White Paper

Silicon Graphics® Tezro™ Visual Workstation Technical Overview

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1 Introduction

The Silicon Graphics® Tezro™ visual workstation represents the next generation of high-performance SGI® desktop workstations. Tezro leverages core technologies from some of the company's most powerful high-performance computing systems, coupling the world's most advanced desktop visualization with world-class system throughput, a proven 64-bit operating environment running on up to four MIPS® processors, industry-leading I/0, versatile form factors, and digital media capabilities that meet the most stringent professional standards.

This paper provides an overview of the key technology features of the Silicon Graphics Tezro visual workstation. Featuring significant advances across the board—in overall performance, processor speed, memory bandwidth, I/O and price/performance—Tezro is designed for customers seeking new levels of performance and reliability in visualization, multiprocessing, and digital media.

1.1 Key Tezro Vertical Markets

Tezro is designed for customers who are pushing the very edge of visual computing in such global industries as manufacturing, sciences, government and defense, media, and energy. For them, Tezro provides a powerful platform to drive not only today's desktop applications, but a new class of technical and creative applications that previously were beyond the reach of even the most powerful workstations. Several vertical applications for Tezro are listed below. Italicized applications indicate where the quad-processor Tezro delivers a new range of capabilities to workstation customers.

Sciences and Pharmaceutical

- Molecular modeling
- Molecular dynamics and simulation
- Crystallography
- Visualization
- *Quantum mechanics*

Manufacturing

- High-end design
- MCAE
- MDO
- *Manufacturing workgroups*

Government and Defense

- Database Generation System
- Development workstations
- Simulation and training
- *Command and Control (C2) centers*
- *Homeland security and anti-terrorism*
- *Embedded systems*

Media

- HD and film resolution editing and compositing
- Film mastering and restoration
- *HD acquisition systems for digital cinema*

Energy

- Seismic interpretation
- *Reservoir simulation*
- *Team rooms*

These demanding environments require systems with balanced architectures to drive real-world, high-productivity applications. The core compute, graphics and I/O technologies built into Tezro—along with its media, storage and networking options—make it an ideal solution for these environments.

2 Tezro System Overview

Two decades of technology innovation are reflected in the design of the Tezro visual workstation. The new system has been architected for high-productivity technical and creative users whose pursuit of ever-increasing performance is coupled with a desire to maximize return on investments in hardware and software. The result is a balanced architecture with a robust and mature 64-bit operating system and fueled by up to four powerful processors in one system.

Base System Architecture	High-bandwidth architecture based on SGI 3000 family of supercomputers
Processors	One, two or four MIPS processors with 4MB DDR full-speed SDRAM secondary cache per CPU
Operating System	IRIX® 6.5.20 and above Robust, secure, scalable, 64-bit UNIX® operating system for visual and technical computing
Form Factors	Tower Rackmount
Graphics	SGI® VPro™ V12 graphics 128MB graphics memory Up to 104MB of texture memory Dual Channel and Dual Head options
Memory	3.2GB/second system memory bus 512MB to 8GB 200 MHz DDR on Tower 512MB to 16GB 200 MHz DDR on Rackmount
Storage	Two removable hard drive bays (toolless) Internal DVD-ROM option External DVD-RAM option
I/O, Connectivity and Networking	Integrated PCI-X at 133/100MHz Up to seven slots on tower system Up to six slots on rackmount system (with one PCI slot) Gigabit Ethernet on board Ultra160 SCSI buses (internal and external) XIO™ OpenGL Vizserver
Media	A full suite of DMediaPro options are available High-definition and standard-definition video 10-bit video processing with DMediaPro DM3 Analog audio standard on tower, option on rackmount IEEE 1394 option available on both
Physical Dimensions and Weight	Tower 17 in. H x 13.75 in W x 20.75 in. D[1] 60.6 lb with skins (rear wheels for easy transport) Rackmount 3.44 in. H x 17.36 in. W x 27 in. D[2], 39.5 lb 21-inch monitor 17.6 in. H x 16 in. W x 16.5 in. D [1]An additional 6.3-in. deep with drive door open [2]An additional 8-in. deep with drive door open

2.1 Dual Form Factors

The Silicon Graphics Tezro visual workstation is available in two form factors: a tower workstation for in-office or deskside computing, and a rackmount system for flexible configurability and OEM deployment. While the performance and key features are the same between the tower and rackmount configurations, there are some differences in storage, I/O, and the audio implementation.

The rackmount configuration is available in dual-head configurations, is expandable to 16GB of memory, and offers a VME expansion option. For rack system users, a 17U short rack and 39U tall rack are also optionally available. Rubber feet are supplied with the systems for use outside a rack.

The tower system features rear wheels that allow easy transportation into offices and under desks or work surfaces. Push buttons on the back of the tower allow side panels to easily drop down, providing fast access to components.

Along with a broad range of digital media options (see section 11.0), professional audio capabilities and an IEEE 1394 audio interface are available for both configurations. Several monitor options, including CRT and flat panel monitors, are also available. Visit *www.sgi.com/peripherals/displays* for display specifics.

For details on storage options, see section 9. For I/0 details, see section 10.

2.2 Single-Processor Configurations

Base single-processor Tezro systems come standard with VPro V12 graphics, 512MB of memory, up to six integrated PCI-X slots, and standard definition video support. Users can also select the DMediaPro DM6 option, a standard-definition video I/O interface. A daughter card upgrade to the VPro V12 graphics subsystem enables Dual Channel support, and an additional graphics board allows Dual Head display support in the rackmount configuration.

On the tower configuration, users have the choice of two MIPS processor speeds, and can upgrade system memory to a maximum of 8GB. Three PCI-X slots are available with a single-processor tower system and audio capabilities are built in.

Rackmount systems are driven by MIPS processors, and support Dual Head display. In 2U configurations, users can take advantage of two 100 MHz PCI-X slots and one 66 MHz PCI slot. In 4U configurations, the one PCI slot is joined by six PCI-X slots. System memory in 4U rack-mounted systems is expandable to 16GB. VME connectivity is also available through external XIO, as is audio support via a PCI add-in card, DMediaPro DM8.

2.3 Multi-Processor Configurations

Multi-processor Tezro visual workstations can be configured with two or four MIPS processors. All systems come with SGI VPro V12 graphics, up to seven PCI-X slots, and a full suite of standard-definition and high-definition DMediaPro options.

All tower systems include onboard audio, support seven PCI-X slots, and can be expanded to a maximum of 8GB of memory.

Rackmount systems offer dual head display capabilities in 4U configurations, along with support for up to 16GB of system memory. In 2U configurations, users can take advantage of two 100 MHz PCI-X slots and one 66 MHz PCI slot. In 4U configurations, the one PCI slot is joined by six PCI-X slots. Rackmount systems also support VME connectivity via external XIO and audio via a PCI add-in card, DMediaPro DM8.

3 SGI 3000 Family System Architecture

The Silicon Graphics Tezro visual workstation is built on the SGI 3000 platform, a high-bandwidth system design created for the most demanding visual computing challenges. The Tezro architecture delivers the bandwidth required to simultaneously process 3D graphics, 2D imagery, and video data. The system also scales to accommodate up to four processors, either in a tower or rackmount configuration.

Designed for office or computer room environments, the air-cooled Tezro visual workstation incorporates five logic boards designed by SGI. The boards provide for the CPUs and memory, I/O interfaces, networking features, and graphics support. The system's two 3.5-inch, low-profile discs are connected to the system I/O processing elements via an Ultra3/160 SCSI interface, which allows peak data transfer speeds of up to 160MB per second between the disk and system memory. Users can easily remove the hard drives without tools — an important benefit in defense and other computing environments where sensitive content must be secured overnight.

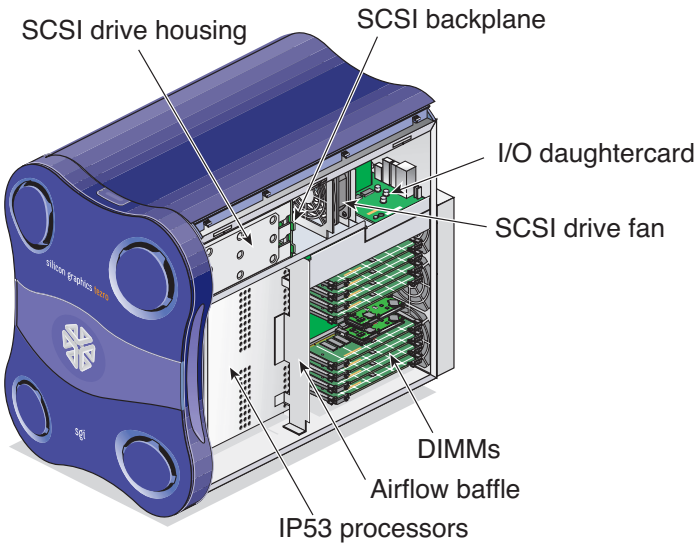

Figure 3.1 Tezro tower configuration is designed for easy access to system components

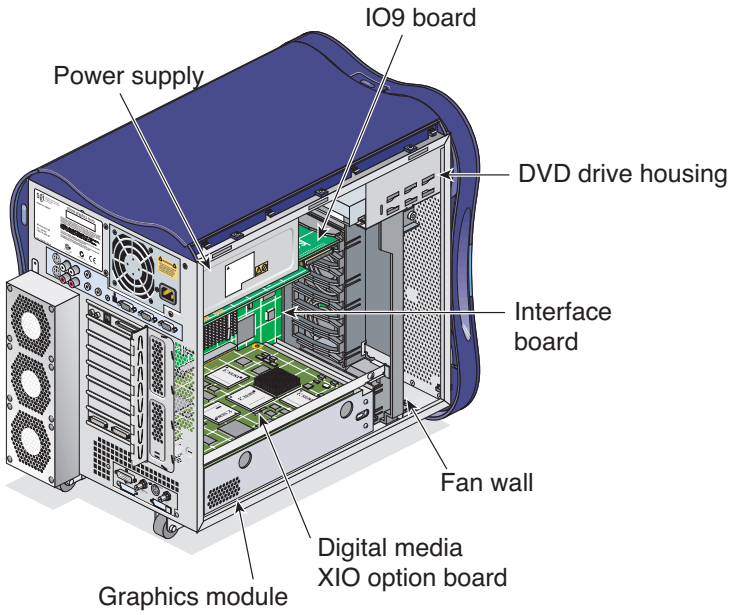

Figure 3.2 Left view of the Tezro tower system layout

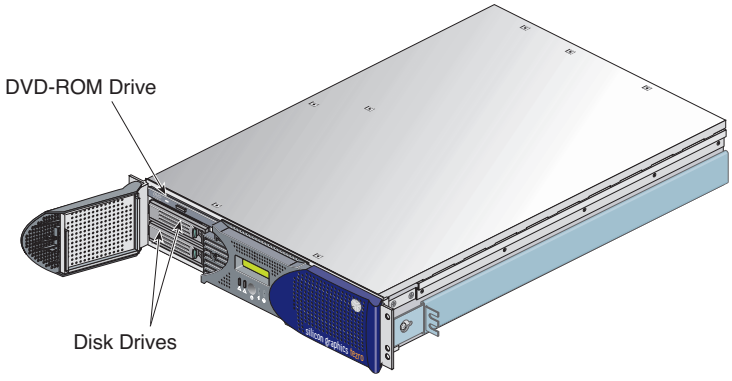

Figure 3.3 The Tezro rackmount is offered in 2U or 4U configurations.

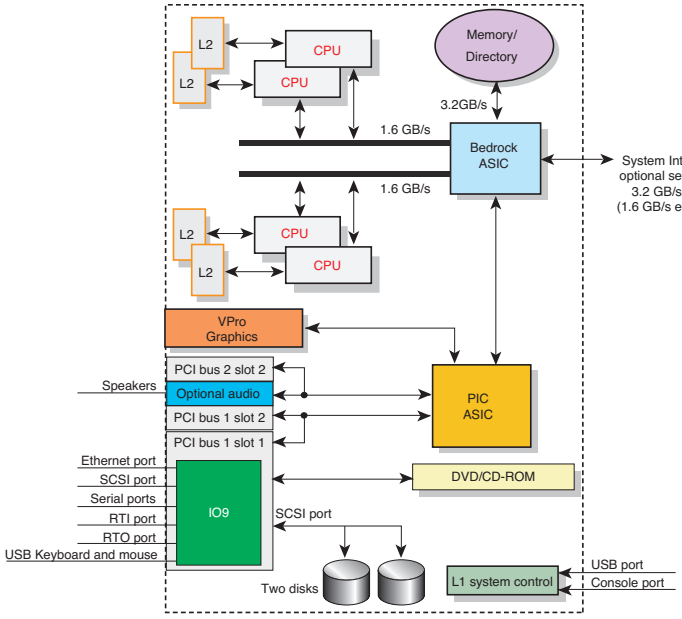

Figure 3.4 A view of Tezro rackmount system components

4 MIPS Processing

The Tezro visual workstation features one, two or four 64-bit MIPS microprocessors. The MIPS processors deliver supercomputer-class processing power while maintaining exceptionally low power consumption and requiring minimal heat dissipation—making the system a convenient and reliable choice for both end users and OEMs.

With the ability to choose both the number of processors and the speed at which they run, users have greater flexibility in configuring the system that best fits their needs. While the single-processor Tezro has the CPU power, bandwidth, and graphics features to satisfy a broad range of technical and creative computing applications, customers seeking maximum I/O expandability and scalability can choose either the dual-processor or quad-processor Tezro workstation. Customers using multithreaded applications whose performance scales with the number of CPUs available—including manufacturing and computer-aided engineering—will also want to take full advantage of the multiprocessor options in Tezro.

4.1 4MB to 16MB of Secondary Cache

With each CPU, Tezro includes a 4MB DDR full-speed SDRAM secondary cache, which is directly controlled by the MIPS processors.

5 System Memory

Tezro users work with massive and complex models, simulations, and animations. To provide the highest levels of application performance and interactivity for image manipulation and real-time visualization with large models and data sets, SGI has designed Tezro with the headroom to support up to 16GB of 200 MHz double-data rate RAM. To further stoke system performance, SGI has built an industry-leading 3.2GB per second bidirectional memory bus into the Tezro design.

Base memory for single-processor Tezro systems is 512MB, 1GB for single-chassis, multi-processor systems. Tower configurations can accommodate a total of 8MB of system memory, while rack mount systems can support 16MB. Eight DIMM sockets can be configured with a broad range of memory upgrades, with the largest DIMM upgrade configuration limited to 2GB.

6.0 64-bit IRIX OS

Key to the sustained application performance and reliability of Tezro is IRIX, the mature 64-bit UNIX operating system whose roots originate from IRIX 6.0, introduced in 1994. Tezro was introduced with IRIX 6.5.20. IRIX® 6.5.2x releases are UNIX 95 certified by the Open Group and supports all major industry standards, including POSIX®, UNIX SVR4, Year 2000, X11 and Motif™, and OpenGL®.

For all users, IRIX 6.5 provides full backward and forward binary compatibility. Each new quarterly update of IRIX 6.5 is a superset of the previous update, hence there is no need to get new versions of applications to support IRIX updates.

6.1 Proven and Reliable Computing Environment

Implemented in large-scale installations the world over, the IRIX operating system is recognized for its stability, scalability, consistency, and richness of functionality. IRIX 6.5 supports 64-bit registers, data manipulation, application development, and access to local and remote 64-bit files and filesystems. IRIX is designed to handle data file sizes of up to 9 million terabytes, and filesystems of up to 18 million terabytes.

The IRIX real-time environment also includes REACT™ and Guaranteed I/O, which together provide consistent and reliable performance. The environment guarantees a maximum latency of 50 us (microsecond) in systems driven by two to 64 processors.

The system can automatically perform predictive analysis on certain components, such as the floating point unit, to identify problems before they affect the availability of the system. IRIX also conducts sophisticated power-on diagnostics every time the system is restarted. In the event of a kernel crash, IRIX automatically analyzes the failure to determine which components have most likely failed. If the failed component is identified with enough certainty, IRIX deconfigures the failed component from the system before rebooting. This allows the system to resume services and continue until service personnel repair the problem, minimizing downtime and preserving productivity and data for mission-critical applications.

6.2 Trusted Operating System

With a security-enhanced feature set, Trusted IRIX™ CMW (an optional version of IRIX) provides a strict security framework so that when application programs run on the system and users attempt to access files, their access is limited to data permit-

ted by a Multilevel Security (MLS) policy. MLS operating systems compartmentalize user interactions according to specific security labels. User and process labels contain two main elements: sensitivity level and sensitivity category. This access structure extends above and beyond classical user permission and group permission schemes available in standard UNIX. These additional operational restrictions need not be hostile to the average or even novice user. Users can continue to execute policy-abiding functions while unauthorized accesses are disallowed before data is compromised.

Trusted IRIX CMW is a significant improvement over conventional secured operating systems derived from the standard UNIX kernel and it is fully integrated with the SGI® IRIX® operating system. High-performance capabilities available in SGI IRIX —such as real-time response guarantee and storage area networks (SANs), and others—continue to be operational in Trusted IRIX CMW. Because MLS is a fully integrated feature, it will not adversely affect your system's performance. The MLS framework present in a Trusted IRIX CMW system asserts three fundamental security aspects: policy, accountability, and assurance. Trusted IRIX CMW is fully configurable to your site's security policy requirements. The security administrator is able to program the site's own security clearance definitions and limitations, permitted special operational capabilities, file access control lists, and choice of password protection scheme. Trusted IRIX CMW allows for auditing and monitoring of key and site-defined operational events, such as file access and modification, network access and modification, invocation of programs, login and logout, and unauthorized attempted accesses to files. The audit log could be used to discover malicious intent.

Trusted IRIX CMW and IRIX are developed to conform to functional requirements set forth in the Common Criteria for IT Security Evaluation (ISO Standard 15408) protection profiles. Labeled Security Protection Profile (LSPP) is derived from the U.S. National Computer Security Center 5200.28-STD Department of Defense Trusted Computer Systems Evaluation Criteria (TCSEC—Orange Book) for a B1-level trusted operating system. Controlled Access Protection Profile (CAPP) is based on a TCSEC C2 security level. Today, Trusted IRIX is evaluated at the assurance level of an LSPP system. IRIX is evaluated at the assurance level of a CAPP system. Formal certification for Trusted IRIX and IRIX was achieved in May 2002. The DII-COE Kernel Version 4.2 p6 also has been certified for IRIX 6.5.17, enabling IRIX to conform to requirements of the Defense Industry Common Operating Environment, a set of common standards established for defense contractors and users.

6.3 Optimized for Complex Applications

IRIX 6.5 has been optimized for large, complex applications, and can handle data file sizes of up to 9 million terabytes, and filesystems of up to 18 million terabytes. The operating environment accommodates RAM of up to 1 Terabyte, and features an extensive set of Data Center Resource Management Tools for tuning run-time applications.

Performance bottlenecks are minimized with solutions like data locality which enables the CPU to access the closest data available. The IRIX operating system's memory page size of 16KB to 16MB is well-suited for processes that require large amounts of data and benefit from less paging with the larger page size. In addition, the MIPSpro™ C, C++, Fortran 77, and Fortran 90 compilers are architected to maximize productivity from the MIPS processors. The compiled code is functionally accurate and uses the algorithms to generate the best performance for the executable. Many of the features once available only for supercomputers have been developed for IRIX 6.5. These features that know how to manage and optimize large processor systems, large datasets, and complex applications, are mainstream on SGI's server systems based on MIPS processors and benefit Tezro users.

6.4 Bundled Tools, Utilities and Libraries

As heterogenous computing environments become more prevalent, users need a way to easily integrate new systems into their existing work environments. Every Silicon Graphics Tezro visual workstation system includes connectivity software that makes it easy to blend the workstation into heterogeneous environments. With built-in applications such as 128-bit Netscape® Communicator®, SGI Apache Web Server, Xinet® AppleTalk® (demo version), and Samba® (optional), SGI systems can instantly share files and printers with PC and Mac® systems. Web-based help lets users access documentation anywhere on their systems, networks, or the Internet, ensuring access to the most up-to-date technical information. The task-based system administration utilizes the intuitive look and feel of the Web and guides users through all system-management procedures.

A wide range of software tools, utilities and run-time libraries also are bundled with the IRIX operating environment.

7.0 Collaborative Software

7.1 OpenGL Vizserver

OpenGL Vizserver is an SGI technical and creative computing solution that delivers advanced visualization capabilities and performance to remote desktop users over standard networks. As a component of Visual Area Networking (VAN), OpenGL Vizserver allows users to collaboratively view and interact with large data sets stored on a large visualization server using virtually any client connected to standard networks.

OpenGL Vizserver has two major functions: to provide application-transparent remote access to high-end graphics resources, and to enable application-transparent collaborative visualization functionality to multiple simultaneous users. The ability to remotely leverage the visualization power of Tezro is ideal for users who are unable to interact with their complex models or who have long waits for data to load and CPU-intensive analysis to complete. When using OpenGL Vizserver, these users will have an experience at the remote desktop that is close to—and in some cases even identical to—the experience of being right at the Tezro system.

Tezro can participate in a Visual Area Network as either a client or as a server.

When used as a client, Tezro users can access the scalable visualization, compute, memory and I/O capabilities of SGI® Onyx® family systems, or they can collaborate with other SGI workstation users who are running the OpenGL Vizserver server on their Tezro, Octane2™, Octane® or Silicon Graphics Fuel® workstation. When running as a client, Tezro users can use remote stereo as well as standard mono-scopic applications. The OpenGL Vizserver client is freely downloadable from http://www.sgi.com/products/evaluation/index.html#gl_viz.

Tezro users planning to utilize their Tezro workstation as a visual server have the option of purchasing the OpenGL Vizserver Workstation Server & Collaboration bundle for personal collaboration with one remote client. Or, they can purchase separate OpenGL Vizserver server and collaboration licenses, which increase the total number of collaborative participants to five or more. The OpenGL Vizserver server is also downloadable from the same location.

Standard OpenGL applications running on Tezro or on a remote visual server run in both single remote user and collaborative mode without modification. This means that individuals and organizations can immediately benefit from the power of these systems without waiting for new applications to be written or new networks to be installed.

Unaltered applications running on Tezro use the full 3D graphics functionality of VPro V12 graphics and generate visual results in the graphics frame buffer. OpenGL Vizserver then takes the visual results from the frame buffer, compresses them, and sends them to the desktop client, where they are displayed with the performance and functionality available with Tezro. Users at the visualization server and/or on remote client workstations can collaborate on the data simultaneously, in real time. Since it runs over standard TCP/IP networks, there is no need for costly and restrictive special-purpose networking. OpenGL Vizserver is application transparent and supports OpenGL API-compliant applications.

Because OpenGL Vizserver is a fully threaded application, it can take full advantage of multiple processors in a Tezro visual workstation. Remote users and collaborative sessions that are using Tezro as a server will see higher application performance with a quad-processor system.

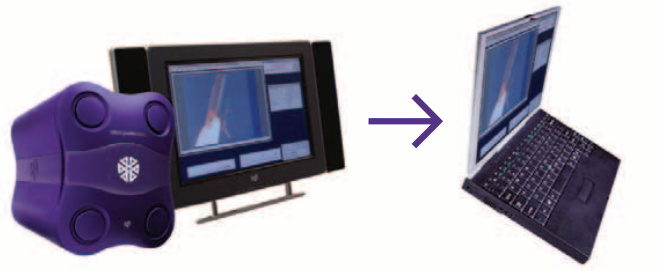

Figure 7.1 Silicon Graphics Tezro has the bandwidth and multiprocessing strength that facilitate Vizserving

7.2 SGImeeting

SGImeeting is a data conferencing tool that enables distributed users to collaborate with each other regardless of what operating system they are using. SGImeeting lets users team up with professionals on systems that use Microsoft® Windows®, Sun™ Solaris™, Apple® Macintosh®, or any system on which an International Telecommunications Union (ITU) T.120 compliant tool is used, including Microsoft® NetMeeting® and SunForum™.

7.3 SGI WebServer

SGI WebServer is based on Apache 1.3.27a, and is a robust, commercial-grade, full-featured, and freely-available source code implementation of an HTTP (Web) server.

7.4 APIs

IRIX incorporates a number of application programming interfaces (APIs) that enable a software developer to build advanced 3D and digital media applications to provide solutions for markets such as CAD/CAM, visual simulation, and entertainment. These include:

- **OpenGL**
  The OpenGL API began as an initiative by SGI to create a single, vendor-independent API for the development of 2D and 3D graphics applications. Prior to the introduction of OpenGL, many hardware vendors had different graphics libraries. This situation made it expensive for software developers to support versions of their applications on multiple hardware platforms, and it made porting of applications from one hardware platform to another very time-consuming and difficult. SGI saw the lack of a standard graphics API as an inhibitor to the growth of the 3D marketplace and decided to lead an industry group in creating such a standard. The result of this work was the OpenGL API, which was largely based on earlier work on the SGI® IRIS GL™ library. The OpenGL API began as a specification, then SGI produced a sample implementation that hardware vendors could use to develop OpenGL drivers for their hardware.
- **OpenGL Performer™**
  OpenGL Performer is a high performance 3D rendering toolkit for developers of real-time, multiprocessed, interactive graphics applications for the SGI product line. OpenGL Performer dramatically simplifies development of complex applications such as visual simulation, simulation-based design, virtual reality, interactive entertainment, broadcast video, CAD and architectural walk-through, while providing a high performance portability path across the entire SGI product line.
- **OpenGL Volumizer™**
  OpenGL Volumizer is the industry's first commercially available, high-level immediate mode volume rendering API for the energy, medical and sciences markets. It features such advanced techniques as dynamic space-leaping tessellation, which is used to discard areas that contain void data, thus eliminating unneeded fill effort. The tessellation can be rapidly re-computed to reflect changes to viewing parameters.
- **OpenGL Multipipe™ SDK**
  OpenGL Multipipe SDK is an API layer for OpenGL that provides a straightforward solution for graphics applications that were designed for single-processor, single-pipe applications to scale seamlessly when run on graphics systems with multiple processors and multiple graphics pipes. Applications written using the OpenGL Multipipe SDK API can run seamlessly from desktop single-processor, single-pipe systems up to large multiprocessor, multipipe scalable graphics systems.
- **OpenML**
  This standard API for graphics, video and audio media devices is discussed in detail in Section 11.9.

8 VPro V12 graphics

The many unique hardware features of the high-performance SGI VPro graphics architecture available in the Silicon Graphics Tezro visual workstation make this system well suited to applications that require high-quality images without compromising performance.

With dedicated host connectivity of 1.6GB per second, VPro V12 graphics features 128MB of graphics memory. As a result, Tezro users enjoy extremely fast geometry and fill-rate performance for high-speed drawing – even with highly complex designs – and high-speed image generation, even with fully textured designs. They also receive maximum flexibility with color and screen resolutions and off-screen graphics memory. SGI VPro V12 graphics also employs advanced texture management with up to 104MB of texture memory with a standard 1280 x 1024 resolution and asynchronous texture download capabilities, allowing interactive rendering of volumetric data sets and rapid processing of textures.

Another key advantage to VPro V12 graphics is its 48-bit (12-bit-per-component) deep-pixel support, which can be used within applications to improve both image quality and workflow productivity. This support for double-buffered, 12-bit-per-component color precision is found not only within the frame buffer used for image display but also throughout the entire OpenGL hardware rendering pipeline. This level of 12-bit-per-component support sets VPro graphics apart in the industry.

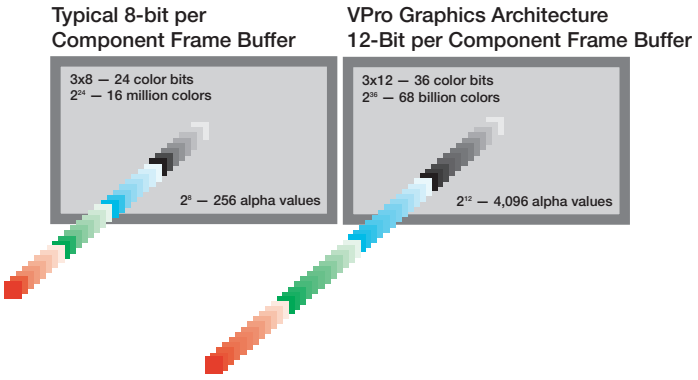

Figure 8.1 Tezro delivers deep-bit pixel support

The VPro V12 graphics architecture also incorporates:

- Integrated vertex processing engine
- Integrated image and texture engine
- 24-bit eye space Z buffer and 8-bit stencil buffers
- 10-bit digital-to-analog (DAC) display interface
- Multiple concurrent visuals (8-bit window ID)
- Swap-ready and genlock

8.1 OpenGL on a Chip

A departure from traditional SIMD graphics systems, the VPro graphics architecture consists of only two principal ASICs: OpenGL on a Chip for transformation and rasterization and a back-end video ASIC that combines the pixel streams from the raster unit and outputs the resulting pixel data to the DAC(s).

Unlike other SIMD architectures, the single-chip design of the VPro graphics architecture does not have the strip length, context switch, or other interchip communication drawbacks. Lighting is fully hardware accelerated for both per-vertex and per-pixel shading. Texturing features include 2D and 3D textures, texture color tables, texture coordinate clamp, texture LOD (level of detail) bias, texture scale bias, detail texture, pixel texture, borders, post-texture lookup tables, specular shading, and post-texture specular highlights. This hardware acceleration aids in the accurate lighting of 3D models and the creation of Phong effects without a performance degradation.

The single-chip design and full hardware OpenGL hardware acceleration also enable efficient execution of an array of high-end graphics effects, including:

- Convolution, histogram, color matrix, color table
- Hardware accumulation buffer
- Quad-buffered stereo support
- Perspective-correct texture and color
- Per-pixel fog, fog function, fog offset
- Line anti-aliasing
- Hardware-assisted full-scene anti-aliasing
- Blend color, blend logic op, blend minmax, blend subtract

8.2 Dual Channel Display Option

A Dual Channel Display option is also provided via a daughter card on the V12 graphics board. Dual Head graphics are also available in the Tezro 4U rackmount configuration. The Tezro Dual Channel Display option is a cost-effective video output option that enables a single Tezro V12 graphics subsystem to drive two display channels. This doubles the display area for enhanced viewing and information management on each screen.

The Tezro Dual Channel Display option creates an ideal solution for markets such as medical, visual simulation, oil and gas, and digital content creation, where additional screen space is especially important. The Dual Channel Display option provides two analog outputs capable of driving CRTs with pixel frequencies of 220 MHz or two Silicon Graphics® flat panel displays, with high-resolution support of up to 1920x1200 at 72 Hz on each screen. The option includes a unified window manager and desktop for efficient information management on each screen.

The Tezro system also can be configured to drive three-way display splitter for sharing and collaboration. In addition, the Dual Channel Display option can be combined with the Dual Head option to drive three or four displays with the same system.

For applications requiring stereo viewing capabilities, a Dual Head Display option, explained below, is available for Tezro.

8.3 Dual Head Display Option

The Dual Head option allows users to drive two texture-intensive graphics heads from the same Tezro system. Designed for applications that require additional screen space on two separate screens, the Dual Head option allows for independent windows on each head and gives programmers the flexibility they need for advanced data modeling and analysis applications. One head might continuously display complex visual information such as seismic data, while the other head is reserved for the user interactions required to analyze and update the visual data.

The Dual Head Display Option for Tezro provides high-resolution support with up to 1920x1200 at 60 Hz or 72 Hz on each screen. Each display is stereo-capable. Combined with the Dual Channel Display option, the Dual Head option can drive up to four displays with the same system, although adding Dual Channel eliminates stereo viewing capabilities.

8.4 Visual Formats

The Tezro visual workstation features a wide range of cost-effective and industry-leading display capabilities:

- RGBA (8,8,8,8) double-buffered, 24-bit Z buffer, 8-bit stencil
- 32-bit RGBA (10,10,10,2) double-buffered, 24-bit Z buffer, 8-bit stencil
- 48-bit RGBA (12,12,12,12); double-buffered; 16-bit Z buffer
- 16-bit RGBA quad-buffered (stereo), 24-bit Z buffer, 8-bit stencil
- 12-bit Colorindex, double-buffered, 24-bit Z buffer, 8-bit stencil
- 12-bit Colorindex, quad-buffered (stereo), 24-bit Z buffer, 8-bit stencil
- 8-bit overlay and 8-bit window ID
- 96-bit (24,24,24,24) hardware accumulation buffer

The Tezro system enables display resolutions ranging from 640x480 at 60 Hz up to 1920x1200 pixels at 60 Hz and 72 Hz.

9 Storage

Tezro features a broad range of internal and external storage options to accommodate the large data sets, models and file sizes generated by technical and creative users.

Two internal 3.5-inch bays accommodate hard drives that can be removed without tools. Base Tezro configurations come with an 18.2GB Ultra160 SCSI disk operating at 15,000 RPMs. Both tower and rackmount systems can accommodate an optional 72.8GB Ultra160 SCSI disk operating at 10,000 RPMs, giving Tezro a total internal hard drive storage capacity of 145.6GB.

The Tezro tower unit also includes a 5.25-inch, half-height option drive storage bay, while the rackmount configuration includes an internal slim-line CD/DVD-ROM bay. These internal bays allow Tezro users to include an optional DVD-ROM drive in their tower or rackmount configuration.

External storage options include a DVD-RAM drive, as well as DDS4 DAT Drive, in addition to SGI® Total Performance 900, SGI® Total Performance 9100, SGI® Total Performance 9300, and SGI® Total Performance 9500 storage systems.

10 I/O Connectivity and Networking

Silicion Graphics Tezro visual workstations feature versatile networking options including industry-standard PCI-X, PCI, and Ethernet. And with OpenGL Vizserver, users can leverage the Tezro system's superior visualization capabilities on remote desktop systems, further maximizing their return on investment in Tezro. (For details, see section 7.1.)

10.1 Integrated PCI-X

With Tezro, SGI is introducing integrated PCI-X connectivity into a workstation for the first time. With seven PCI-X slots in a multi-processor system, Tezro distinguishes itself as a system engineered specifically for users in highly demanding environments, such as medical sciences and media creation and production. These technical and creative professionals will find that Tezro provides the expansion options they need to maximize their productivity.

The Tezro visual workstation incorporates integrated 64-bit/133/100 MHz PCI-X buses compatible with 3.3 V and Universal 64-bit/66 MHz PCI. PCI-X and PCI interface options vary by Tezro configuration:

Tower System	PCI-X Slots	PCI Slots
1 CPU	3 (at 133/100 MHz)	0
2 or 4 CPUs	7 (at 133/100 MHz)	0

Rack-Mountable	PCI-X Slots	PCI Slots
1, 2 or 4 CPUs (2U)	2 (at 100 MHz)	1 (at 66 MHz)
1, 2 or 4 CPUs (4U)	6 (at 100 MHz)	1 (at 66 MHz)

10.2 Ethernet and Other Connectivity

The Tezro system's networking features also include:

- Onboard Ethernet operating at 1Gb per second
- XIO interface to VPro V12 graphics, DMedia Pro modules, and optional VME
- Ultra160 SCSCI buses (internal and external)
- Four serial ports on rackmount; two on tower
- PS-2 keyboard and mouse ports
- 2-loop, 2Gb Fibre Channel (optional)
- IEEE 1394 interface (optional)

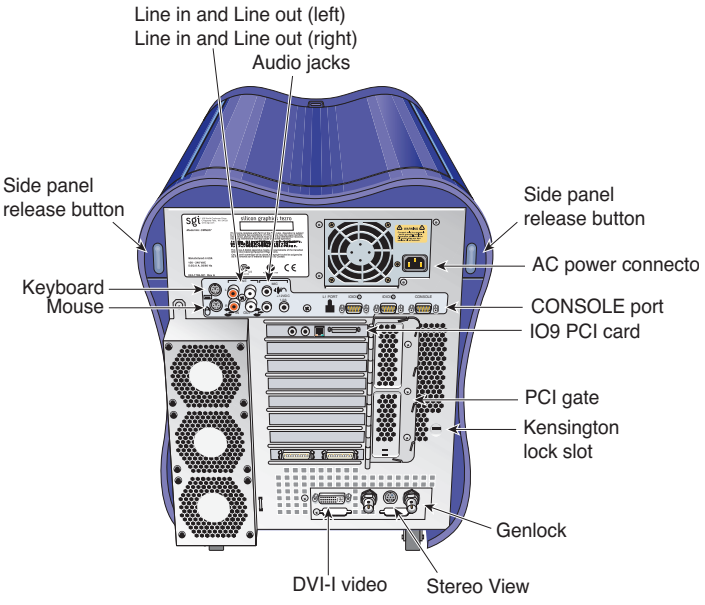

Figure 10.1 Rear view of the tower configuration

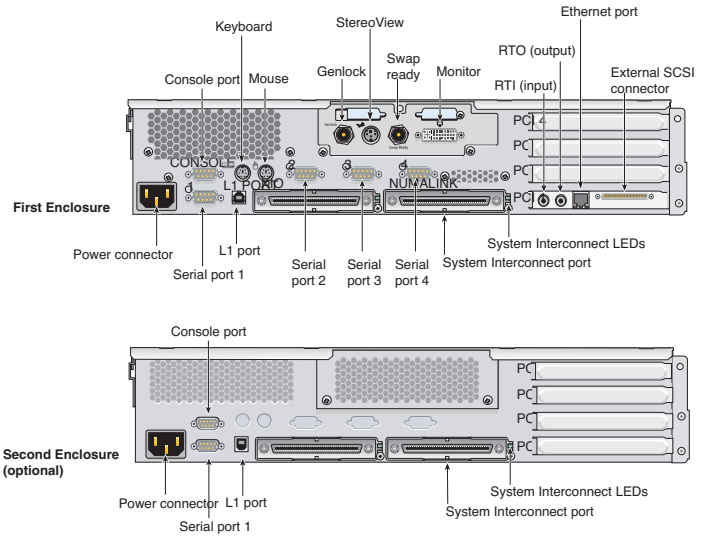

Figure 10.2 Rear view of the rackmount configuration

11 DMediaPro Video Options

A full suite of DMediaPro options is available for Silicon Graphics Tezro. With DMediaPro, media and creative professionals can make their Tezro system the highest quality, most powerful, and most complete multi-resolution workstation available. The Tezro system's high-bandwidth architecture provides the data throughput required for broadcast, post-production, and film.

Along with the baseline analog audio output capabilities and desktop speakers that come standard with the Tezro tower workstation, users have access to optional analog audio via the DMediaPro DM8 option via a PCI card on the rackmount system. An IEEE 1394 Digital Video interface also is available via DMediaPro DM10 option.

SGI also enables users to upgrade their systems with a full series of high-end SD and HD video I/0 solutions. They include:

11.1 DMediaPro DM3 High-Definition and Standard-Definition Video I/O

DMediaPro DM3 for the Tezro visual workstation allows users to process high-quality uncompressed HD and SD digital video. The combination of DMediaPro DM3 and the Tezro workstation adds support for playback of two streams of uncompressed 10-bit 4:4:4 HDTV and single stream of 10- and 12-bit 2K data and 8-bit 3K data. This option also offers two independent input and two independent output channels that can be combined for a dual-link signal with video and alpha. HD support includes all major film, broadcast, and postproduction HD formats, including 1080p, 1080i, and 720p, while SD support includes PAL and NTSC timings. Features include:

- 4:2:2 or 4:4:4 YCrCb video sampling with 8- or 10-bits per component
- 4:4:4 RGB video sampling with 8- or 10-bits per component
- Support for full sample rate alpha channel (8- or 10-bits)
- Patented real-time colorspace conversion
- 16x9 or 4x3 aspect ratio
- Video BreakOut Box (VBOB) provides SDI and genlock connections
- Support for OpenML (See section 11.9)

11.2 DMediaPro DM5 High-Definition and Standard-Definition Graphics-to-Video Output

DMediaPro DM5 offers high-quality uncompressed HD and SD graphics-to-video output from 3D graphics, 2D imagery, and video data. All major film, broadcast, and postproduction HD formats are supported, including 1080p, 1080i, and 720p, while SD support includes PAL and NTSC timings. DM5 for the Silicon Graphics Tezro visual workstation is designed to be used in conjunction with DMediaPro DM3 to deliver unrivaled desktop video quality, versatility, and performance. Features include:

- Patented real-time colorspace conversion from RGB to YUV
- Support for user-definable region of the graphics frame buffer for display
- 4:2:2 or 4:4:4 YCrCb video sampling with 8-or 10-bits per component
- 4:4:4 RGB video sampling with 8- or 10-bits per component
- Support for full sample rate alpha channel (8- or 10-bits)
- 16x9 or 4x3 aspect ratio
- Video BreakOut Box provides SDI and gunlock connections
- Compatibility with DM3 and DM6 and support for their respective formats
- Support for OpenML (See section 11.6)

11.3 DMediaPro DM6 Standard-Definition Digital I/O

DMediaPro DM6 for Tezro offers high-quality uncompressed SD digital video at an attractive solution price. Format support includes PAL and NTSC timings. DMediaPro DM6 offers industry-standard BNC connections to external video devices via serial digital interfaces for video I/O and an analog genlock input for locking to house sync. Multiple video streams can be routed directly to and from main memory in real time. High-quality real-time colorspace conversion during input and output supports capture and playback of RGB or YCrCb to and from disk arrays. The OpenML software development kit provides a robust programming interface and ensures audio and video synchronization.

Other features include:

- Support for NTSC (480i) and PAL (576i) SD digital component video formats
- 4:2:2 YCrCb video sampling with 8- or 10-bits per component
- 4:4:4 RGB video sampling with 8-bits per component
- Selectable overlay of digital outputs
- Universal half-length single-slot PCI board for 32- and 64-bit PCI bus, operable at 3.3 and 5 volts
- SMPTE 259M SDI video I/O

11.4 DMediaPro DM8 Audio I/0

The DMediaPro DM8 PCI option provides the SGI Tezro workstation with high-quality surround sound and recording capability. This option is available on Tezro rackmount systems. Key features include:

- 24-bit/192 KHz audio playback on all output channels.
- Supports all speaker configurations from stereo (or headphones) up to 7.1
- Analog line in supports recording up to 24-bit/96 KHz
- Analog microphone in supports recording up to 24-bit/96 KHz
- S/N Ratio A->D: 100 dB
- S/N Ratio D->A: 107 dB (eight channel/two channel)

11.5 DMediaPro DM10 IEEE 1394 Digital Video Interface

Connectivity via PCI/PCI-x to video devices is enabled by the DMediaPro DM10 IEEE1394 interface card. In addition to data transfer rates of up to 400Mb per second, the DM10 leverages IRIX support for the IIDC Video 1394-based protocol.

For video devices, SGI recommends the use of GlobalMedia GM051394-KD 1394 FireWire camera with legs. The 1394 KD Camera has a remarkably sharp image. It facilitates videoconferencing in a variety of situations with a set of legs that are not only stylish, but also perfectly practical for a laptop. This user-friendly camera has a universal mount, a manual focus ring, a 1394 FireWire connection for quick and clear imaging, and a noise reduction feature to eliminate vertical bands from the picture.

11.6 OpenML Support

The SGI DMediaPro family of products is compatible with OpenML. OpenML is a standard API for graphics, video and audio media devices that allows digital content application developers to more easily integrate video and graphics capabilities into their application suites and will make these applications more portable over multiple operating systems, CPU architectures and add-in hardware devices. Similar to the API standards provided by OpenGL, OpenML consists of standard techniques for input and output of digital video and audio data, and includes extensions to OpenGL to support seamless video and graphics integration.

12.0 Conclusion

Increasingly driven to deliver cutting-edge results in ever shorter production cycles, designers, scientists, engineers, defense specialists, film producers, and geophysicists are facing the toughest computing challenges in history. Yet they recognize that data sets will only grow larger, filesystems more complex, and applications more demanding.

The balanced, 64-bit architecture of the Silicon Graphics Tezro visual workstation sets a new standard for performance, bandwidth, scalability, I/0 connectivity and digital media functionality. Tezro is expressly designed to address today's most advanced visual computing challenges, while providing the headroom, scalability and reliability to serve tomorrow's high-productivity environments.

For more information on Tezro, visit
www.sgi.com/workstations/tezro

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