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Second-Generation Highly Parallel System Architecture vs. the Intel® 440 BX/GX AGPset in the Workstation Market

Customers with demanding applications such as computer-aided engineering, financial analysis, computer-aided design, and digital content creation require the highest performance from their workstations. With the Professional Workstation SP700, Compaq is introducing a new second-generation Highly-Parallel System Architecture that provides the performance needed by these resource-intensive applications. Because many workstation customers may also be evaluating systems based on the Intel 440 BX/GX AGPset, this brief compares the second-generation Highly Parallel System Architecture to the GX architecture, and explains why the Highly Parallel System Architecture is the superior architecture for the demanding Windows NT® workstation marketplace.

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Second-Generation Highly Parallel System Architecture vs. the Intel® 440 BX/GX AGPset in the Workstation Market

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INTRODUCTION

Compaq is introducing its second-generation Highly Parallel System Architecture in the Compaq Professional Workstation SP700. The second-generation Highly Parallel System Architecture provides uncompromising performance for workstations by using multiple data paths, high-speed data buses, and balanced system resources. Because many customers may also be evaluating systems based on the Intel 440 BX/GX AGPset, this brief compares the key features of the Intel GX architecture with the second-generation Highly Parallel System Architecture. By comparing key subsystem features, this brief will explain why the Highly Parallel System Architecture is the superior architecture for the demanding NT workstation market.

ARCHITECTURE OVERVIEW

Intel's GX architecture and the Highly Parallel System Architecture are both targeted for the workstation market. Workstation applications typically place a high demand on the memory, graphics, and input/output (I/O) subsystems; and successful architectures must be able to provide the necessary bandwidth to these critical subsystems. The following sections will highlight the key features of the GX architecture and the Highly Parallel System Architecture.

GX Architecture

The GX architecture is a successor to the Intel LX architecture introduced in 1997, with the addition of enhanced AGP graphics, a 100-MHz AGTL+ system bus, and support for 100-MHz SDRAM memory. The GX architecture has the following features:

- Support for up to two Intel Pentium® II or Pentium® II Xeon™ processors
- Single memory bus
- Single PCI bus
- AGP bus for graphics controllers

Figure 1 illustrates the GX chipset architecture. The memory controller supports 800 megabytes per second (MB/s) bandwidth, the AGP graphics controller is capable of supporting a 533 MB/s bandwidth, and the single PCI bus handles I/O data with a peak throughput of 133 MB/s.

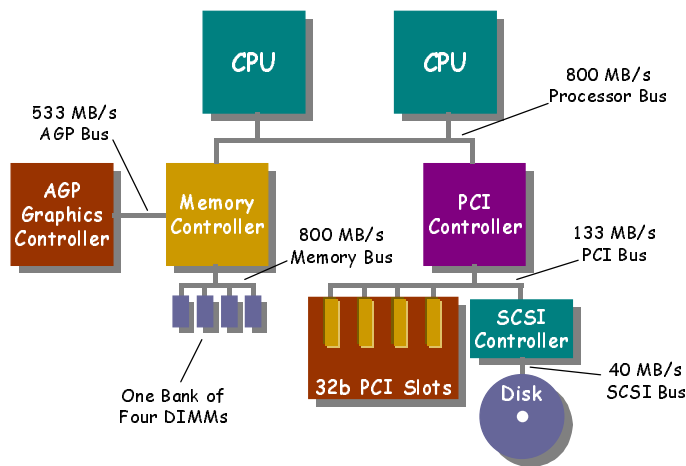


Figure 1. Block diagram of the GX architecture

AGP: Accelerated Graphics Port

AGTL: Advanced Gunning Transistor Logic

SDRAM: Synchronous Dynamic Random Access Memory

The Second-Generation Highly Parallel System Architecture

As the name implies, the second-generation Highly Parallel System Architecture is an extension of the very successful industry-standard architecture found in the Compaq Professional Workstations 5100, 6000 and 8000. The second-generation architecture adds AGP capability, a 100-MHz AGTL+ system bus, and support for 100-MHz SDRAM memory. Key features of the second-generation Highly Parallel System Architecture include

- Support for up to two Pentium II Xeon processors
- Dual memory controllers
- Dual-peer PCI buses
- AGP bus for graphics controllers
- Dual Wide-Ultra SCSI controllers

Figure 2 shows a block diagram of the second-generation Highly Parallel System Architecture. Peak memory bandwidth with the dual memory controllers is 1.6 GB/s, while peak I/O bandwidth through the dual PCI buses is 267 MB/s.

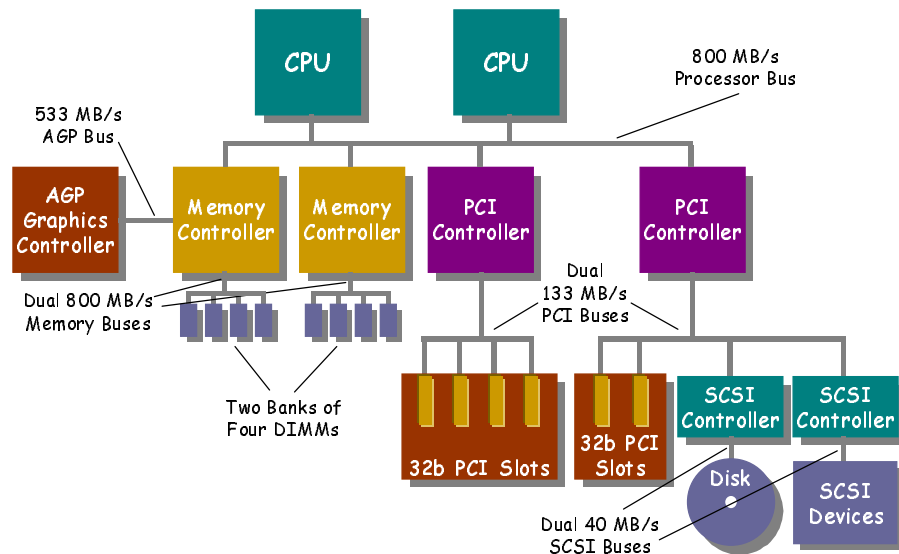


Figure 2. Block Diagram of the second-generation Highly Parallel System Architecture.

PROCESSOR, MEMORY, PCI, AND GRAPHICS SUBSYSTEMS

Compared with the GX architecture, the Highly Parallel System Architecture offers superior performance, scalability, and expandability. The Highly Parallel System Architecture is designed to deliver maximum bandwidth to critical subsystems by exploiting concurrency whenever possible. Dual memory controllers and PCI controllers provide users with twice the memory and I/O bandwidth of GX-based systems, allowing applications to tackle resource-intensive tasks. The best way to highlight the advantage of the second-generation Highly Parallel System Architecture over the GX architecture is to compare each of the key subsystems. Table 1 lists important metrics for the processor, memory, PCI, and graphics subsystems.

Table 1. Second-Generation Highly Parallel System Architecture and GX Subsystems

	440 BX/GX	2 nd -Generation Highly Parallel System Architecture
Processors		
Processors supported	Pentium II and Pentium II Xeon	Pentium II Xeon
Number of processors	2	2
Concurrent requests	4	8
Memory		
Peak Bandwidth	800 MB/s	1.6 GB/s
Memory Supported DIMM sockets	100-MHz SDRAM 4	100-MHz SDRAM 8
PCI		
Peak Bandwidth	133 MB/s	267 MB/s
No. Slots (without a PCI-to-PCI bridge)	4 plus 2 integrated peripherals	Up to 6, plus 3 integrated peripherals
Graphics		
Graphics port	AGP	AGP
Texture memory	256 MB	2 GB*

These four subsystems will be discussed in detail in the following sections.

*Current operating systems may not support 2 GB of texture memory

Processor

Both the GX and second-generation Highly Parallel System architectures support up to two Pentium II Xeon processors on a 100 MHz AGTL+ bus. However, the Highly Parallel System Architecture is specifically engineered for optimized multiprocessing support. While each processor can issue up to four transactions on the AGTL+ bus, the GX architecture limits the processors to four concurrent transactions. In contrast, the Highly Parallel System Architecture permits the processors to post up to eight simultaneous transactions, improving scalability by permitting both processors to operate at peak utilization in a multiprocessing environment. Additionally, the second-generation Highly Parallel System Architecture supports deferred reads from PCI locations. During a deferred read, the processor requests data from a PCI device and then relinquishes control of the bus until the data is returned, allowing other processors to access the bus while the read is pending.

Memory

The Highly Parallel System Architecture and GX architecture support 100-MHz ECC SDRAM technology. However, the Highly Parallel System Architecture is structured to gain the most memory performance from these devices. The dual memory controllers employed in the Highly Parallel System Architecture provide twice the memory bandwidth of the single memory controller subsystem in the GX architecture, 1.6 GB/s compared with 800 MB/s. The greater

DIMM: Dual Inline Memory Module

bandwidth results in improved system responsiveness, especially in memory-intensive applications such as ANSYS Finite Element Analysis software.

In addition, the Highly Parallel System Architecture allows customers more flexibility with memory configurations. For example, the Compaq Professional Workstation SP700 provides eight DIMM sockets, compared to the four DIMM sockets in GX-based systems. More sockets allow users to reach larger memory capacities without having to use more expensive memory. For example, the Compaq Professional Workstation SP700 could be configured with 1 GB of RAM by using eight 128-MB DIMMs instead of four 256-MB DIMMs. Currently, one 256-MB DIMM costs at least 50 percent more than two 128-MB DIMMs. Additionally, the Highly Parallel System Architecture can support up to 4 GB of system memory (using eight 512-MB DIMMs) – twice the memory expandability of GX-based systems. Larger memory expandability gives Compaq workstations greater ability to run memory-intensive applications with large datasets, such as NASTRAN and VCS.

The Highly Parallel System Architecture is designed to improve memory responsiveness in other ways as well. For example, the Highly Parallel System Architecture retrieves data from registered DIMMs in three clock cycles compared with four clocks for the GX architecture. Also, due to the dual memory controllers, the Highly Parallel System Architecture doubles the number of pages that can be opened – 64 pages compared with 32 pages for the GX architecture. Doubling the number of pages in memory greatly increases the chances that memory requests can be serviced as a faster memory page hit cycle.

Because data integrity is just as critical as performance, the Highly Parallel System Architecture provides hardware-based ECC memory scrubbing. With memory scrubbing, single-bit errors are repaired in the actual memory location, so that subsequent reads from that location are correct. Allowing the hardware to fix single-bit errors instead of requiring software intervention reduces the workload on the processors, freeing them for other tasks.

PCI

Just as second-generation Highly Parallel System Architecture improves memory and processor bandwidth over the GX architecture, the Highly Parallel System Architecture also offers significant I/O advantages in terms of overall throughput and expandability. The Highly Parallel System Architecture uses dual-peer PCI buses to provide twice the bandwidth (267 MB/s) as the single 133-MB/s PCI bus in GX systems. The dual bus structure of the Highly Parallel System Architecture also allows customers the flexibility to deploy I/O-intensive peripherals across independent buses to prevent I/O bus bottlenecks. In contrast, systems based on the GX architecture must locate all I/O devices except graphics controllers on the single PCI bus, allowing lower performance devices such as tape backup devices to consume bandwidth needed by higher performance peripherals.

NIC: Network Interface Card

Due to the dual I/O controllers, the Highly Parallel System Architecture supports as many as four more PCI devices than the GX architecture, without the use of performance-degrading PCI bridge chips. For example, the Compaq Professional Workstation SP700 provides six PCI slots, in addition to NIC and SCSI controller embedded peripherals.

SCSI: Small Computer System Interface

Graphics

The second-generation Highly Parallel System Architecture and the GX architecture both provide AGP support. AGP provides a dedicated 66-MHz PCI-based bus connection between the graphics controller, processor bus, and main memory. In addition, AGP graphics systems are able to store texture and Z-buffer information in non-cached system memory. AGP graphics controllers are installed in special AGP slots in the system, and are not hardware compatible with standard PCI slots. On the Compaq Professional Workstation SP700, the AGP port is directly connected to one

of the memory controllers. If the graphics controller requires more memory to store textures than is available on the primary controller, the AGP bus will also use memory from the secondary controller.

In AGP graphics, the Graphics Address Remapping Table (GART) handles the allocation of graphics memory. The Compaq AGP GART solution is designed to provide a high degree of flexibility and performance. For example, the Compaq GART implementation uses a two-level look-up table that allows the GART information to be located in smaller, non-contiguous memory blocks. Among other benefits, a two-level GART allows applications to use up to 2 GB for texture memory, in contrast to the 256 MB allowed by the GX implementation. Graphics applications that use large numbers of textures such as flight simulators can benefit from this additional memory resource. GART table entry caches and other special architectural features further minimize address translation times and enhance graphics performance.

For more details on AGP graphics, please refer to the technology brief *Accelerated Graphics Port Technology*, Compaq document number ECG081/0898 which can be found on the Compaq Web site at www.compaq.com.

CONCLUSION

Compaq has specifically designed the second-generation Highly Parallel System Architecture to furnish the bandwidth needed to power today's demanding workstation applications. Compared with systems based on the Intel GX architecture, the second-generation Highly Parallel System Architecture provides optimized multiprocessing, enhanced AGP support, and twice the memory and I/O bandwidth, affording users outstanding performance in an industry-standard workstation.