WHITE PAPER

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Compaq Computer Corporation

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Compaq Servers: Enterprise Class Systems Leading the Way to Deschutes and Merced

Executive Summary

Today's computing environments call for balanced systems that are built for high performance, high availability, and high scalability. They call for the flexibility and cost advantages of industry-standard platforms. And they call for advanced tools and services and integrated management solutions to help customers control their growing environment and lead the way to future technology. Today's computing environments call for a leader - and that leader is Compaq.

Compaq has a proven track record as a leader in server platforms. The company provides the highest levels of scalability in the industry on Intel platforms. Compaq also offers five levels of availability solutions in order to meet its customers' requirements. In addition, Compaq provides integrated management solutions and strong partnerships to ensure that its systems are the most manageable and cost-effective in customers' environments.

With leadership that delivers integrated, powerful, highly available and scalable platforms, Compaq is able to provide the newest technology to improve the performance and control of its systems. This new technology includes 8-way processing. Combining Compaq's own systems engineering expertise with Corollary's innovative Profusion architecture and Intel's next-generation Deschutes processors, Compaq is taking 8-way standards-based servers into the forefront of enterprise technology.

Compaq also plans a seamless transition to Intel's Merced 64-bit processor. Compaq will be the leading supplier of Merced-based products and expects to ships systems with Intel's first Merced production processor.

By effectively meeting customers' needs in the past with its industry-standard server platforms and committing to future customer needs with the next-generation technology, Compaq's track record as an enterprise class performer will continue to be unbeatable.

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NOTICE

White Paper: Compaq Servers: Enterprise Class Systems
Leading the Way to Deschutes and Merced

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INTRODUCTION

Nearly 2 million servers shipped. More than 1 billion transactions processed in one day. Providing more than twice as many servers in the worldwide market than the nearest competitor in the first three quarters of 1997. This is the Compaq story as a leader in providing server integration excellence.

COMPAQ SERVERS EQUAL INTEGRATION EXCELLENCE

Using the latest industry-standard technology and its own innovations, Compaq integrates high scalability, high availability, integrated management solutions, and total cost of ownership into every server it builds.

Scalability

Compaq provides the industry's highest levels of scalability on x86 platforms. In May 1997, Compaq achieved an enterprise computing milestone of more than 1 billion transactions per day–far exceeding typical transaction loads of the world's largest commercial mainframe systems. This demonstration shows the scalability of Compaq's systems to meet and exceed the most demanding business requirements and validates Compaq's decision to bring new levels of scalability to large enterprises using industry-standard platforms.

"Compaq is a leader in moving enterprise computing from yesterday's expensive, inflexible proprietary systems to today's cost-effective open environment," said Jim Allchin, Senior Vice President, Personal and Business Systems group, Microsoft. "Compaq is a key ally with proven expertise in developing and bringing to market scalable, high-performance solutions."

Price:Performance

Compaq's server architecture, designed from the ground up, balances processor and memory with the I/O architecture, which enables the company to uphold a tradition of leading price:performance. In October 1997, the Compaq ProLiant 7000 achieved the best transaction performance ever on a 4-processor Intel-based server running Windows NT on the TPC-C benchmark. The server performed **11,055 transactions per minute (tpmC) at just $39.25/tpmC** with four 200 MHz Pentium Pro processors running Microsoft SQL Server 6.5 Enterprise Edition and Windows NT Server 4.0 Enterprise Edition.*

The Compaq ProLiant 6500 has also set records. In September 1997, the ProLiant 6500, combined with Oracle 8.0.4, set stunning, record-breaking numbers for both query processing and price:performance in a decision support environment. The query processing number of 869.4 QppD raised the bar by an amazing 64 percent over the previous Windows NT record. The price:performance ratio number of $892.23 per QphD was below the $1,000 barrier for the first time, clearly making the Compaq/Oracle combination the most cost-effective Windows NT solution available. Most recently, the ProLiant 6500 was used in a record-setting 6-node cluster configuration with Tandem's ServerNet interconnect technology to achieve 27,383tpmC at $72/tpmC.*

* Refer to http://www.tpc.org for more details

High Availability

System performance is only part of the Compaq story concerning enterprise class performance. High availability is also required for database servers to support applications that are required to be available around the clock to support critical business needs. Compaq uses five levels of availability spanning a wide spectrum of availability requirements to design solutions tailored to each customer's environment.

- **Level 1 High Availability (HA),** currently available, is a realm characterized by single server configurations. Although these are single server environments, a lot of HA capability is built into Compaq servers to enhance uptime and minimize downtime, (e.g. redundant components, hot-swap components, etc.). Level 1 HA includes the standard subsystems such as Error Checking and Correction (ECC) memory, PCI Hot Plug, and Redundant NIC technology. Remote Insight Board, a highly intelligent remote management board providing continuous out-of-band communication and critical alert delivery, is also a Level 1 HA property. Remote Insight Board offers complete hardware independence from the server. With its own processor, memory, and battery backup, the board allows access to the server even if there has been a hardware fault or power loss. Thus, even though server components or the entire server have failed at a remote location, support staff at another location can dial into the server, ascertain the problem, and begin problem resolutions. As a result, server "health" is always known, and unplanned downtime can be greatly reduced.

  Combined with these hardware HA features, availability-enhancing software, such as system and network management facilities and anti-virus protection, are combined with good business practices such as security and appropriate training. In addition, appropriate services agreements are implemented, (e.g. improved response time).

- **Level 2** solutions, also currently available, are designed to increase data protection and to improve data availability. Compaq servers utilize hardware RAID technology such as Compaq Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.) drives, and SMART-2 controllers and drive arrays. Compaq further improved data high availability by recently delivering fibre channel-based storage solutions to the market, which results in non-disruptive growth. In addition, Level 2 solutions include On-Line Storage Controller Recover Option (OSCRO) that is an automatic failover option that protects from server failure, a failed array controller, or a failed external cable. Using OSCRO, these systems will automatically failover, providing redundancy without loss of access to storage.

- **Level 3** solutions build upon Level 2 data availability solutions and concentrate on delivering higher server and application availability for both planned and unplanned downtime. Level 3 HA is based on multi-server, cluster configurations, in which two or more servers are connected together for increased availability, or higher performance, or both. Cluster management software constantly monitors the health of each server. If either server experiences component or complete server failure, the cluster management software automatically detects the error or failure. Immediately and automatically, ownership of application software, disk and network resources is passed to the other node in the cluster, quickly returning complete services to end users. Such error or failure detection and application failover is fully automated; no operator intervention is required. Level 3 RSO Clusters are currently available.

  In addition to RSO Clusters already offered, Compaq will offer two new series of cluster products within the ProLiant Cluster family. Both of these new products utilize the Microsoft Cluster Server (MSCS) as the cluster software. The "Series F" supports a broad range of

ProLiant server models, in both matched-pair and mixed-pair configurations, and supports both Uniprocessor-Uniprocessor and SMP-SMP combinations. The Series F also offers a choice of either Ethernet or ServerNet as the server-to-server interconnect, and provides Compaq's industry standard fibre channel as the interconnect between servers and storage. There are currently over 14 certified configurations available. This number will expand as new servers and combinations are introduced. Compaq is the first company to receive certification on Microsoft's NT Cluster Server with a storage system based on the Fibre Channel technology standard.

The ProLiant Cluster/"Series S" solutions are also based on MSCS and support a broad range of ProLiant servers. S Series clusters are characterized by the use of SCSI technology as the server to storage interconnect, and support Ethernet as the server-to-server interconnect.

- **Level 4** of Compaq's availability involves scalability clusters that deliver increased performance and high availability. Each node in a scalability cluster is active on a separate "copy" of the same application. Since more than one node works on the same application, more computer resources can be applied to the same application, thus increasing performance. Also, since separate copies of the same application reside on all nodes in the cluster, a failure or crash of one node in the cluster will not cause an application outage. Recovery, therefore, is very rapid. Performance Scalability clusters are available now from Compaq for Unix, including Tandem Unix, and will be available in 1999 for NT.
- **Level 5** HA solutions, also known as Geographically Dispersed Clusters (GDC), are single clusters, a collection of servers connected by a very high speed interconnect and sharing a single heartbeat. In GDCs, the nodes of a cluster are distributed not merely building to building, as in a campus cluster, but city to city, or state to state, or region to region. In the event of failure, the automatic failover will then occur in not just node to node in the same room or building to building, but also city to city, state to state, and region to region, automatically returning compute services back to end users and allowing them to quickly return to full production work. This level of availability solutions will be available in the year 2000, if market demand develops.

Software Reliability

A recent customer satisfaction survey demonstrated that Compaq servers provide significantly higher software reliability than its closest competitors. Competitive servers were twice as likely to fail as a result of NOS or application software than Compaq servers.[1] This is not surprising given Compaq's extensive work with partners such as Microsoft, SCO, Novell, and others to ensure integration excellence of their software on Compaq platforms.

Integrated Management Solutions

In addition to unprecedented availability and scalability, servers also require integrated management solutions. Compaq delivers the right combination of management and integration tools necessary for establishing and maintaining optimized, consistent systems throughout a customer's distributed enterprise. Compaq's systems management strategy has four major components:

- Engineering manageability built into all Compaq products
- Advanced automation for integration and management
- Partnering with the leaders in systems management to enable broad management of all Compaq products

[1] Survey conducted by Research International, December 1997 (margin of error is plus or minus 10%).

- Focusing on the total cost of ownership by giving customers the best price:performance value and the broadest array of possible solutions available for deployment

Engineering Manageability

Compaq designs extensive manageability into its products, enabling fault prediction and alerting detailed asset and configuration inventory, and performance monitoring. More than 1,000 parameters are instrumented, all monitored by Compaq Insight Management Agents. These agents provide predictive failure alerts and access to management parameter values from a broad range of operating environments including Novell NetWare, Microsoft Windows NT and Windows 95, OS/2, and SCO UNIX and UnixWare.

Compaq Insight Manager

Compaq Insight Manager (CIM) is an intelligent management tool that constantly monitors and analyzes critical information for every Compaq server. It brings information to the customers and gives them the tools to respond. Customers can quickly and easily address problems before they become disasters–preventing downtime and costly data loss while saving customers time and legwork. Compaq's Insight Manager is also based on a 32-bit architecture, making it scalable and powerful enough to manage thousands of systems from a single console.

Compaq Insight Manager is a key component of the Integration Management process. CIM supports this process through the Integration Server Maintenance feature, which lets customers compare their current software versions with the latest software available from Compaq, and then recommends key updates. Customers can download the updates to their Integration Server, a central software repository, via the Internet, by modem, or from CD, so they have continual access to the latest versions but manage upgrades to meet their needs. And soon, Compaq will use the Internet to offer proactive, automatic notification of the latest revisions of Compaq software, firmware, drivers, and technical support information relevant to customers' specific network environment.

Comprehensive Server Management Includes Partnerships

Compaq is committed to adhering to industry standards and building strong partnerships with leading software vendors to ensure that its systems are the most manageable in a customer's environment.

Compaq Insight Manager gives customers the flexibility to manage Compaq servers from leading enterprise management platforms like OpenView for HP-UX and NetView for AIX. The CIM modules extend OpenView and NetView capabilities for managing Compaq systems. Also, to enhance existing management capabilities, Compaq has developed Compaq Systems Management Partnerships with industry-leading vendors such as BMC Software, Boole & Babbage, Cabletron Systems, Seagate EMS, and Tivoli Systems. These partners have enhanced their products to integrate Compaq Insight Manager information, making Compaq systems the most manageable in a customer's environment.

Total cost of ownership

As part of its value-add integration, Compaq is committed to high ownership satisfaction and lower cost of ownership. The total cost of ownership is the cost of the entire life cycle of IT solutions required to create a business advantage and includes not only acquisition price but additional factors such as support, administration, and technology refreshing costs. Compaq is committed to addressing the cost concerns of its customers across the entire life cycle of the solution. Compaq's value model has always been based on reducing the cost of computing

through the design and development of innovative, industry-standard building blocks, tools, and solutions.

THE COMPAQ CONNECTION TO NEXT-GENERATION PROCESSING

With its solid leadership in delivering the most flexible computing platforms, Compaq, together with its strategic partners, is able to provide a smooth transition to next-generation processor support, unlike other server vendors.

8-Way Technology

Compaq is set to unleash the power of highly scalable processors with 8-way technology. Compaq will offer 8-processor servers and clustered servers for customers who need the highest transaction processing power and highest levels of availability. The Compaq ProLiant 7000, a proven performance leader, is designed to migrate easily to 8-way technology. Combining Corollary's innovative Profusion architecture and Intel's next-generation Deschutes/Slot-2 processors with Compaq's own systems engineering expertise, Compaq will take 8-way standards-based servers into the forefront of enterprise technology.[2]

Compaq and Corollary

In the history of standards-based SMP machines, two companies have demonstrated a consistent vision and commitment to advancing SMP technology: Compaq and Corollary. Compaq and Corollary announced in early 1997 a technology exchange agreement to develop a standards-based 8-way multi-processing server. Corollary has designed an advanced memory controller for its Profusion 8-way architecture. Compaq is bringing its experience with I/O subsystems and PCI Hot Plug technology to enhance this 8-way architecture. Intel was so impressed with this jointly developed architecture, they recently purchased Corollary.

By entering this technology agreement, Compaq and Corollary are ready to take full advantage of the Deschutes/Slot-2 processor in SMP servers. The combination of Compaq's I/O design with Corollary's Profusion system controller and the next-generation Deschutes/Slot-2 processor by Intel will yield a balanced, high-performance 8-way system architecture for the first time. Intel has publicly endorsed the Compaq/Corollary architecture as **the** industry standard 8-way architecture.

Compaq Implementation of Deschutes Technology

By midyear 1998, Intel will deliver the next-generation Intel 32-bit (IA32) processor, code-named "Deschutes", offering two processors, Deschutes/Slot-1 and Deschutes/Slot-2. Based on the current Pentium II processing core, the Deschutes/Slot -1 is targeted for the mainstream server, mainstream workstation, desktop, and consumer markets while the Deschutes/Slot-2 will be optimized for high-end servers and is the right choice for 8-way systems. The benefits of Deschutes/Slot-2 systems over the current Pentium Pro and Pentium II Intel processors include support for a faster Intel 100MHz system bus, large secondary cache size (>512K), and a faster, full-speed internal cache bus.

The key differences between Deschutes/Slot-1 and Deschutes/Slot-2 processors include:

- **System Bus Speed:**

[2] Refer to Technical Briefs: *Compaq 8-Way Multiprocessing Architecture* Doc. ECG051.1197 and *8-Way Technology and the Compaq ProLiant 7000* Doc. ECG050.1097 for more information

- Slot 1: 66MHz and 100MHz
- Slot 2: 100MHz
- **Operating Frequency:**
- Slot 1: 333MHz on 66MHz system bus; 350, 400, and 450 on 100MHz system bus in 1998
- Slot 2: 400 and 450 on 100MHz system bus in 1998
- **L2 Cache Size:**
- Slot 1: Performance DT PC: 512KB
- Slot 2: 512KB, 1MB, 2MB
- **L2 Cache Speed:**
- Slot 1: 1/2 speed of processor core (same as current); on-die L2 cache: TBD
- Slot 2: Same speed as processor core (full speed)

Compaq Servers Designed for the Future

To take advantage of this next-generation technology and to allow a growth path for the future, Compaq engineers specifically designed the subsystems of the ProLiant 3000 with the flexibility to accommodate future needs for the Deschutes/Slot-1 processor and the ProLiant 7000 for the Deschutes/Slot-2 processor and for up to 8-way Deschutes/Slot-2 configurations. By planning in advance for Deschutes/Slot-2 and 8-way requirements, Compaq has been able to engineer the ProLiant 7000 power supplies, thermal capacity, and chassis with extra headroom to accommodate this additional load.

Customers should expect the following from Compaq systems and Deschutes processors:

- In-chassis upgrades for the ProLiants 6000, 6500, and 7000
- Performance benefits: 4-way Deschutes/Slot-2 400MHz will outperform the 8-way Pentium Pro for a smaller cost and with far greater processor longevity
- System bus speed up to 100MHz
- Processing core operating frequency - up to 450MHz on 100MHz system bus
- L2 cache sizes of 512KB, 1MB and 2MB

Other Companies' Choices

Currently, ALR, NCR, Axil, and Unisys (and others that OEM their products) all offer Pentium Pro-based 8-way servers, according to a Meta Group report. With 4-way Deschutes/Slot-2 systems offering equivalent performance to (if not greater than) 8-way Pentium Pro systems, user investment in >4-way Pentium Pro systems becomes tactical. These investments will be further marginalized; because of major differences in Pentium Pro and Deschutes/Slot-2, upgrading Pentium Pro-based servers will require at least entire system board replacements, if not an entirely new box. Further, given Intel's Corollary acquisition, Meta Group believes the majority of existing >4-way vendors will cancel proprietary 8-way Deschutes/Slot-2 plans. In other words, vendors who are not using the Intel 8-way architectures will run the risk of not adhering to widely adopted standards.

There are several other common potential weaknesses to these competitive architectures including transitions requiring significant engineering, memory controller problems, incompatibility with the Intel 450NX chipset, and no support for delayed transactions with the Intel 450NX host-to-

PCI bridge. Compaq's decision to combine its I/O design with Corollary's memory subsystem and the next-generation Deschutes/Slot-2 processor by Intel is clearly the right one. With the Pentium Pro soon to reach its natural end of life, the Compaq/Corollary/Intel combination will yield a balanced, high-performance system architecture for the future.

Compaq Implementation of Merced Technology

Compaq is prepared to develop innovative and optimized industry-leading systems for the Intel Architecture (IA)-32 architecture to provide a clear and straightforward migration path to Intel's Merced microprocessor generation, the first true 64-bit member of the IA family. Merced processors, expected to be delivered sometime in 1999, will run all software that currently operates on 32-bit Intel processor-based machines. Compaq will be the leading supplier of Merced processor-based servers and expects to ship systems with Intel's first Merced production processor.

Intel is committed to the concept of a level playing field concerning Merced, according to Linley Gwennap in his MicroDesign Resources forecast report. "Although there were initial indications that HP would be allowed to develop and even manufacture its own IA-64 processors, the companies have now made it clear that all IA-64 chips will be built by Intel and available to all interested system vendors."[3]

Gwennap added that in the long run, the Intel partnership probably gives HP no significant hardware advantage over other IA-64 system vendors. "Assuming equal access to the chips, which Intel will provide, the key issue for system vendors is getting input to and advance information on the system interface of the processor. Although HP played a major role in defining the internal architecture of Merced, Intel drove the definition of the external interfaces, working with Compaq, Sequent, and other key customers as well as with HP. Once the interface definition was complete, these vendors had the same early access to Merced documentation that HP did."[3]

Thus, with this early access and as the only leading vendor with servers and workstations focused solely on Intel architecture, Compaq has dedicated a substantial team of its best hardware, integration, and systems engineers to work directly with Intel on advancing the capabilities of Compaq systems using the Merced processor. Compaq is working to ensure that applications and operating systems used by Compaq customers today will work smoothly on IA-64 processor-based systems. Together with Intel, Compaq will conduct extensive systems testing and integration to help ensure a compatible growth path for customers that use Compaq systems running Pentium, Pentium Pro, Pentium II, or Deschutes processors.

Compaq has established Compaq Solutions Centers to help strategic independent software vendors (ISVs) and customers optimize their applications for Compaq servers based on current and future Intel microprocessors, including Merced. Through the centers, Compaq helps ISVs ensure that applications used by Compaq customers today will work seamlessly on future Compaq systems based on Merced.

Compaq Solutions Centers provide various porting and compiling tools jointly with Intel, as well as dedicated hardware to help software partners, including Microsoft, optimize their applications for multiprocessor IA-32 architectures and port the applications to future IA-64 architectures.

"The company's experience and extensive systems expertise in Intel servers and efforts with Intel on future 64-bit platforms help ensure that Compaq Solutions Centers will provide valuable

[3] "Intel's Merced and IA-64: Technology and Market Forecast" by Linley Gwennap; MicroDesign Resources, 1997.

resources for software partners and customers around the world," said John Miner, Vice President and General Manager, Enterprise Server Group, Intel Corporation.

What to expect from Compaq systems with Merced processors

- World-class performance, manageability, scalability, and availability without the cost of proprietary solutions.
- Protection of existing software investments and ensuring a compatible growth plan into the future due to Merced's compatibility with today's 32-bit operating systems and application.

Summary

Compaq's industry-standard server platforms with high scalability, high availability, integrated management solutions, and total cost of ownership illustrate that Compaq is the leading supplier and number one customer choice in enterprise class servers. This leadership will enable Compaq to provide a seamless transition to next-generation technology that includes Deschutes and Merced.