



Mac OS X v10.2 Technologies

Quartz Extreme and Quartz 2D



Features

Quartz Extreme

Hardware-accelerated graphics performance on supported graphics cards¹

- The window compositor has been moved from the CPU to the graphics processing unit (GPU) for dramatically improved system performance.
- Compositing of 2D, 3D, and QuickTime content is accelerated using OpenGL.

Quartz Updates in Jaguar

Performance improvements

- The Quartz Compositor uses the PowerPC G4 with Velocity Engine to accelerate window compositing.
- Improved symmetric multiprocessing support delivers additional acceleration on dual processor Power Mac G4 systems.
- Window scrolling is hardware accelerated.

Enhanced PDF support

- Full PDF 1.3 imaging model support yields device-independent and resolution-independent rendering of anti-aliased text, bitmap images, and vector graphics.
- Support for PDF 1.4 transparency allows saving and printing of Quartz-generated transparent objects.
- Support for PDF 1.4 security enables Preview to observe viewing, copy/paste, and printing restrictions.
- A new "Save as PDF" button in the print dialog makes it even easier to save documents as PDF files in any Mac OS X application.

Richer font support

- The default instance of Multiple Master (PostScript) fonts is supported.
- An ATM Lite PostScript rasterizer is built in, eliminating the need for third-party PostScript font-rendering software.
- Even more high-quality fonts are included, enabling users to spice up documents and communicate in other languages, including Arabic and Hebrew.
- Four font-smoothing styles can be specified to increase readability: Standard (best for CRT displays), Light, Medium (best for flat-panel displays), and Strong.

ColorSync

- All content drawn by Quartz is color managed using ICC profiles, so that the color you capture is the color you see and print.

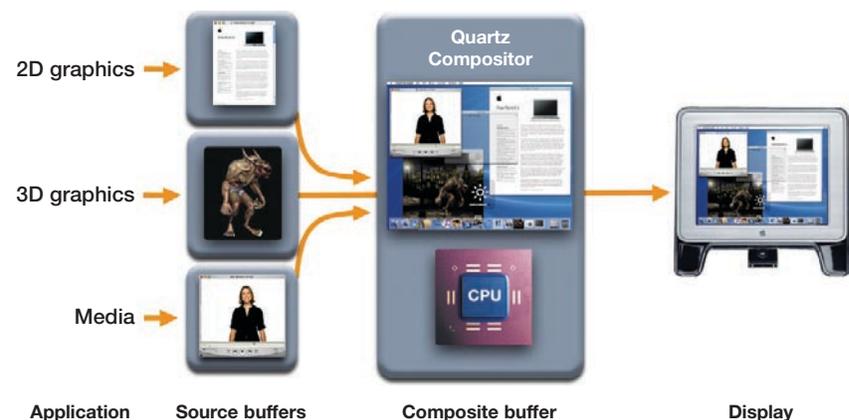
Mac OS X delivers an unparalleled graphically rich computing experience. The user interface in Mac OS X version 10.2 is fast and fluid, thanks to breakthrough use of today's advanced graphics processing units (GPUs). In addition, Mac OS X v10.2 includes comprehensive support for the Portable Document Format (PDF) imaging model, rich font support, and control over the degree of text anti-aliasing.

The Mac OS X graphics system consists of Quartz 2D, which renders fonts as well as vector and bitmap graphics; OpenGL for generating 3D graphics; and QuickTime for producing dynamic media. These media types are blended together on the display by the window server, called the Quartz Compositor, the engine behind the unique effects in Aqua, such as transparency and drop shadows.

Introducing Quartz Extreme

In earlier versions of Mac OS X, the Quartz Compositor operated entirely in software and used the central processing unit (CPU) to position window content on individual layers. Quartz then composited the layers into a single frame and sent the frames to the graphics card. In this case, the graphics card simply acted as a conduit carrying frames to the display.

Mac OS X v10.2 takes computer graphics to the next level by using hardware to accelerate the Quartz Compositor. If a supported GPU¹ is installed, Mac OS X v10.2 automatically enables Quartz Extreme which moves the Quartz Compositor from the CPU to the GPU. This allows the CPU(s) to focus on application-specific needs. As a result, the entire system feels faster and more responsive when Quartz Extreme is enabled, and CPU use drops dramatically.

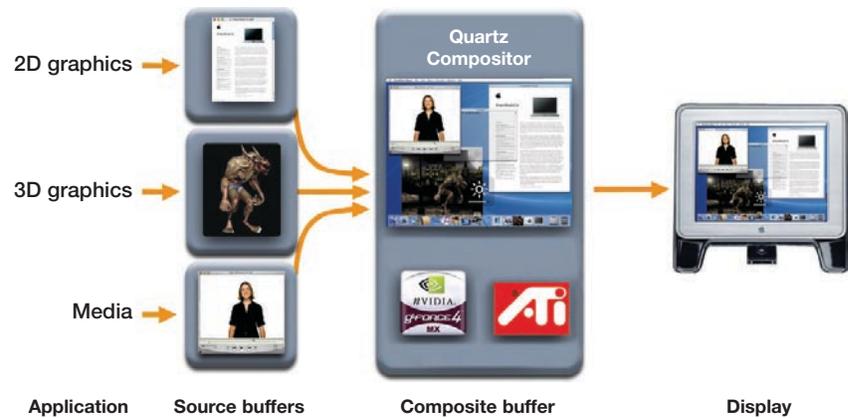


Applications draw windows into source buffers. The Quartz Compositor assigns each window to a separate layer, arranges then flattens (composites) the layers, and pushes each scene through the graphics card to the display.



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With Quartz Extreme, the graphics processing unit (GPU) performs window compositing functions in place of the CPU. (NVIDIA and ATI GPUs are supported.)

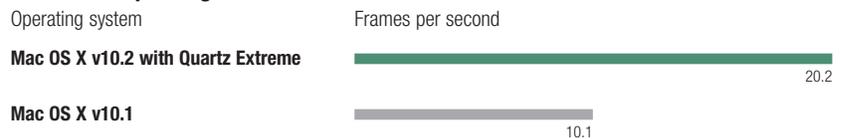
Using OpenGL to accelerate compositing

With Quartz Extreme, every pixel on the screen is sent through the Mac OS X OpenGL pipeline. Each onscreen element—2D, 3D, and video graphics—becomes an OpenGL texture applied to objects representing those elements. The elements are composited in real time to deliver the unique user experience offered by Quartz Extreme. You'll enjoy more fluid, higher-frame-rate graphics in intricately composited scenes, such as complex, translucent 3D objects overlaying a full-motion DVD video.

That means shadows will drop more quickly and transparent objects will layer faster—and Mac OS X can do more processing in the background while you work in the foreground.

To gauge the performance improvement in compositing content with Quartz Extreme, window compositing on Mac OS X v10.1 was compared to window compositing on Mac OS X v10.2 with Quartz Extreme enabled on a supported graphics card.

Window Compositing Performance



Test: Internal Apple test tool that forced several semitransparent windows to flush, which performs window compositing. All tests results represent the best of three tries.

Test configuration: Mac OS X v10.2, Dock hidden, default desktop, no desktop icons; 1280x1024x32-bit display; 600x600-pixel window; dual 1.25GHz Power Mac G4 with 256MB RAM, NVIDIA GeForce4 Titanium graphics card, and 17-inch Apple Studio Display.

Quartz Extreme doubled the compositing performance of Mac OS X v10.1.

Implementing Quartz Extreme requires a robust OpenGL implementation. Rendering the desktop can require sustained periods of uploading hundreds of megabytes per second of dynamically changing textures traveling from main system memory to the memory on the graphics card. Working closely with graphics card vendors, Apple has tuned these code paths to minimize CPU overhead and maximize throughput.



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Running the windowing system requires careful virtualization of texture memory resources. At times the desktop may contain more windows than can actually fit in video memory. Apple OpenGL implements a sophisticated demand-paged texture memory scheme that pages video memory on and off the card as needed, with minimal CPU overhead and maximum throughput.

New avenues for innovation

Quartz Extreme delivers incredible real-time graphics performance that creates new avenues for innovation. Today the technology delivers raw performance gains that empower software developers, including Apple, to rethink the term “user experience” and design entirely new classes of applications based on Quartz Extreme. With Quartz Extreme, the traditional distinctions between 2D, 3D, and dynamic media continue to fade.

Additional performance improvements

Quartz 2D is significantly enhanced in Mac OS X v10.2 by the use of hardware acceleration. Window scrolling is now performed by the graphics card. In addition, the Quartz Compositor is completely vectorized to take advantage of the powerful G4 Velocity Engine and receives an extra boost from symmetric multiprocessing (SMP). Every Mac with a G4 processor will benefit from these software improvements. The SMP optimizations will further augment the graphics performance and responsiveness of Jaguar on dual processor Power Mac G4 systems.



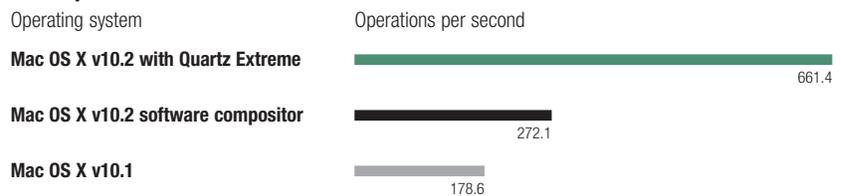
Quartz is optimized for both the Velocity Engine and multiple processors.

Three tests were conducted to gauge performance improvements in moving, resizing, and scrolling windows. For window move and window resize, tests measured Mac OS X v10.1, Mac OS X v10.2 with Velocity Engine and SMP optimized (but without Quartz Extreme enabled), and Mac OS X v10.2 with Quartz Extreme enabled on a supported graphics card. For the window scroll test, Quartz Extreme was not a factor.

The window move test uses a situation similar to moving a semitransparent Terminal window—moving a window by linear offset. Due to the operations involved, this is the most complex window to move.

“Operations per second” refers to the number of calculations (individual tasks in the process chain required to perform a window move) that can be performed in one second.

2D Graphics Performance: Window Move



Test: Internal Apple test tool that calls Quartz directly to perform a window move operation on a buffered, semitransparent window with alpha. All test results represent the best of three tries.

Test configuration: Mac OS X v10.2, Dock hidden, default desktop, no desktop icons; 1280x1024x32-bit display; dual 1.25GHz Power Mac G4 with 256MB RAM, NVIDIA GeForce4 Titanium graphics card, and 17-inch Apple Studio Display.

Mac OS X v10.2 using Quartz Extreme posted numbers that were more than 3.5 times better than those of Mac OS X v10.1. Mac OS X v10.2 using the software compositor performed nearly 1.5 times more operations per second than Mac OS X v10.1.

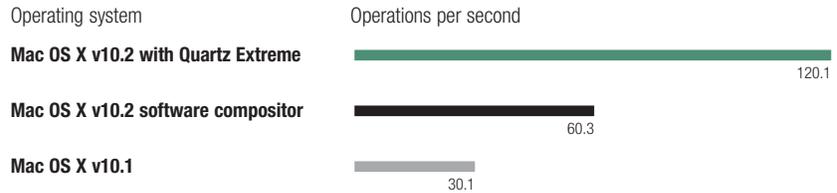


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The window resize test is similar to resizing an average-size TextEdit window.

2D Graphics Performance: Window Resize



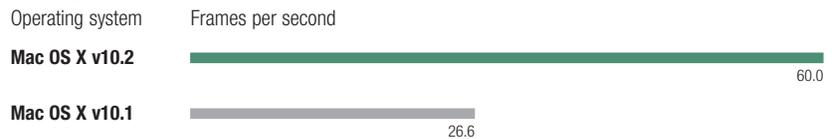
Test: Internal Apple test tool that calls Quartz directly to resize a buffered, opaque window from 600x600 pixels to 700x700 pixels.

Test configuration: Mac OS X v10.2, Dock hidden, default desktop, no desktop icons; 1280x1024x32-bit display; dual 1.25GHz Power Mac G4 with 256MB RAM, NVIDIA GeForce4 Titanium graphics card, and 17-inch Apple Studio Display.

Mac OS X v10.2 (without Quartz Extreme enabled) doubled the operations per second achieved by Mac OS X v10.1, while Mac OS X v10.2 with Quartz Extreme quadrupled the number of operations per second.

The window scroll test is similar to scrolling through a very long TextEdit document in a very large window.

2D Graphics Performance: Window Scroll



Test: Internal Apple test tool that performs vertical scrolling by 16-pixel increments in a Quartz window.

Test configuration: Mac OS X v10.2, Dock hidden, default desktop, no desktop icons; 1280x1024x32-bit display scrolling a nearly full-screen (1280x1002) window; dual 1.25GHz Power Mac G4 with 256MB RAM, NVIDIA GeForce4 Titanium graphics card, and 17-inch Apple Studio Display.

Mac OS X v10.2 almost tripled the frames per second generated during a window scroll. This is because the window content is already on the graphics card, and only the updated region of the window needs to be flushed. It should be noted that in this test, scrolling is tied to the beam sync of the display. Each time the display refreshes, the content is flushed. The refresh rate of the test display is 60Hz. This means Quartz is recompositing as fast as the display can accept the data.

Quartz 2D rendering enhanced in Jaguar

In addition to its advanced windowing system, Quartz 2D offers a sophisticated two-dimensional drawing engine based on the Portable Document Format (PDF) imaging model. Quartz 2D offers Mac OS X applications professional-strength drawing functionality. It delivers on-the-fly rendering and anti-aliasing of PostScript-grade graphics and text, providing Mac OS X with its unique translucence, drop shadows, animation effects, and interleaved windows. In Jaguar, Quartz 2D builds on this incredibly strong foundation.



New Fonts in Jaguar

Arabic²

Al Bayan (plain, bold)
Baghdad
DecoType Naskh
Geezah
Kufi
Nadeem

Roman

Cochin

Cyrillic

Charcoal CY
Geneva CY
Helvetica CY (plain, bold, oblique, bold oblique)
Monaco CY
Times CY (regular, bold, italic, bold italic)

GB18030/Simplified Chinese fonts

SinoType Hei
SinoType XiHei
SinoType Song
SinoType FangSong
SinoType Kaiti
GB18030 Bitmap

Devanagari (Indic)²

Devanagari MT (regular, bold)

Gujarati (Indic)²

Gujarati MT (regular, bold)

Gurmukhi (Indic)²

Gurmukhi MT

Hebrew²

Arial Hebrew (regular, bold)
Corsiva Hebrew (regular, bold)
New Peninim MT (regular, bold, inclined, bold inclined)
Raanana (regular, bold)

Thai²

Ayuthaya
Krungthep
Sathu
Silom
Thonburi

Comprehensive PDF support

In Jaguar, Quartz 2D fully supports the open-standard PDF imaging model (version 1.3). This advance delivers device-independent and resolution-independent rendering of anti-aliased, high-quality text and bitmap and vector graphics onscreen and in print. Parts of the PDF 1.4 specification, including the advanced security features and transparency, are also implemented. Quartz 2D can now both save and print any transparent object it draws onscreen, without flattening the transparency. And the built-in Preview application supports PDF file security, maintaining the author's restrictions on viewing, copying, and printing the contents of a secure PDF file. A new "Save as PDF" button in the print dialog makes it even easier to save PDF files in any Mac OS X application. And integrating PDF into the operating system allows any Mac OS X application to save a color-managed PDF file.

Rich font support

Mac OS X delivers industry-leading support for OpenType, PostScript, and TrueType fonts and collections. A PostScript font rasterizer is built in, eliminating the need for third-party PostScript font-rendering software.

In Jaguar, Quartz 2D now supports the Multiple Master font format. The default instance of Multiple Master fonts can be viewed, printed, and embedded in saved PDF files.

Text in Mac OS X looks great and is easy to read on all displays. Jaguar includes a new control in the General system preference that allows users to select one of four font-smoothing styles to increase readability: Standard (best for CRT displays), Light, Medium (best for flat-panel displays), and Strong. Jaguar employs sophisticated font-rendering technology using subpixel filtering, yielding increased effective resolution. This technology is specifically tuned for flat-panel LCD displays.

Even more high-quality fonts are included in Jaguar, with support for non-Roman languages such as Arabic, Hebrew, and Thai via Unicode. Apple also made significant updates to Zapfino, rescaling it and adding many more glyphs. Support for Arabic, Hebrew, Thai, and traditional Greek has been added to Lucida Grande, as well as more symbols and Roman glyphs. Numerous other fonts have also been updated to include additional typefaces and language encodings.

Mac OS X v10.2 supports a hierarchical folder structure in Fonts directories. Searches of the Fonts directories are recursive, so any number of subdirectories can be used. This allows for more flexible organization and grouping of fonts.

Advanced color management

Quartz 2D works in concert with ColorSync to color-manage every pixel drawn. Applications can specify colors in numerous color spaces: grayscale, RGB, CMYK, and several calibrated spaces. Quartz 2D automatically consults with ColorSync to ensure that the requested color is faithfully reproduced both onscreen and in print. Full support for embedded ICC color profiles ensures that images and PDFs drawn by Quartz 2D always display as they were meant to look.



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Mac OS X v10.2 Jaguar: Wildly innovative

Mac OS X delivers the power and stability of UNIX with the legendary simplicity of the Macintosh. The latest release, Mac OS X version 10.2, builds on this innovation and delivers more than 150 new features, including Rendezvous instant networking, QuickTime 6, industry-leading networking technologies, and applications like iChat, iCal, and Sherlock. The extraordinary graphics performance delivered by Quartz Extreme and Quartz 2D enhancements paves the way for the next generation of hardware and software offerings from Apple and other companies.

System Requirements

Quartz Extreme

GPU requirements

- 16MB of video memory (32MB recommended)
- AGP 2X (AGP 4X recommended)
- Any Macintosh desktop computer with an AGP 2X slot or better can be upgraded with a supported graphics card to take advantage of Quartz Extreme.

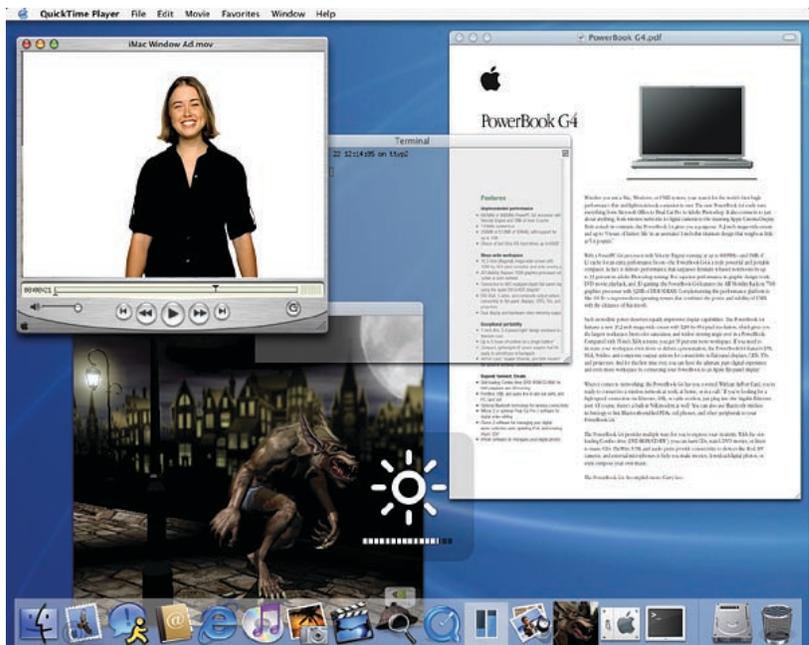
Supported graphics cards

- NVIDIA GeForce2 MX, GeForce3, GeForce4 Ti, or GeForce4 MX graphics cards
- ATI AGP-based Radeon graphics cards
- On cards with 16MB of video memory, Quartz Extreme is not supported in the extended desktop mode of multiple-display configurations. Quartz Extreme is supported in video mirroring mode.

Quartz 2D

- Only Power Mac G4 and PowerBook G4 computers receive the benefit of the G4 Velocity Engine enhancement.
- Only dual processor Power Mac G4 computers benefit from symmetric multiprocessing enhancements in Quartz.

- 1 Quartz Extreme requires an NVIDIA GeForce2 MX, GeForce3, GeForce4 Ti, GeForce4, or GeForce4 MX card or any ATI AGP Radeon card. A minimum of 16MB of video memory is required; 32MB is recommended for optimum performance.
- 2 These fonts are available to applications with Unicode support, including TextEdit.



Quartz 2D and Quartz Extreme deliver phenomenal graphics performance, outstanding rendering of text and graphics, smooth playback, and live compositing.

For More Information

For more information about Quartz, Quartz Extreme, and Mac OS X, visit www.apple.com/macosx. To purchase Apple products, visit the Apple Store online (www.apple.com or 800-MY-APPLE), an Apple Store near you, or an authorized Apple reseller.