



Power Mac G5 Performance

White Paper
June 2003

Contents

Page 3	World's Fastest Personal Computer
Page 4	System Performance Processor Serial ATA FireWire 800
Page 9	Application Performance Design and Graphics Audio Production Scientific and Technical Computing 3D Gaming
Page 15	Test Details

World's Fastest Personal Computer

Power Mac G5 Performance Highlights

Compared with a dual 3.06GHz Xeon-based workstation, the dual 2GHz Power Mac G5:

- Scored significantly higher on industry-standard SPEC CPU2000 "rate" benchmarks for dual processing systems.¹
- Ran 45 Adobe Photoshop filters 2.2 times faster.²
- Played nearly 50 percent more simultaneous audio tracks.
- Executed BLAST word searches up to four times faster.

Apple's Power Mac G5 is a revolutionary 64-bit desktop system designed to meet the high-performance, no-compromise requirements of the creative professional. With 64-bit power and a high-bandwidth architecture, this groundbreaking new system alleviates the limitations and bottlenecks of the traditional PC—opening up a wealth of possibilities for 2D and 3D designers, video and audio producers, scientists and researchers, and game programmers and players.

All this performance begins with the 64-bit PowerPC G5 processor. Developed in collaboration with IBM and produced using state-of-the-art process technology, the PowerPC G5 yields clock speeds up to 2GHz. This breakthrough processing power combines with the industry's fastest frontside bus, a point-to-point architecture, high-speed memory, and the latest I/O technologies. The result? The world's fastest personal computer.³

How fast is it? Apple put the Power Mac G5 to the test against two top-of-the-line competitive systems. The Dell Dimension 8300, equipped with the latest 3GHz Pentium 4, provided a baseline for most of the tests. We also tested the Dell Precision Workstation 650 with dual 3.06GHz Xeon processors. Although the Power Mac G5 supports more memory than either of the Dell systems, all systems in each test were configured with equal amounts of memory.

For overall system performance, Apple relied on SPEC CPU2000, the most respected benchmark suite in the industry. For real-world performance, we tested popular applications for creative professionals, including Adobe Photoshop and Logic Platinum from eMagic. All Mac systems used Mac OS X v10.2 "Jaguar"; unless otherwise noted, the competitive systems used Windows XP Professional Service Pack 1.

Test results clearly demonstrate the superior processing performance of the Power Mac G5, as well as faster performance in key application categories. We invite you to learn more about the capabilities of the Power Mac G5 with the 64-bit PowerPC G5 processor.

System Performance



The PowerPC G5 processor

The groundbreaking Power Mac G5 sets a new standard for desktop computing. It's the industry's first 64-bit personal computer, with the industry's fastest frontside bus and the latest I/O technologies—including up to 500GB of internal Serial ATA storage⁴ and FireWire 800 for connecting high-performance devices.

Processor

The PowerPC G5 features an entirely new superscalar, superpipelined execution core based on the architecture of the IBM POWER4 server processor. It has 12 discrete processing units that execute various types of calculations in parallel: an optimized Velocity Engine, two floating-point units, two integer units, two load/store units, and a unique three-component branch prediction unit. By arranging internal operations using an efficient group-tracking scheme, the PowerPC G5 can manage up to 215 in-flight instructions simultaneously, 70 percent more than the 126 instructions in the Pentium 4.

Data bandwidth is further optimized thanks to a frontside bus—one on each processor in dual processor systems—running at up to 1GHz. This superfast interface provides 8-GBps throughput between each processor and the rest of the system, for an aggregate 16-GBps throughput in dual processor Power Mac G5 systems.

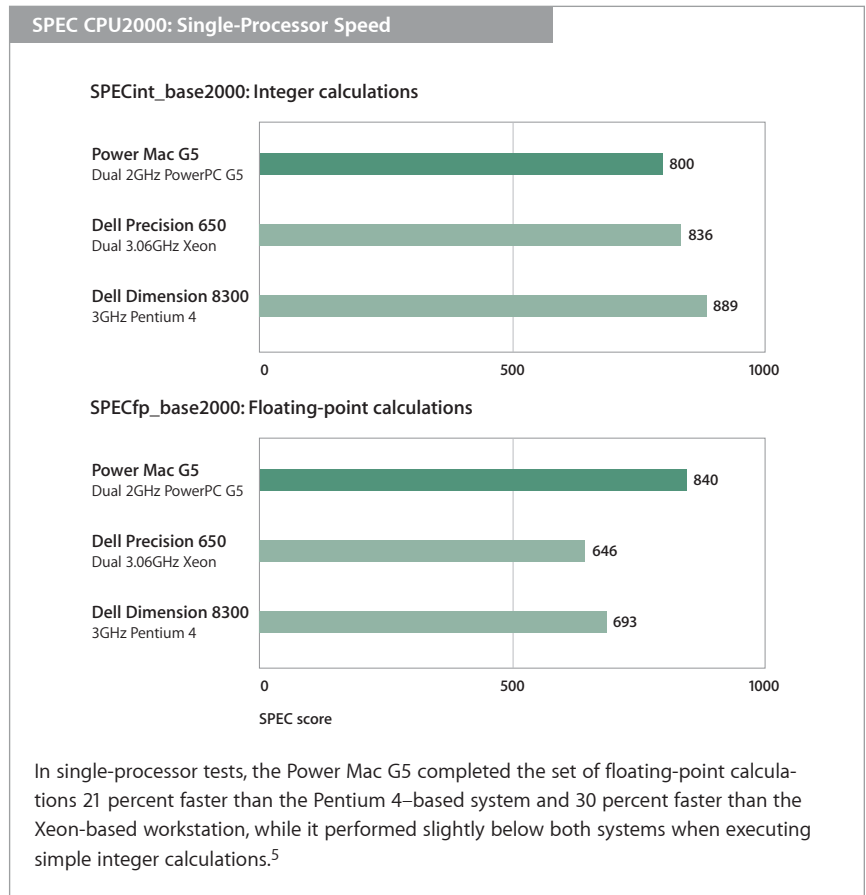
SPEC CPU2000

The Standard Performance Evaluation Corporation (SPEC) CPU2000 benchmark suite is the recognized industry standard for assessing processing performance. SPEC is a nonprofit organization of hardware and software vendors, universities, and consultants. They developed the SPEC CPU2000 benchmarks based on actual end-user applications. These tests depend on processor, memory subsystem, and compiler performance when executing integer and floating-point computations. For more information on the benchmarks, see www.spec.org.

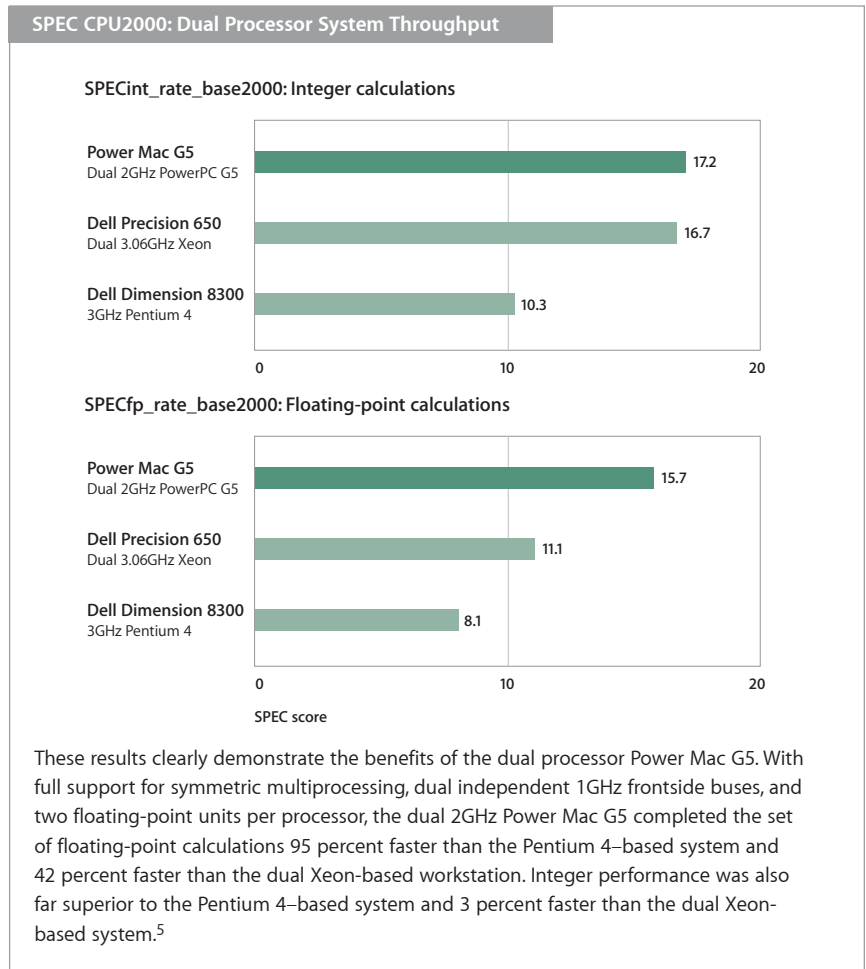
VeriTest, an independent testing service, conducted the tests according to the specifications on the SPEC website. SPEC provides the benchmarks as source code, which VeriTest compiled with GCC, a cross-platform, open source compiler used by programmers around the world. The Power Mac G5 used Mac OS X v10.2.7 (G5), and the Intel-based systems used Red Hat Linux 9.0.

The SPEC CPU2000 benchmark suite comprises four metrics—SPECint_base2000, SPECfp_base2000, SPECint_rate_base2000, and SPECfp_rate_base2000—to represent different performance characteristics of the system.

SPECint_base2000 and SPECfp_base2000 measure the speed of a single task—either an integer calculation or a floating-point calculation—executing on a single processor. Each test measures how long the processor takes to complete the benchmark set of single tasks relative to a SPEC-defined baseline score. SPECint_base2000 is composed of eleven C and one C++ benchmark applications, including a chess program, a data compression utility, and a place-and-route simulator. SPECfp_base2000 consists of six Fortran-77, four Fortran-90, and four C benchmark applications, including shallow-water modeling, neural-network simulation, and computational chemistry.



For comparisons that more accurately demonstrate the performance of a dual processor system, VeriTest used the “SPEC rate” metrics, which recognize multiple processors. With SPECint_rate_base2000 and SPECfp_rate_base2000, the benchmark code is compiled and multiple copies are run concurrently, allowing both processors to work in parallel. SPEC rate tests determine the number of times a system can complete the benchmark per hour, also referred to as system throughput.

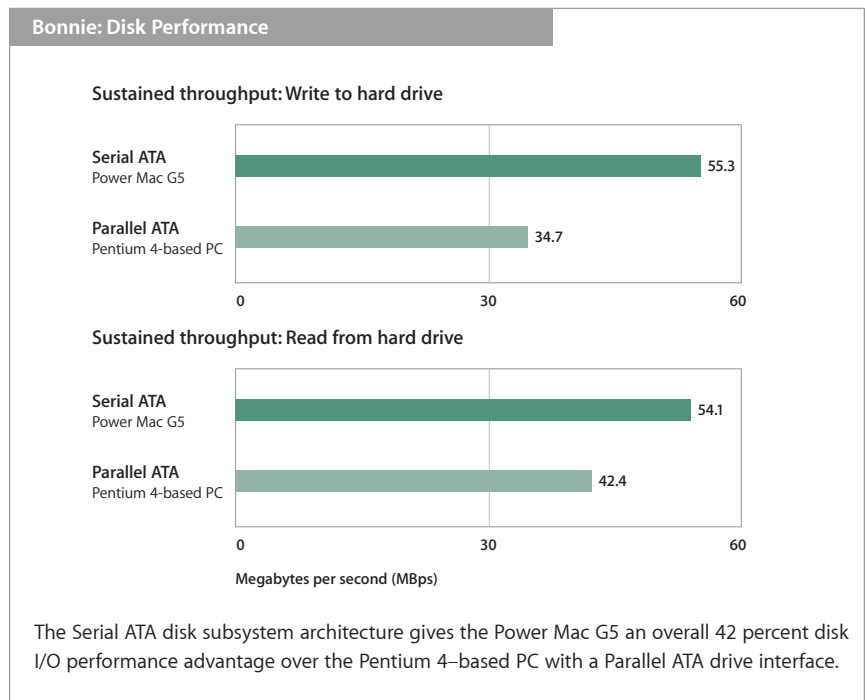


For a detailed report of SPEC CPU2000 test results, see www.veritest.com.

Serial ATA

Serial ATA is the next-generation industry-standard storage interface, replacing the Parallel ATA interface. Designed to keep pace with the demands of digital video creation and editing, audio storage and playback, and other data-intensive applications, Serial ATA supports a data rate of 150 MBps, removing the storage interface as a bottleneck. The Power Mac G5 features two internal Serial ATA drives, each on an independent bus—so there is no competition for drive performance, as with Parallel ATA.

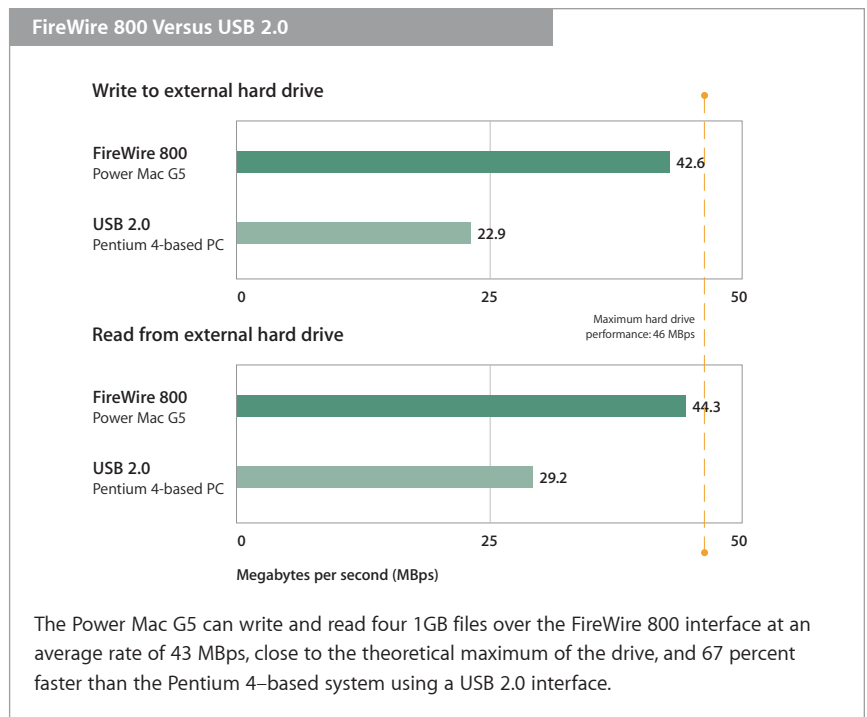
Apple tested storage performance using Bonnie, an open source benchmark, ported to Mac OS X by Apple. Bonnie measures the throughput of drive systems by writing to and reading from the disks using standard UNIX system calls, reporting results as maximum block read and write performance. A file-size setting of 2GB was used to ensure that the data was written to the disks and not to the drive cache or the RAID controller buffer.



FireWire 800

FireWire is a powerful I/O interface with a theoretical maximum throughput of 800 Mbps.⁶ FireWire is ideal for transferring large quantities of data to and from external devices, such as hard drives, DV cameras, and scanners. The Power Mac G5 features one FireWire 800 and two FireWire 400 ports for easy connection to these high-performance peripherals.

Apple compared the performance of the FireWire 800 interface on the Power Mac G5 with the performance of USB 2.0, the fastest standard I/O interface on Pentium 4-based systems. The test consisted of writing and reading four 1GB files to and from a 120GB Western Digital hard drive. With a maximum throughput of 46 MBps, this is the fastest external FireWire 800/USB 2.0 combination drive on the market.



Application Performance

The success of today's creative professionals depends on their ability to crunch increasing quantities of data quickly and efficiently. They need vast amounts of RAM to handle memory-intensive applications and enormous media files. They need superfast, sophisticated graphics capabilities to visualize complex 3D models and manipulate high-resolution images. And they need comprehensive input and output options to connect to a myriad of industry-specific peripherals.

The Power Mac G5 opens up a wealth of computing opportunities. Graphic designers can manipulate Adobe Photoshop images for print, web, and animation more than two times faster than on the fastest PC.² Video producers can manipulate multiple streams of DV and SD content in real time. Musicians and audio producers can process an unprecedented number of audio tracks, all with complex filters and digital effects. Scientists can execute high-precision math on extremely large 64-bit numbers and return results faster than ever. Artists, game developers, architects, and researchers can model and render complex 3D visualizations at remarkable speeds.

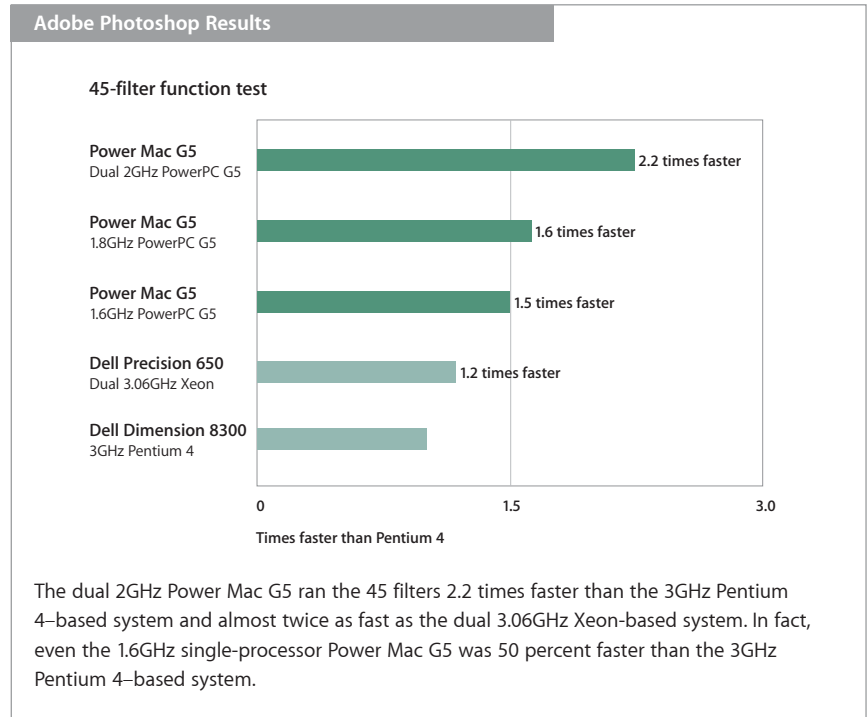
Design and Graphics

The Power Mac G5 provides the performance leap that design and publishing professionals have been waiting for. More system memory and a faster memory architecture make it possible to manipulate massive images and layouts entirely in RAM, reducing the need to access the hard drive. And with state-of-the-art I/O technologies—Gigabit Ethernet, SuperDrive, FireWire 800, and USB 2.0—standard on all configurations, designers and digital artists have fast and easy access to the peripherals that their workflows demand.

Adobe Photoshop

To demonstrate the superiority of the Power Mac G5, Apple conducted tests using Adobe Photoshop, the most popular application among creative professionals. Photoshop is an effective cross-platform measure of system performance because it has been optimized for both Macintosh and Windows platforms. It even takes advantage of the latest processor technologies on both platforms: SSE2 in the Pentium 4 and the Xeon, and Velocity Engine in the PowerPC G5.

Apple ran the Adobe Photoshop tests using a 600MB Photoshop file and a suite of 45 commonly used Photoshop actions, including file saving, image adjustments, mode changes, and filters. (See "Test Details" for a complete list.) We measured the time to execute each filter or function and compared the performance of all actions using an indexed score. The files were stored entirely in RAM, making this a good test of each system's processor and memory bandwidth capabilities.²



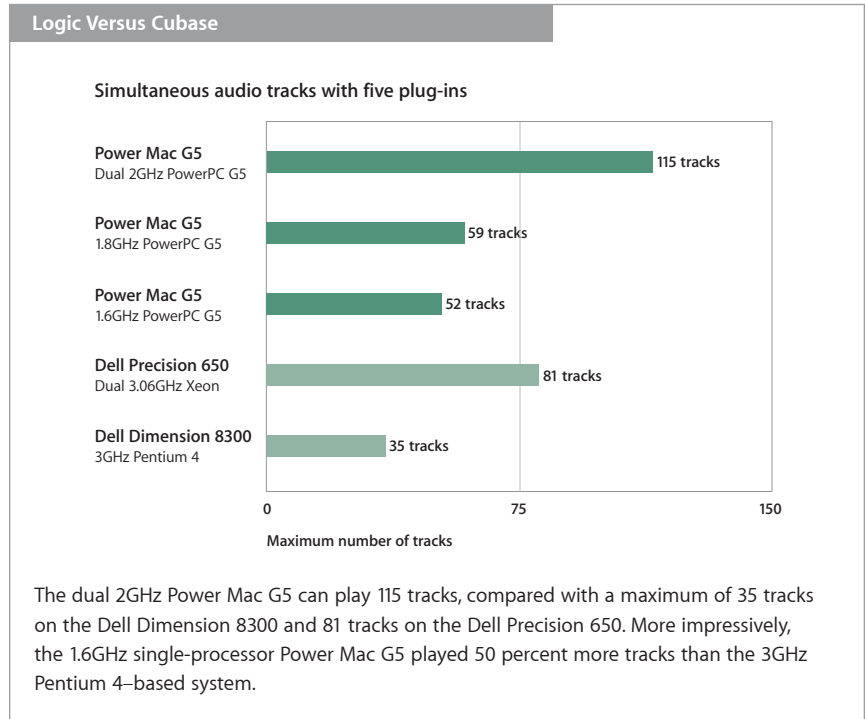
Audio Production

As digital audio rendering becomes more sophisticated, processing performance gains are paramount to the success of professional audio producers. The 64-bit G5 processor provides the computing power and the Power Mac G5 system architecture provides the bandwidth to support more simultaneous channels, plug-ins, and polyphony than ever before. FireWire 800 and USB 2.0 ports connect to high-performance MIDI and multichannel audio devices, and optical digital audio input and output ports connect to professional production equipment, as well as to traditional analog devices.

Logic versus Cubase

To quantify the performance advantages of the Power Mac G5 for audio production, Apple tested two of the industry leaders in professional audio software: eMagic's Logic Platinum for the Macintosh and Steinberg's Cubase SX 1.051 for the PC. We created a processor-intensive workload of projects containing multiple unique audio tracks; assigned five default reverb plug-ins to each of the audio tracks; and tested each platform to see which could play more plug-ins.²

For Logic, we used the default settings for the Fat EQ, AutoFilter, Chorus, and Silver Compressor plug-ins. For Cubase, we used an equalizer and the default settings for the StepFilter, Chorus, and Compressor plug-ins.



Scientific and Technical Computing

The typical researcher's desktop has two or more computers: a UNIX workstation for research and analysis applications; and a PC or a Mac for mainstream applications such as writing, budgeting, and presentations. The Power Mac G5 makes it possible for a researcher to run both productivity applications and high-performance UNIX applications on a single system. In fact, the impressive floating-point performance of the PowerPC G5 processor enables Power Mac G5 systems to outperform many UNIX workstations. The PowerPC G5 also significantly accelerates vector processing with the Velocity Engine—making the Power Mac G5 ideal for users in the life sciences, physical sciences, and other technical computing disciplines.

A/G BLAST

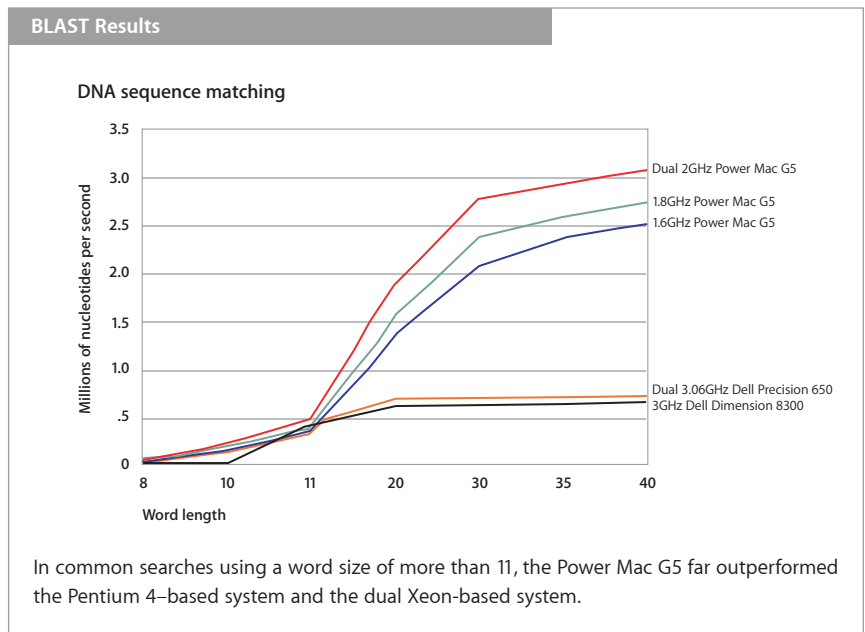
A/G BLAST is an optimized version of NCBI BLAST developed by Apple in collaboration with Genentech. Optimized for dual PowerPC G5 processors, the Velocity Engine, and the symmetric multiprocessing capabilities of Mac OS X, A/G BLAST makes a wide variety of searches available at higher speeds. Before A/G BLAST on the Power Mac, this kind of search was impractical, because it required an enormous amount of time.

BLAST

To demonstrate the performance advantages of the Power Mac G5 for processor-intensive scientific analysis, Apple used Basic Local Alignment Search Tool, or BLAST. BLAST is a popular open source biotechnology application used by life science researchers to find matches in DNA and protein sequences—a highly processor-intensive task.

BLAST searches are based on word size, or the number of nucleotide pairs specified by the researcher to register as a match. For example, a word size of 40 means that two sets of genetic code have 40 nucleotides in common. Different word sizes are used for different kinds of research, and users can adjust word size to the sensitivity appropriate to their needs. With long-word-size, or high-performance, searches, the researcher is looking for similarities between DNA sequences that are nearly identical—for example, comparing DNA samples from two different mice. For short-word-size searches (fewer than 11), the researcher is comparing more distantly related sequences, such as mouse DNA versus human DNA. These searches require high resolution in order to find the small matches between dissimilar sequences.

Apple compared the performance of the dual 2GHz Power Mac G5 running A/G BLAST with a 3GHz Pentium 4–based system and a dual 3.06GHz Xeon-based system, both running Red Hat Linux 9.0 and NCBI BLAST.²

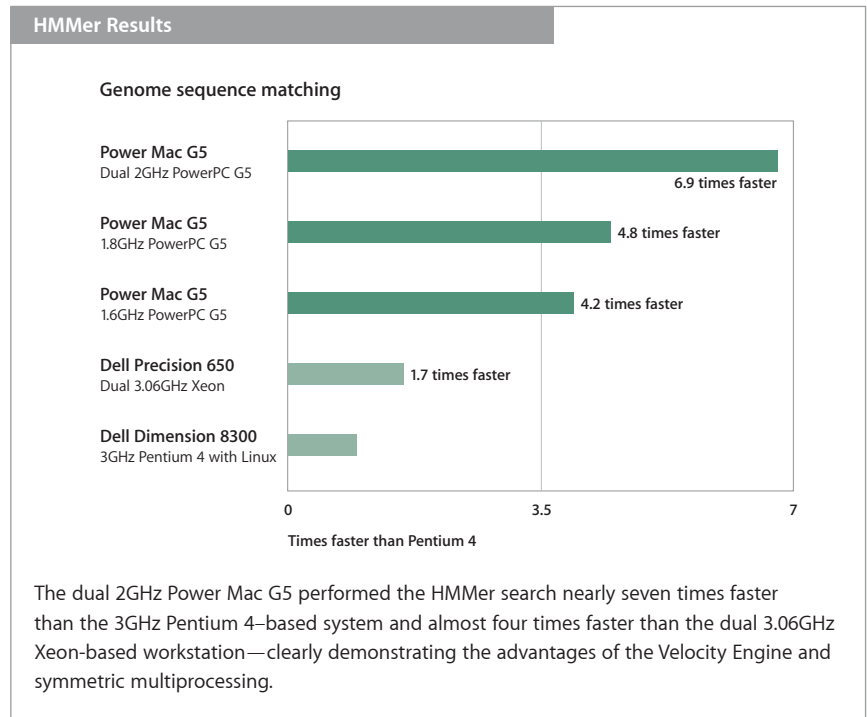


HMMer

HMMer is another application that demonstrates the performance advantages of the Power Mac G5 with Velocity Engine for processor-intensive scientific analysis. HMMer is a genome sequence–matching application that uses Hidden Markov Models (HMMs) to identify similarities in genetic structures—a critical task in areas such as speech recognition and protein and DNA sequence analysis. By representing the properties of a sequence family as a statistic, an HMM makes it possible to perform highly sensitive database searches.

Erik Lindahl of Stanford University has optimized the standard HMMer source code for the Velocity Engine. The core routines of HMMer repeatedly perform the same operation on large amounts of data. Utilizing single-instruction, multiple-data (SIMD) technology, the Velocity Engine enables the application to perform the same operation on four pieces of data in a single clock cycle. With Lindahl's optimized code, the performance of a HMMer search is now seven to eleven times faster.

To test the performance of the HMMer code, Apple searched for an HMM created from a 358-residue sequence in the protein databank (PDB) and measured the time to search the entire PDB. The Power Mac G5 used Mac OS X v10.2.7 (G5), and the Intel-based systems used Red Hat Linux 9.0.²





The ATI Radeon 9800 Pro features the industry's first 8-pixel pipeline architecture and a superfast 256-bit memory interface—enabling superior 3D rendering, sophisticated real-time effects, and unsurpassed image quality. A 128MB frame buffer supports large textures in the latest games and design applications, delivering a truly cinematic visual experience.

3D Gaming

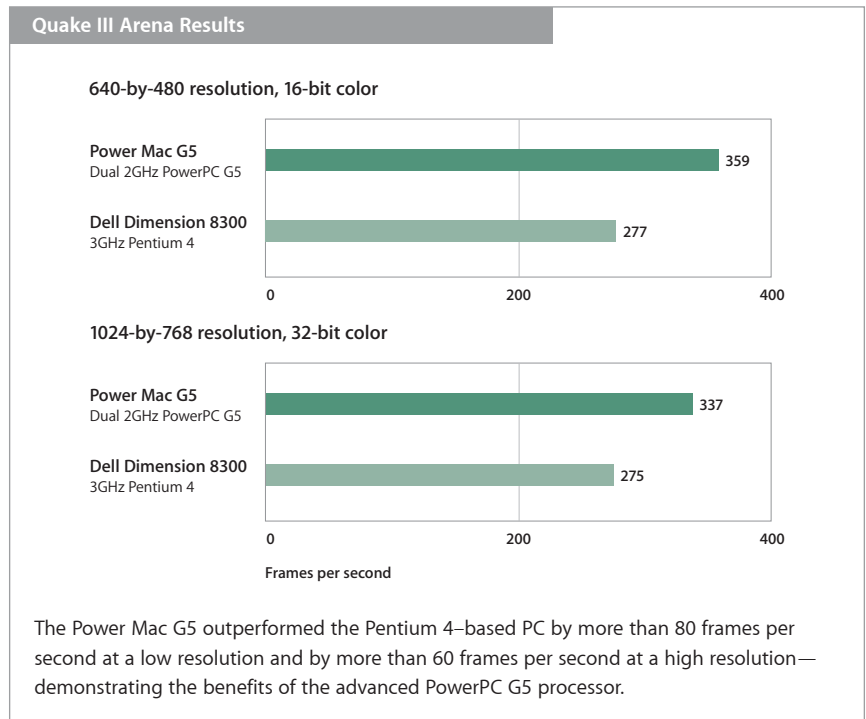
3D gaming involves complex visualizations and rapid movements that require maximum processor performance and top-of-the-line graphics capabilities. The Power Mac G5 provides a robust platform that not only supports the latest in 3D technology, but also delivers a great gaming experience.

An avid gamer understands that every frame per second counts when trying to survive in the gaming arena. With the addition of the latest graphics interface, AGP 8X Pro, the Power Mac G5 doubles the maximum data transfer rate over AGP 4X, and the amount of data transferred in a single AGP bus cycle also doubles. This advanced AGP technology combines with the superfast PowerPC G5 processor to deliver more frames per second at higher resolutions and with improved complexity and texturing.

Quake III Arena

Leading games such as iD's Quake III Arena bring the benefits of the Power Mac G5 to the forefront. The de facto industry standard for 3D game benchmarking, Quake III Arena stresses the system's processor and graphics card to provide a reliable representation of graphics performance.

Apple configured both the dual 2GHz Power Mac G5 and the 3GHz Dell Dimension 8300 with the same industry-leading graphics card, the ATI Radeon 9800 Pro. We tested Quake III Arena 1.32 at two resolutions to differentiate between demands on the processor and demands on the graphics card. The test was conducted with all default settings using the Demo_4 benchmark.²



Test Details

Adobe Photoshop Filters

- Save as PSD
- Save as TIFF
- Save as GIF
- Levels
- Curves
- Color Balance
- Hue/Saturation
- Desaturate
- Replace Color
- Variations
- Fill Selection
- Stroke Selection
- Transform Scale
- Transform Rotate
- Calculations
- Image Size
- Canvas Size
- Rotate
- Flip Canvas Horizontal
- Flip Canvas Vertical
- Blur More
- Gaussian Blur
- Motion Blur
- Add Noise Uniform
- Despeckle
- Dust & Scratches
- Sharpen
- Sharpen Edges
- Unsharp Mask
- Find Edges
- High Pass
- Normal Blend
- Multiply Blend
- Screen Blend
- Darken Blend
- Lighten Blend
- Saturation Blend
- Make Path
- Make Selection (from Path)
- Fill Path
- Flatten Image
- RGB to Grayscale
- RGB to Indexed
- RGB to Lab
- RGB to CMYK

For More Information

For more information about the Power Mac G5, visit www.apple.com/powermac.

¹Based on SPEC CPU2000 benchmark results against 3GHz Pentium 4–based Dell Dimension 8300 and dual 3.06GHz Xeon-based Dell Precision Workstation 650, run with GCC 3.3 compiler and independently tested, June 2003. ²Tests performed by Apple in June 2003 using preproduction Power Mac G5 units and, with the exception of HMMer, application software optimized for the PowerPC G5. ³“World’s fastest” based on SPEC CPU2000 benchmark results and leading professional application performance tests against 3GHz Pentium 4–based Dell Dimension 8300 and dual 3.06GHz Xeon-based Dell Precision Workstation 650. SPEC CPU2000 benchmarks run with GCC 3.3 compiler and independently tested; professional applications tested by Apple, June 2003. ⁴1GB = 1 billion bytes; actual formatted capacity less. ⁵Based on SPEC CPU2000 benchmark results against 3GHz Pentium 4–based Dell Dimension 8300 and dual 3.06GHz Xeon-based Dell Precision Workstation 650m, performed by VeriTest, June 2003. ⁶Actual rates will vary.

© 2003 Apple Computer, Inc. All rights reserved. Apple, the Apple logo, FireWire, Mac, Macintosh, Mac OS, and Power Mac are trademarks of Apple Computer, Inc., registered in the U.S. and other countries. SuperDrive and Velocity Engine are trademarks of Apple Computer, Inc. Adobe is a trademark or registered trademark of Adobe Systems Incorporated in the U.S. and/or other countries. PowerPC is a trademark of International Business Machines Corporation, used under license therefrom. SPEC is a registered trademark of the Standard Performance Evaluation Corporation (SPEC); see <http://www.spec.org> for more information. Other product and company names mentioned herein may be trademarks of their respective companies. Product specifications are subject to change without notice. This material is provided for information purposes only; Apple assumes no liability related to its use. June 2003 L29736A