SGI Chip Set Powers NT Workstations

New Systems Feature Proprietary "Interactive Visual Computing" Chip Set

by Peter N. Glaskowsky

The first fruit of the relationship between Silicon Graphics and Intel has finally ripened, and it didn't fall far from the SGI family tree. The new 320 and 540 Visual Workstations feature Intel's Pentium II and Pentium II Xeon processors, respectively, and run Windows NT instead of IRIX. In most other respects, however, these systems are more like SGI's proprietary Unix workstations than commodity PC workstations, and they provide performance to match their seemingly BMW-inspired model numbers.

The two machines share a new chip set that implements a unified memory architecture (UMA) like that found in SGI's previous O2 workstation. Where most PCs have a hierarchy of buses, SGI's Interactive Visual Computing (IVC) architecture gives each major subsystem direct access to main memory through the chip set, as Figure 1 shows. This architecture allows all subsystems to operate simultaneously, rather than taking turns.

Although IVC has its roots in previous SGI systems, it also incorporates technology found on Intel-architecture PCs and licensed from Intel. For example, the 320 and 540 have a P6 front-side bus rather than a MIPS processor bus. Because the SGI machines share a single bus among multiple CPUs, the multiprocessor arbitration logic also comes from Intel. While the IVC core logic is not available on the open market, it provides an interesting point of comparison for Intel's 440GX workstation chip set (see MPR 7/13/98, p. 11).

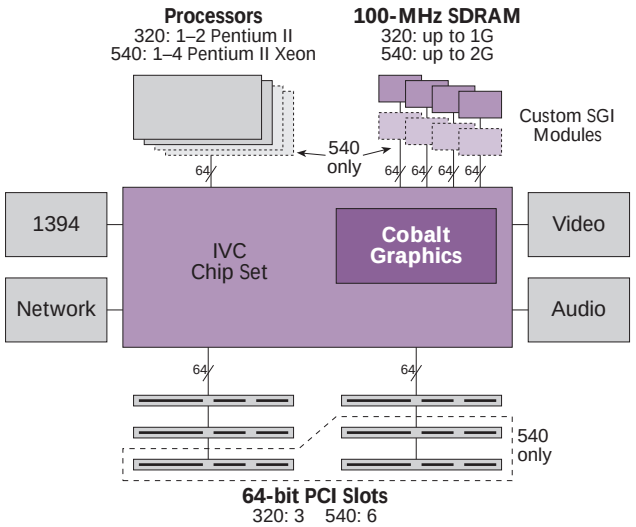

Figure 1. SGI's two new Windows NT workstations share the same architecture, which provides high bandwidth to main memory for all major subsystems.

CPUs, Peripherals Share Fast Memory

The CPU bus in the 320 connects to one or two Pentium II processors, positioning the 320 against low-end PC workstations that provide the same processor options. The 540 differs from its competition by supporting up to four Pentium II Xeon modules. There are no other announced NT workstations designed to accept four Xeon processors, giving the 540 an edge in scalability over dual-Xeon systems, such as those based on the 440GX. We expect SGI to offer Pentium III and Pentium III Xeon processors for its systems as soon as these CPUs become available.

If the 320 and 540 had a memory subsystem like that of competing PC workstations, the IVC architecture would produce no real-world benefit. Instead, SGI gifted the new machines with an unmatched 3.2 Gbytes/s of main-memory bandwidth, four times that achieved by the 440GX. The extra bandwidth comes from a 100-MHz noninterleaved 256-bit-wide memory array, compared with the standard 64-bit 100-MHz interface on the 440GX. Direct connections from the CPU and I/O buses to the memory controller account for up to 800 Mbytes/s and 1.6 Gbyte/s of this bandwidth, respectively. The remaining 800 Mbytes/s, plus whatever is not used by the CPUs or I/O, is available for graphics operations.

SGI's review of the current state of the art in PC workstations revealed that memory-access contention is a serious problem for some critical professional applications. The broadcast industry, for example, requires true real-time video processing. No interruptions, no matter how brief, are acceptable. Video peripherals in typical PCs can experience several-millisecond delays due to PCI-bus arbitration, and memory accesses can be further delayed if the host processors or other devices are accessing memory at the same time. To solve this problem, the 320 and 540 include analog video I/O ports with direct access to the memory controller. The 540 also provides an optional digital video I/O port, again with direct memory access.

To provide similar low-latency access for other traffic, the 320 and 540 also have direct-access ports for their network controllers (10/100Base-T Ethernet), CD-quality audio I/O, and an IEEE-1394 controller. Some I/O support is implemented conventionally, using PCI-based controllers. Both systems include an integrated 33-Mbyte/s PCI-bus Ultra-IDE disk controller; the 540 adds an integrated 64-bit PCI Ultra2 SCSI controller for its internal hard-disk drives. SCSI support is optional on the 320.

SGI's implementation of PCI is somewhat unusual and will cause compatibility problems. SGI chose to provide a 3.3-V PCI bus rather than the conventional 5-V bus found on today's PCs. This bus can accept only 3.3-V PCI cards or

Pricing and Availability

The Silicon Graphics 320 ships this month, starting at $3,395 with one Pentium II processor, 128M of SDRAM, and a 6.1G ATA hard-disk drive. The 540 is due in 2Q99, priced from $5,995 with a single Pentium II Xeon processor, 128M, and a 9G Ultra2 SCSI drive. More information is available online at *visual.sgi.com*.

the so-called Universal PCI cards that can operate on 3.3 V or 5 V. Many PCI cards—especially older models—still require 5 V, however, and will not work in these machines.

This restriction will create a problem for some customers, but the problem will diminish over time. There are already a few Universal and 3.3-V PCI cards on the market, and this number will certainly grow. Most ASIC foundries offer dual-voltage processes today, and all will eventually provide 3.3-V support. Also, SGI's professional customers may not need as much flexibility in add-in card selection as mainstream home or business users, especially given the many features built into the new workstations.

Cobalt Graphics Make New Machines Shine

The high point of the new Visual Workstations, and the most critical element for their success, is the new Cobalt graphics subsystem. SGI considered and rejected the common approach to PC graphics architecture—a separate subsystem with its own local memory linked by an AGP interface—in favor of a UMA solution much like that on the O2.

Although UMA was a failure in the mainstream PC market, the O2 has been moderately successful for SGI. On UMA PCs, graphics accesses to main memory interfere with CPU accesses. In the O2 and Visual Workstation designs, the 3D engine can access all of main memory without reducing bandwidth to the CPU. Graphics tasks aren't limited by the amount of memory on an add-in card; any graphics data that fits in main memory can be displayed at full speed.

Although this capability is its own reward for many applications, it's especially valuable in shops that use a wide range of systems. SGI's UMA approach allows low-end systems to run the same software and process the same data files as much more expensive machines, as long as enough memory is installed. Performance may be lower than that of the high-end systems, but compatibility is ensured.

The performance of the 320 and 540 is excellent, however. SGI claims a peak polygon rate of 7.4 Mtriangles/s from Cobalt's hardware-geometry engine, which accelerates transform calculations and computations for up to four light sources. Both systems achieve a peak fill rate of 176 Mpixels/s with trilinear texturing. This fill rate is significantly lower than the 250 Mpixels/s achieved by Nvidia's Riva TNT, but the TNT, like most PC-graphics chips, performs well only on textures stored in its relatively small 16M of local memory.

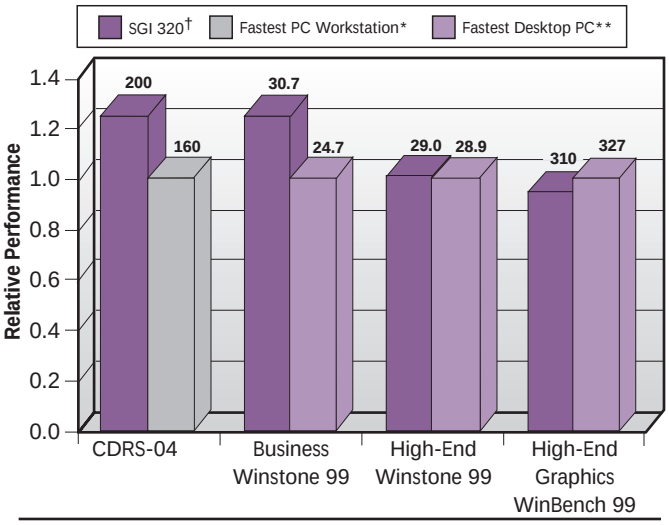

Figure 2. The SGI 320 performs well on both CAD and productivity applications. *Results from the SPEC GPC Web site, 1/7/99. **Results from *PC Magazine*, 12/1/98. †Results from SGI.

Long before these machines were announced, SGI promised analysts that they would outrun existing PC workstations, not just on 3D-intensive CAD benchmarks but also on mainstream productivity applications such as Microsoft Word and Excel. As Figure 2 shows, SGI kept its promise. The 320's performance on application-based benchmarks surpasses that of all mainstream PC desktops equipped with the same 450-MHz Pentium II processor that were reviewed in *PC Magazine*'s most recent "Best PC" issue. At the same time, the 320 outperforms competing PC workstations on many CAD benchmarks, including the oft-quoted CDRS-04.

Though scores on Graphics WinBench lag slightly behind the best desktop PCs, this is more an indication of how today's PC graphics chips have been highly optimized for the Graphics WinBench tests. We believe SGI chose not to pursue such optimizations, feeling they were not relevant to professional users. Although customers run applications, not benchmarks, SGI's competitors are sure to draw attention to these anomalous results.

By combining top-notch performance with access to the large (and growing) base of Windows NT applications, the Visual Workstations are sure to be more popular than SGI's current Unix-based RISC workstations. At $3,395 and up, these new SGI workstations are more expensive than commodity PCs, but SGI is not attempting to compete with ordinary PCs. The 320 and 540 are aimed at professionals who need their unique capabilities and are willing to pay a premium price to get them. Other NT workstations offer good software support and low prices, but few can match the features or scalability of the 320 and 540. M

The chief engineer of the workstation division of Silicon Graphics, Zahid Hussain, will describe the new Visual Workstations at the March 18 MDR dinner meeting. For more information, visit www.MDRonline.com/events/sve/.