WHITE PAPER

Contents

The Compaq Highly Parallel System Architecture

This paper provides an overview of the Highly Parallel System Architecture that is an integral part of the Compaq Professional Workstation 5100, 6000 and 8000. This unique, standards-based architecture allows the Professional Workstations to deliver uncompromising application performance by increasing overall system bandwidth. This paper reviews the architecture design and key benefits to performance.

NOTICE

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INTRODUCTION

The system design of the Compaq Professional Workstation 5100, 6000 and 8000 is based on the Highly Parallel System Architecture. This design enables the Compaq Professional Workstation 5100, 6000 and 8000 to deliver uncompromising performance in demanding applications. Based on industry standards, the Highly Parallel System Architecture addresses the need for greater system bandwidth in the key subsystems including memory, I/O, and processor. This paper will explain the architecture's design, how it differs from other architectures, and the performance benefits it delivers.

HIGHLY PARALLEL SYSTEM ARCHITECTURE

The Compaq Professional Workstation 5100, 6000 and 8000 have been designed with a Highly Parallel System Architecture that maximizes system bandwidth to improve performance in demanding applications. Most workstations in the NT/X86 market support two CPUs to process instructions concurrently. However, overall system bandwidth is limited since each CPU must compete for access to critical subsystems such as memory and I/O whose bandwidth has not been correspondingly increased.

The Highly Parallel System Architecture implemented in the Compaq Professional Workstation 5100, 6000 and 8000 addresses the need for greater overall system bandwidth by utilizing dual memory controllers, dual-peer PCI buses, and advanced multiprocessing support.
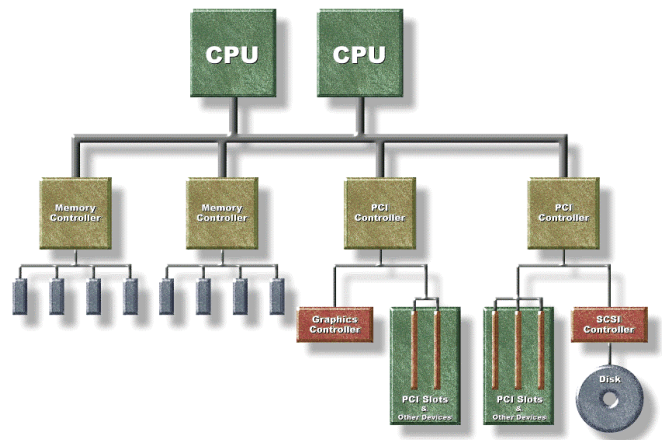
Figure 1. Highly Parallel System Architecture desgin.

DUAL MEMORY CONTROLLERS

The Compaq Professional Workstation 5100, 6000 and 8000 use dual memory controllers that process memory requests in parallel, significantly increasing overall memory bandwidth. Other workstations in the NT/X86 market offer memory bandwidth of either 267MB/second or 533MB/second depending on the memory controller chipset used. The Compaq Professional Workstation 5100, 6000 and 8000 use two memory controllers, each with a bandwidth of 533MB/second. Therefore, total memory bandwidth increases to 1.07GB/second- two to four times that of other systems.

The Compaq Professional Workstations use 60ns, EDO DRAM DIMMs with ECC support for fast and reliable memory operation. The Compaq Professional Workstation 5100 and 6000 support a maximum memory configuration of 512MB (which is the maximum

Figure 2. Dual memory controllers

supported by the Intel Pentium II processor). For computational intensive applications that use large data sets, the Compaq Professional Workstation 8000 supports up to 3GB of memory.

To ensure that both memory controllers in the Highly Parallel System Architecture are being used, and therefore processing memory requests concurrently, memory should be placed in the appropriate memory slots.

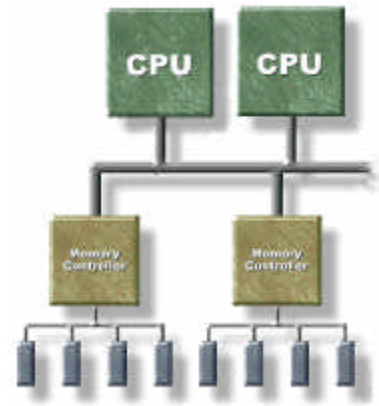The Compaq Professional Workstation 5100 includes eight DIMM slots on the system board. DIMM slots one through four are associated with one memory controller and DIMM slots five through eight are associated with the other memory controller. To ensure optimum performance, the table below outlines the suggested memory configurations to use based on the amount of total memory desired.

TABLE 1: GUIDE FOR CONFIGURING DUAL MEMORY BUSES TO OPTIMIZE PERFORMANCE IN THE COMPAQ PROFESSIONAL WORKSTATION 5100

Memory Size	Memory Bus 1				Memory Bus 2				Optimization Level**
	DIMM Slot 1	DIMM Slot 2	DIMM Slot 3	DIMM Slot 4	DIMM Slot 5	DIMM Slot 6	DIMM Slot 7	DIMM Slot 8	
32MB*	1 x 16MB		1 x 16MB						1
64MB*	1 x 16MB		1 x 16MB		1 x 16MB		1 x 16MB		1
128MB	1 x 32MB		1 x 32MB		1 x 32MB		1 x 32MB		2
128MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1
256MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1
256MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 64MB	1 x 32MB		1 x 32MB		2
256MB	1 x 64MB		1 x 64MB		1 x 64MB		1 x 64MB		3
384MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 64MB	1
512MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 64MB	1 x 32MB	1 x 128MB	1 x 32MB	1 x 128MB	1
512MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1

* Indicates memory configuration of standard models

** The degree of performance optimization is indicated by a numerical range. Level 1 represents the best performance. Levels 2, 3, and 4 indicate progressively lower performance.

Both the Compaq Professional Workstation 6000 and 8000 come with four DIMM slots on their system boards, and a memory expansion board is available that can be used in both systems to provide an additional eight DIMM slots. The memory expansion board comes standard with the Compaq Professional Workstation 8000 and is offered as an upgrade for the Professional Workstation 6000. The memory slots on the system board and the memory slots on the memory expansion board are associated with separate memory controllers and should both be populated with memory to improve system performance. The table below outlines the best memory configuration based on the amount of memory desired.

TABLE 2: GUIDE FOR CONFIGURING DUAL MEMORY BUSES TO OPTIMIZE PERFORMANCE IN THE COMPAQ PROFESSIONAL WORKSTATION 6000 AND 8000

Memory Size	Memory Bus 1 DIMMs				Memory Bus 2 DIMMs								Opt. Level **
	Slot 1	Slot 2	Slot 3	Slot 4	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Slot 8	
32MB[1]	1 x 16MB	1 x 16MB											1
64MB	1 x 16MB	1 x 16MB			1 x 16MB	1 x 16MB							1
64MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB									3
64MB[1]	1 x 32MB	1 x 32MB											3
128MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB	1 x 16MB					1
128MB[2]	1 x 32MB	1 x 32MB			1 x 32MB	1 x 32MB							2
128MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB									3
128MB[1]	1 x 64MB	1 x 64MB											4
256MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB	1 x 32MB					1
256MB	1 x 64MB	1 x 64MB			1 x 64MB	1 x 64MB							2
256MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB									3
256MB	1 x 128MB	1 x 128MB											4
512MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB					1
512MB	1 x 64MB	1 x 64MB			1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB			2
512MB					1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	3
512MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB									4
1GB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1 x 64MB	1
1GB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB					1
1GB					1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	1 x 128MB	3
1GB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB									3
2GB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB					1
2GB					1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	1 x 256MB	2

[1] Standard memory configuration in Compaq Professional Workstation 6000
[2] Standard Memory configuration in Compaq Professional Workstation 8000

** The degree of performance optimization is indicated by a numerical range. Level 1 represents the best performance. Levels 2, 3, and 4 indicate progressively lower performance.

The memory architecture used in these Compaq Professional Workstations also allows for added flexibility when configuring memory by providing 8 DIMM slots on the Compaq Professional Workstation 5100 and up to 12 DIMM slots on the Compaq Professional Workstation 6000 and 8000. This allows users to reach larger memory capacities without having to use newer, more

expensive memory technologies. For example, the Compaq Professional Workstation 5100 and 6000 could be configured with 512MB of RAM by using eight 64MB DIMMs modules instead of four 128MB DIMM modules. Since 128MB DIMMs are based on 64Mbit technology, one of these modules costs more than two 64MB DIMMs which are based on 16Mbit technology. So, using DIMMs of a smaller size is cost effective and delivers the best performance when the DIMMs are split between the two memory controllers.

DUAL-PEER PCI BUSES

The Compaq Professional Workstation 5100, 6000 and 8000 also use dual-peer PCI buses to increase system I/O bandwidth. A single PCI bus provides I/O bandwidth of 133MB/second, which must be shared by many key peripherals such as the graphics controller, hard drive, and NIC. With dual-peer PCI buses, each bus can provide peek bandwidth in parallel with the other controller, allowing an aggregate I/O bandwidth of 267MB/second. This implementation provides twice the bandwidth of single bus architectures.

Another benefit of dual-peer PCI buses is the ability to balance system resources across the two buses to gain improved performance. For example, on the Compaq Professional Workstation 5100, 6000 and 8000, the embedded Wide-Ultra SCSI controller and PCI-based graphics controller board are associated with separate buses. This means that these two highly used peripherals do not have to compete for access to the same PCI bus, which again improves performance.

Figure 3. Dual-peer PCI buses.

Finally, the dual PCI buses also allow for greater system I/O integration and expandability by supporting up to 12 PCI devices which is twice the number supported on single bus implementations. This allows the Compaq Professional Workstation 5100, 6000 and 8000 to deliver more PCI-based I/O expansion slots while also integrating other PCI components, such as the SCSI and network controllers on the system board. Though other workstations may offer the ability to support more than 6 PCI devices, they achieve this support through the use of a PCI bridge. This bridge effectively extends the PCI bus and allows more devices to be connected to it, but, this is still a single bus implementation with a maximum bandwidth of 133MB/second. By extending the bus to accept more devices, this design can actually cause greater traffic on the PCI bus and may lower performance.
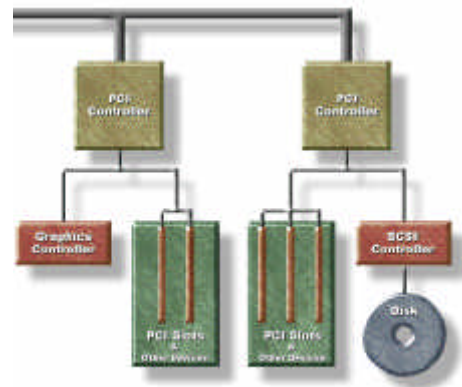
OPTIMIZED MULTIPROCESSING SUPPORT

Finally, with dual memory controllers and dual peer-PCI buses, the Compaq Professional Workstation 5100, 6000 and 8000 are able to deliver optimized multiprocessing support. Both the Intel Pentium II and Pentium Pro processors enable multiprocessor support by including circuitry in the processor that determines how multiple processors can share the CPU bus. However, most multiprocessing implementations in the NT/X86 workstation market take advantage of this support by simply adding an additional processor to an already existing desktop design. Compaq takes multiprocessing to the next step with the Highly Parallel System Architecture by enhancing memory and I/O bandwidth as well. Multiprocessor Systems designed without the Highly Parallel System Architecture will quickly encounter a bottleneck as the multiple processors try to access the other system resources, such as memory and I/O subsystems, that have not been enhanced to accommodate the additional data traffic. The Highly Parallel System Architecture significantly reduces these bottlenecks by incorporating enhanced

subsystem resources, such as dual memory controllers and dual peer-PCI buses, to accommodate the increased data traffic from the multiple CPUs.

Dual Independent Bus Architecture

Complimenting the Highly Parallel System Architecture, both the Pentium Pro and Pentium II use Intel's Dual Independent Bus architecture providing two (dual) independent buses: a processor-to-cache bus, and a processor-to-memory bus. The processor-to-memory bus runs at the core system speed of 66MHz. The processor-to-cache bus speed depends on which processor is being used. With Pentium Pro, this bus runs at the processor speed (i.e. 200MHz in a 200MHz processor). In a Pentium II processor, the processor-to-cache bus runs at half the speed of the processor (i.e. 133MHz in a 266MHz processor).

This design delivers significantly more bandwidth than a single bus architecture processor because the buses can work independently which essentially doubles the throughput. And, as processor speeds increase, so will the speed of the processor-to-cache bus, which will allow performance to scale with MHz.

CONCLUSIONS

The Highly Parallel System Architecture being implemented in the Compaq Professional Workstation 5100, 6000 and 8000 improves overall system performance by delivering increased bandwidth to critical subsystems including memory and I/O. Dual memory controllers, dual-peer PCI buses, and optimized multiprocessing support make the Highly Parallel System Architecture the best choice for delivering uncompromising performance in today's demanding applications.