for applications, thus removing a large percentage of operating system and server processing overhead for functions such as LAN and WAN packetizing and depacketizing. This architecture provides customers high degrees of application and data availability as well as increased application performance. In addition, scalability is enhanced by partitioning the application(s) into more efficient subprograms executing on different clustered nodes and passing dynamic information only as required to complete the transaction(s).

[5] Refer to White Paper *PCI Hot-Plug Technology*, Doc. No. 398a/1196 for more information.
[6] Refer to White Paper *Intelligent Power Supply Technology*, Doc. No. ECG025.0897 for more information.

Compaq Advantage - Compaq has taken a leadership role in creating and defining VI Architecture. Compaq, Intel, and Microsoft Corporation developed primary work on the VI Architecture specification. This initiative illustrates Compaq's drive to build upon industry standards and to provide the enterprise level computing platforms and performance that enterprise customers demand.

- **Fibre Channel** - is a key technology for the system interconnect, the serial drive interface and high-speed networking in delivering bigger, faster, more reliable network data storage solutions. It provides opportunity for the integration of primary and secondary storage as well as shared storage between multiple users.

  Key Benefits - Fibre Channel's performance is 10 times faster than fast SCSI, 5 times faster than Fast-Wide SCSI, and 2 l/2 times faster than Ultra-SCSI. Its performance is unmatched.

  Compaq Advantage - Compaq is the world's second largest storage vendor. Compaq's Fibre Channel Storage System will be the first of a new generation of storage products based on Fibre Channel technology. Through an early access program, Compaq currently has hundreds of Fibre Channel Storage products in evaluation at leading companies and partners around the globe. Compaq's Fibre Channel Storage System will also provide greater availability for business critical systems through support for cluster server solutions such as Microsoft Cluster Server (MSCS). IT departments that expect rapid growth in storage capacity will benefit from the superior manageability, backup, storage consolidation, and scalability of Fibre Channel solutions. The recent partnership between Compaq and Hewlett-Packard Components Group (HPCG) enables the two organizations to share interoperability information in order to establish Fibre Channel as a stable platform for highly reliable, high-speed storage applications–making it easier for customers to adopt the Fibre Channel interconnect as an industry standard.

  Compaq is one of the sponsors of the American National Standards Institute (ANSI) Committee responsible for developing the Fibre Channel standards. Fibre Channel technology will deliver higher reliability, greater capacity, and higher performance than those servers with traditional SCSI solutions.

- **I_2O Readiness** - The I_2O Initiative defines a standardized general architecture for intelligent I/O. Its basic objective is to provide an industry-wide I/O subsystem architecture that is independent of both the specific device being controlled and the host operating system.[7]

  Key Benefits - The potential benefits of I_2O products will be more consistent OS support, a shorter time to market for new products because of reduction in the number of drivers needed, greater OS stability, and potential improvements in overall system performance through lower host processor overhead. The I_2O Initiative also provides increased system scalability with the ability to run more devices per server.

  Compaq Advantage - Compaq was first to introduce server-optimized intelligent I/O and memory architectures and continues to produce leadership intelligent I/O adapters such as the SMART-2 array adapters. Compaq delivers its I_2O solution in a flexible, scalable architecture that will allow customers to scale the performance and functionality of the I/O in their servers. As one of the original members of the I_2O Steering Committee, Compaq's extensive experience and leadership in developing intelligent I/O solutions can be used to help advance a unifying standard for eliminating potential I/O issues of the future.

- **Compaq Recovery Server Option** - is a low-cost option, which can be configured in either of three ways, providing protection against specific server component failures or even

[7] Refer to White Paper *Intelligent I/O and the I_2O Initiative* Doc. No. ECG040.1097 for more information.

complete server failures. The options include Standby Recovery Server (SRS), On-Line Recovery Server (OLRS), and On-Line Storage Controller Recover Option (OSCRO). Each of these configuration options provides fully automated detection of failures and fully automated recovery within a minimal amount of time. Each of these configurations can be implemented in Microsoft NT Server Standard Edition or Novell NetWare environments.

Key Benefits - *Standby Recovery Server:* With Standby Recovery Server, one ProLiant or ProSignia server stands by as an idle backup for the other. Both servers are attached to a common set of ProLiant Storage Systems holding a single copy of the operating system and data. If the primary server fails, the recovery server automatically boots and brings users back on-line in minutes. This configuration offers increased system and application availability and affordability. In this SRS configuration, failover is uni-directional, from the active server to the standby server.

On-Line Server Recovery (OLRS): With OLRS, two ProLiant or ProSignia servers are concurrently active, processing independent workloads. Each server acts as a backup for the other. In the event of failure of either server, the failure is automatically detected and workloads are automatically transferred to the other server in the cluster, where the applications are re-started , returning full productive services to end users. In this OLRS configuration, application failover is bi-directional. Benefits include increased system availability, fully automated switchover, the ability to pair independently operating servers with identical or different hardware configurations, the ability to schedule server maintenance at a convenient time, and low cost.

On-Line Storage Controller Recover Option (OSCRO): is an automatic failover system for single-server environments that provides storage controller redundancy, automatic recovery from storage controller failure, and higher data availability at a cost-effective price. In an OSCRO configuration, two SMART-2 array controllers are linked into a pair using the OSCRO software. One controller acts as a hot standby for the primary controller. In the event of a failure of the primary controller, the access and control of the storage subsystem automatically fails over to the standby controller, providing a continued connection with no loss of data availability. OSCRO offers redundancy at the controller level, providing very high data availability at a very low cost.

Compaq Advantage - Compaq was the first company in the industry to offer low cost, highly effective solutions for automatic recovery from controller and server failures in the NT Server and Novell environments. The Recovery Server Option has been available since May 1995 and is currently installed at over 8,000 customer sites worldwide, making it a recognized leader in High Availability clustering solutions.

- **RAID -,** Redundant Array of Inexpensive (or Independent) Disks, is a way of storing data across several drives to improve performance and/or provide fault tolerance. If one drive on a system fails, its data will be reconstructed from the other drives in the array. Compaq offers two distinct array controllers to cover the spectrum of business needs: the SMART-2DH Array Controller and the SMART-2SL Array Controller.

  Key Benefits - The ***SMART-2DH Array Controller*** offers performance, fault tolerance, and capacity expansion. Customers can add the SMART-2DH controllers up to the number of available PCI slots in their servers. Online expansion keeps information accessible even as customers add storage. The array accelerator is also removable. The ***SMART-2SL Array Controller*** provides investment protection and a low cost solution for implementing RAID technology. Customers can also easily upgrade to the SMART-2DH controller.

  Compaq Advantage – Compaq was the first company with RAID controllers in the x86 server marketplace. Compaq was also the first to put write cache on the controller, to introduce fast SCSI, hot-pluggability, and a fast, full-speed PCI bus with online expansion of

RAID. The SMART-2DH Array Controller's online capacity expansion and configuration means scalability without server downtime. The SMART-2SL Array Controller is industry leading in price:performance.

- **Redundant NIC Technology -** is a network interface controller (NIC) technology that eliminates downtime without any loss of service due to failures of the network card or adapter. Compaq servers support a second network controller that is installed as a standby NIC.[8]

  Key Benefits - The redundant NIC technology provides automatic fail-over to a standby NIC. The standby controller assumes operation without any loss of service.

  Compaq Advantage- Compaq was the first in the industry to offer redundant NIC technology on industry-standard architecture. Few competitors offer redundant NIC technology, which may result in costly downtime and loss of service for their users. Used in combination with Compaq servers, which support PCI Hot Plug, redundant controller technology can provide automatic and unattended fail-over and controllers can be replaced online without taking the server down.

- **ECC Memory -** ECC (Error Checking and Correcting) Memory ensures the highest degree of system protection from memory errors. Compaq includes ECC Memory in its line of mainstream servers and Advanced ECC Memory standard in its high-availability servers to provide protection from memory errors.

  Key Benefits - An ECC Memory scheme improves error detection and adds the capability to correct some errors. ECC Memory can detect and correct single-bit memory errors. Advanced ECC Memory adds all the protection of ECC Memory plus the ability to correct adjacent double-bit errors.

  Compaq Advantage - Compaq's ECC Memory provides a greater level of data integrity for all network environments while maintaining competitive prices. Compaq engineers have designed and integrated this ECC logic into the processor boards. This design provides higher system availability for the most mission-critical environments.

- **Next-generation microprocessor and 8-way processor support –** Compaq is prepared to deliver the performance and power of standards-based 8-way technology based on Intel's Deschutes/Slot-2 processor, the Corollary Profusion architecture, and its own innovative engineering. Compaq's ProLiant 7000 is designed with specific power supplies, cooling and mountings to provide 8-way upgrade paths.

  Key Benefits – Customers can invest in a 4-way Pentium Pro system today and upgrade to the headroom and performance provided by the Deschutes processors. By planning in advance for the Deschutes/Slot-2 and 8-way requirements, Compaq engineered the ProLiant 7000 power supplies, thermal capacity, and chassis with extra headroom to accommodate the additional load. These systems will support a faster 100 MHz system bus, larger secondary cache size (>512K), and a faster, full-speed internal cache bus.

  Compaq Advantage - Because Compaq develops and designs its own systems and systemboards, it can control the upgradability of its servers, unlike OEMs. Compaq has designed upgrades for the ProLiant 6500 and 6000 to support the Deschutes requirements. In addition, Compaq's ProLiant 7000 offers upgrade paths for 8-way processors. Compaq is leading the charge in developing standards-based 8-way processor scalability. This will provide customers with true value of their current servers with the emergence of the Deschutes/Slot-2 processor while protecting their existing investment in server hardware. The 8-way servers that are based on the current Pentium Pro architecture provide inadequate

[8] Currently, ProLiants 3000, 5500, 6500, and 7000 offer standard Redundant NIC support.

price:performance, limited scalability, and multiple transitions without a strong price:performance payoff.

- **Rack-Mount Design -** Compaq's leadership in industry standard-based products resulted in its design of a true rack-optimized server to give customers greater utilization of space and greater serviceability. Compaq's design, requiring minimal floor space, allows customers to readily install servers in a variety of locations, even where space is at a premium.

  Key Benefits - Compaq's rack-mount designs increase manageability, flexibility and security. Network operations can be centralized into one location near the 24-hour support.

  Compaq Advantage - Compaq had a three-year lead advantage providing rack-mounted server industry standards of 19-inch racks over x86 machines from other vendors including Hewlett-Packard and IBM. Compaq simplifies customers' rack enclosure decisions by offering three racks: a 42U, a 36U, and a 22U and a full suite of rack accessories that provide a lower cost of ownership. Customers are able to integrate up to 14 servers into a single cabinet.[9] The leadership in rack designs continues with Compaq's Rack Builder, an automated tool to facilitate rapid planning and prototyping of racks by ensuring that all required parts are included.

COMPAQ DRIVES STANDARD VALUE TO CUSTOMERS

Compaq's long successful history of innovations that have been driven to industry standards proves that this company is listening to its customers. Compaq designs useful product innovations, solutions, and strategies not only because it can, but also because it provides a better product for its customers than commodity-based providers.

Compaq's solution to customer needs is systems built on industry-standard technology that are powerful, yet relatively easy to install and operate, are delivered through channel partners, and are supported by a virtual organization of Compaq's service operations and those of third-party service providers.[10]

"Today's customers want open, industry-standard systems that perform at the level of proprietary RISC/UNIX systems but that deliver more value, flexibility, and adaptability to changing business cycles," said John T. Rose, Senior Vice-President and Group General manager, Enterprise Computing Group, Compaq Computer Corporation. "The business model of the proprietary RISC/UNIX systems providers has traditionally been a high margin, yet high cost business. But Compaq is a different breed of systems company. We start with a highly efficient cost structure, invest our engineering prowess in broadly accepted standards like Windows NT, Pentium Pro . . . then bring the best ingredients from the best partners into powerful platforms that are seamlessly integrated with the application and network for confident deployment throughout the customer's organization."

Compaq steers away from the commodity-based provider prototype. Instead, Compaq pushes the industry-standard base through innovation, seamless partnerships, leading management solutions, and a customer focus. With its unparalleled archetype of unique architecture design and technology, Compaq provides ample opportunity to drive its products to industry standards over the commodity-based providers.

By basing products on industry standards, Compaq gives customers the best price:performance value and the broadest array of possible solutions available for deployment. By delivering

[9] For example, 14 ProLiant 850Rs can fit in a 42U rack

[10] Whiting, Rick. *Compaq: The 'Virtual' Partner*. Client Server Computing, January 1997

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products based on x86-compatible architectures that use the industry-standard operating systems, Compaq also offers the most flexible and adaptable computing platforms today as compared to the commodity-based providers.

"I'm pretty well convinced that the RISC/UNIX proposition can no longer hold," Rose said. "It's never delivered on its promise; it's not adaptive to changing business cycles; it's economically not feasible; it's highly proprietary; and it's not open. We've got a better value proposition."

Summary

Compaq has a long tradition of taking its innovations to industry standards. From the Compaq Systempro to the Compaq ProLiant family, Compaq engineers its products from the ground up using industry standards. Not content with resting on its accomplishments, however, Compaq continues to lead the server market with other recent innovations including PCI Hot Plug and Virtual Interface Architecture. Compaq's history in developing and adhering to industry standards has made it the **WorldWide Leader in Server Technology.**