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Abstract: The article presents information on the Mac series of computers from Apple Computer Inc. In announcing Apple's switch to Intel processors back in June 2005, chief executive Steve Jobs explained that Intel's road map for future chip development looked more promising than IBM's. First, there was the laptop problem. Apple's PowerBook line of professional laptops had stalled. The clock speed of the PowerBooks' G4 processors was advancing slowly. But Apple couldn't put a faster G5 chip in the PowerBook, because of the immense heat the G5 generated. Second, the G5 processor itself had hit a performance wall. Apple saw better speed potential in chips from Intel, which spends enormous resources on developing fast chips specifically for PCs, than in chips from IBM, which has been increasingly focused on supplying chips for servers and game consoles. The new iMac ran as much as two to three times taster than the previous iMac, and that the new MacBook Pro laptop ran as much as four to five times faster than the PowerBook G4.

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Inside the Intel iMac

THEY MAY NOT LOOK DIFFERENT, BUT APPLE'S FIRST INTEL MACHINES COMPLETELY CHANGE THE MAC MARKET

Apple's move to Intel is a really big deal. Not just because Apple is embracing the products of a company it once mocked. And not only among the geekier of us who like to argue vociferously about the minutiae of microprocessors. No, the Intel transition is a big deal for all Mac users because it will define the speed, features, and usability of every new Mac for the foreseeable future. So the release of the first Intel-based Mac is important to you — even if you'd never buy an iMac and couldn't care less about who makes the chips inside your Mac.

For our analysis of how the first Intel Macs perform, how they compare to previous Macs, and what they might tell us about Macs to come, as well as for our in-depth review of the

systems, read on.

Making the Switch

In announcing Apple's switch to Intel processors back in June 2005, CEO Steve Jobs explained that Intel's road map for future chip development looked more promising than IBM's.

First, there was the laptop problem. Apple's PowerBook line of professional laptops had stalled. The clock speed of the PowerBooks' G4 processors was advancing slowly. But Apple couldn't put a faster G5 chip in the PowerBook, because of the immense heat the G5 generated. Second, the G5 processor itself had hit a performance wall — famously, Apple had to renege on its promise of 3GHz Power Mac G5s after IBM failed to deliver chips at those speeds.

Apple saw better speed potential in chips from Intel, which spends enormous resources on developing fast chips specifically for PCs, than in chips from IBM, which has been increasingly focused on supplying chips for servers and game consoles.

But how well has that potential been fulfilled in the first Intel-based Macs? When Steve Jobs stood on stage at Macworld Expo in January, he claimed that the new iMac ran as much as two to three times faster than the previous iMac, and that the new MacBook Pro laptop ran as much as four to five times faster than the PowerBook G4. There was loud applause from the crowd and a sigh of relief from Mac watchers everywhere.

Of course, as jobs himself pointed out, those performance claims were based on some very specific tests. When Macworld tested the new Intel-based iMacs, we found that speeds varied widely — but that many tasks commonly performed by Mac users ran only between 1.1 and 1.3 times as fast (or, in other words, 10 to 30 percent faster) on the Intel-based 2GHz iMac as on the 2.1 GHz iMac G5. So while Apple's marketing materials for the new iMac prominently proclaim that the new machines are "2x faster" than their G5 predecessors, the reality is far more complicated — and for most typical uses, far less dramatic.

Different Kinds of Fast

Let's be clear: Apple wasn't fibbing when it reported that certain tests showed that the Intel iMac was faster than its predecessor by a factor of 1.9 to 3.2. But those tests were carefully selected to show the new iMac, and the Intel Core Duo chip that powers it, at its very best.

When running Universal apps — those that have been rewritten to run on Intel chips — we did see dramatic results in a few of our tests (see "iMac Core Duo: Universal Tests"). Rendering a 3-D scene using the Java-based program Art of Illusion, the 2GHz Intel-based iMac was 3.2 times as fest as its G5 counterpart. In two tests with a Universal version of Aspyr's Doom 3, that new iMac was 1.7 and 2.1 times as fast. Yet many of our other tests showed comparatively modest speed improvements, with the Intel-based system commonly between 1.1 and 1.3 times as fast as the G5 model.

In tests with two iLife '06 applications — iMovie and iPhoto — we found remarkable performance differences. On the 2GHz Core Duo iMac, applying one iMovie effect to a video clip was 1.8 times as fast as on a G5. But when we applied a different effect, we saw only half that improvement; with another, we saw no speed increase at all. And both of our attempts to export from iMovie (to an iPod and to a Web-encoded movie) were slower on the Intel-based Mac. (As we went to press, Apple released an iLife '06 upgrade

that addressed some iMovie bugs. See macworld.com/1177 for the results of our retesting.)

Other tests — creating a Zip archive in the Finder, encoding an audio file in iTunes, and generating a DVD image (including all required MPEG-2 rendering) in iDVD — resulted in the most common range of speed improvements: between 1.1 and 1.2 times as fast on the Intel-based iMac as on the iMac G5.

Are Two Cores Better than One?

There are numerous reasons for such variations in test results, but by far the most important has to do with the Intel Core Duo's dual core.

In the past, Macs got faster because the clock speeds of the processors got faster — for example, a 1.2GMz PowerBook G4 was clearly faster than a 1 GHz PowerBook G4. However, there's another way to make a Mac faster: add more processors. Apple has used this approach before. Multiprocessor Power Macs have been available for a while; all the current Power Mac G5 models use dual-core chips — essentially, two processors on one physical chip.

But here's the catch: Programs must be specifically designed to support multiple processors to gain any benefit.

Since powerhouse Power Macs have supported multiple processors for years now, many heavy-duty professional programs — including Adobe Photoshop, Maya, Cinema 4D, Final Cut Pro Studio, and Adobe After Effects — have been modified to take advantage of them. As Intel-specific versions of such apps arrive, they'll undoubtedly perform well on these new iMacs.

But these iMacs are consumer systems. Many consumer-level apps — such as those in the Microsoft Office suite — don't take advantage of multiprocessing. To really take advantage of the Core Duo's second processor, such programs will need updating. (If you're running several programs at once, Mac OS X is smart enough to spread them out across multiple processors. This can provide a speed boost if you are switching between several processor-intensive programs.)

To find out just how much our test programs took advantage of the iMac's dual-core chip, we disabled one of the iMac's two cores and ran several of our tests (see "Are Two Processors Better?"). The results showed, for example, that some tasks in iPhoto (importing images and exporting to QuickTime) took advantage of the second processor much more than others (exporting to files and Web pages). iTunes is very good at using both processors for ripping MP3s, while the Finder seems to use only a single processor when creating a Zip archive.

Rosetta: Compatibility with a Caveat

There's yet another wrinkle in the performance of the Intel-based iMacs. Programs compiled for the PowerPC chip can't run natively on these new Intel CPUs. Instead, they have to run on Rosetta, an emulation technology that lets Intel-based Macs run PowerPC apps.

We tested three such applications-iTunes 6.0.1, Adobe Photoshop CS2, and Microsoft Word 2004 — on the Intel-based iMac and on the iMac G5 (see "iMac Core Duo: Rosetta Tests"). Those tests showed that PowerPC applications run less than half as fast on the Intel iMac as on the GS. Our Microsoft Word scrolling test took twice as long on the 2GHz

Intel-based iMac as on the 2.1 GHz iMac G5; our battery of 14 Photoshop CS2 tasks took more than twice as long; an MP3 encode using the non-native iTunes 6.0.1 took almost three times as long.

But those speed differences are relative. If you bought an iMac G5 a few months ago, your PowerPC apps will run half as fast on an Intel-based iMac; however, if you're upgrading from a four-year-old iMac, you might see a speedup. When we compared the new 2GHz iMac Core Duo to a 700MHz iMac G4, which was released in 2002, we found that the Intel iMac executed our Rosetta application tests much faster than its four-year-old predecessor.

Many of the non-native apps you use every day aren't particularly processor-intensive (Microsoft Office is a great example) and will probably seem quite usable under Rosetta. Others (games, for instance) may be nearly unusable.

Just because a program is Universal doesn't mean that it has reached its full speed potential on Intel-based Macs. Software development is an evolutionary process. Software vendors (including Apple) continue to tweak and refine those apps to work better and better on the new CPUs. For example, Apple officials have admitted to us that iLife '06 could stand to be better optimized.

In addition, the tools that developers use — Apple's Xcode development environment and Intel's collection of code compilers — will also likely improve, making it easier for developers to wring even more performance out of their Intel-compatible software. Even portions of OS X itself, although they do run natively on Intel processors, will likely benefit from further optimization.

Alien Software
The release of Intel-based Macs is a major milestone for users of OS 9 software. Intel-based Macs don't support OS X's Classic mode. So if you rely on old-school OS 9 applications to get your job done, these new Macs simply aren't for you.

While it's extremely unlikely that Apple will ever bring back Classic, you may be able to use a Mac emulator, a sort of Mac equivalent of Virtual PC. As we wrote this story, two open-source emulators were already available in "experimental versions" for Intel Macs: SheepShaver (macworld.com /1116), which emulates a Power Mac, and Basilisk II (macworld.com/1117), which emulates either a Mac Classic or a Mac II. But keep in mind that since they're both emulators, they'll be running those Classic applications at low speed.

Anyone who's keeping a spare PC around the office to run Windows programs, on the other hand, might well have rejoiced at the news of Apple's switch to Intel. But such rejoicing was premature. There isn't yet a verified way to install Windows on a Mac and boot into it. (Intel-based Macs use a boot system called EFI, rather than the more traditional BIOS, which makes things harder: Windows XP doesn't support EFI, although the forthcoming Windows Vista will.) But plenty of clever hackers are working hard at the problem, and it's only a matter of time before someone figures it out.

And it's likely that Microsoft will update Virtual PC so that it runs on Intel-based Macs. When that happens, you can expect that it'll run Windows at speeds approaching those of a typical PC. (It won't run Windows at full speed, however, because Windows will be running inside an application and sharing space with your Mac software.) Other Windows-in-a-box products will probably appear, too.

Different Chips for Different Folks

Both Apple and Intel make it clear that the Intel Core Duo was designed for laptops; it represents a compromise between performance on one hand and good power-consumption and heat-generation characteristics on the other. The Core Duo processor in the new iMacs (as well as the forthcoming MacBook Pro) is clearly not meant to be the be-all and end-all when it conies to raw computing power.

As a result, it's difficult to extrapolate the entire future of the Mac product line from the iMac Core Duo. For example, Apple's future professional desktop Macs — whatever they're called, since they almost certainly won't be called Power Macs — will most likely use n new, high-speed Intel chip created specifically for desktop PCs. They'll be fast, and they'll be designed to consume a bit more power and provide higher speed.

(They'll also probably support 64-bit processing, which is important to many current PowerMac G5 users.)

At the other end of things, there's no way of telling how Apple might take advantage of the upcoming low-power version of the Core Duo processor, not to mention the Core Duo's single-core sibling, the Core Solo. Intel's various chips give Apple a large palette to paint with; the mystery is which colors Steve Jobs will choose.

The Last Word

With two iMac models as our only solid evidence of the Mac's transition to Intel processors, it's far too soon to issue any final judgments about how the transition will go. There are lots of huge questions yet to be answered, including the speed of the MacBook Pro, the speed of the forthcoming Universal versions of Apple's professional applications, and the speed of the first professional Intel-based desktop Macs.

However, these new iMacs do clear up several mysteries and generally make us feel that the Intel transition will be a pretty smooth one. Apple's claim that the new iMac is two times faster than the previous model may be debatable, but the fact that it is noticeably faster at almost every native task — and much, much faster at tasks that are multiprocessor-friendly — is indisputable.

We also expect that, as time goes on, the apparent speed of these first Intel Macs will increase — thanks to optimizations in Mac OS X, and thanks to individual applications that take better advantage of multiple processors and specific traits of the Intel-based Mac architecture. And of course, as programs that currently run in Rosetta are updated to be Universal, users will see significant improvements in those apps.

Most important — and when we start focusing on chips and test results, it's easy to fail to see the forest for the trees — these new systems are Macs, period. That Intel chip embedded deep inside may have a lot of meaning when it comes to the appearance, features, and performance of future Mac models, but you'd never know it from sitting down at one of these iMacs. The Intel revolution has begun — not with a bang, hut with a familiar and comforting Mac boot-up chime.

" While Apple's marketing materials prominently proclaim that the new machines are '2x faster' than their G5 predecessors, the reality is more complicated."

"Programs compiled for the PowerPC cant run natively on the Intel CPUs. PowerPC apps run less than half as fast on the Intel iMac as on the G5."

iMac Core Duo: Universal Tests: How the iMac Core Duo compares with the iMac G5

```
Startup
iMac Core Duo/2GHz          0:25
iMac Core Duo/1,83GHz       0:25
iMac G5/2.1GHz              0:46
iMovie6: Export to iPod
iMac Core Duo/2GHz          6:39
iMac Core Duo/1,83GHz       7:14
iMac G5/2.1GHz             6:00
iMovie 6: Export to Web
iMac Core Duo/2GHz          9:20
iMac Core Duo/1,83GHz      10:20
iMac G5/2.1GHz             3:20
iMovie 6: Apply B&W Effect
iMac Core Duo/2GHz          1:45
iMac Core Duo/1,83GHz       1:54
iMac G5/2.1GHz             3:11
iMovie 6: Apply Aged Effect
iMac Core Duo/2GHz          1:12
iMac Core Duo/1,83GHz       1:19
iMac G5/2.1GHz             1:12
iMovie 6: Apply Rain Effect
iMac Core Duo/2GHz          2:05
iMac Core Duo/1,83GHz       2:12
iMac G5/2.1GHz             2:43
iPhoto 6: Import 100 Files
iMac Core Duo/2GHz          0:53
iMac Core Duo/1,83GHz       0:55
iMac G5/2.1GHz             1:22
iPhoto 6: Export to QuickTime
iMac Core Duo/2GHz          1:08
iMac Core Duo/1,83GHz       1:12
iMac G5/2.1GHz             1:31
iPhoto 6: Export to Web
iMac Core Duo/2GHz          2:01
iMac Core Duo/1,83GHz       2:12
iMac G5/2.1GHz             2:12
iPhoto 6: Export to File
iMac Core Duo/2GHz          2:55
iMac Core Duo/1,83GHz       3:06
iMac G5/2.1GHz             2:40
Finder: Create Zip Archive
iMac Core Duo/2GHz          2:32
iMac Core Duo/1,83GHz       2:44
iMac G5/2.1GHz             2:53
Doom 3 v1.3.1303: Universal Beta Demo 1
iMac Core Duo/2GHz          35.9
iMac Core Duo/1,83GHz       27.3
iMac G5/2.1GHz             17.0
iTunes 6.0.2: MP3 Encode
iMac Core Duo/2GHz          1:14
iMac Core Duo/1,83GHz       1:20
iMac G5/2.1GHz             1:23
Art of Illusion 2.2: Render
iMac Core Duo/2GHz          1:55
iMac Core Duo/1,83GHz       2:03
iMac G5/2.1GHz             6:07
```

```
BBEdit: Run Text Factory
iMac Core Duo/2GHz        1:37
iMac Core Duo/1,83GHz     1:41
iMac G5/2.1GHz            2:02
```

BEST RESULTS IN BOLD. REFERENCE SYSTEM IN ITALICS.
All scores are in minutes, second s, except Doom results, which
 are in frames per second. Alt systems were running Mac OS X 10.4.4
 and had 512MB of RAM, We set the G5's processor performance 10
 Highest in (he Energy Saver preference pane. Using iMovie at its
 default settings, we compressed a 6-minute-and-46-second movie
 for export to an iPod and export to the Web, We also applied
 three different video effects to a 1-minute movie, one at a
 time. We imported 100 JPEG photos into iPhoto and then exported
 them as a QuickTime movie and as files, resized to a maximum of
 2,000 by 1,500 pixels, We created a Zip archive from a 1G8 folder
 in the Finder. We ran the Demo 1 test on a beta Universal version
 of Doom 3, which we set to use Ultrahigh graphics at a resolution
 1,024 by 768; we set all advanced options to Yes except for
 vertical sync and antialiasing. We converted 45 minutes of AAC
 audio files to MP3 using iTunes' High Quality setting. We rendered
 a scene using the Java-based Art of Illusion 3-D program. We saved
 an iDVD project containing a 6-minute-and-46-second movie as a
 disk image. We used BBEdit to run a Text Factory containing five
 editing, replacement, and sorting tasks on a 75.1MB text file.
 — MACWORLD LAB TESTING BY JAMES GALBRAITH AND JERRY JUNG

Are Two Processors Better?: The iMac Core Duo — with and without its second processor

```
UNIVERSAL
iMovie 6: Apply B&W Effect
iMac Core Duo/2 GHz                       1:45
iMac Core Duo/2GHz with one processor     2:18
iMovie 6: Apply Aged Effect
iMac Core Duo/2 GHz                       1:12
iMac Core Duo/2GHz with one processor     1:43
iMovie 6: Apply Rain Effect
iMac Core Duo/2 GHz                       2:05
iMac Core Duo/2GHz with one processor     2.41
iPhoto 6: Import 100 Files
iMac Core Duo/2 GHz                       0:53
iMac Core Duo/2GHz with one processor     1:29
iPhoto 6: Export to QuickTime
iMac Core Duo/2 GHz                       1:08
iMac Core Duo/2GHz with one processor     1:36
iPhoto 6: Export to Web
iMac Core Duo/2 GHz                       2:01
iMac Core Duo/2GHz with one processor     2:13
iPhoto 6: Export to File
iMac Core Duo/2 GHz                       2:55
iMac Core Duo/2GHz with one processor     2:59
Finder: Create Zip Archive
iMac Core Duo/2 GHz                       2:32
iMac Core Duo/2GHz with one processor     2:33
Doom 3 V 1.3.1303: Universal Beta Demo 1
iMac Core Duo/2 GHz                       35.9
iMac Core Duo/2GHz with one processor     34.3
iTunes 6.0.2: MP3 Encode
iMac Core Duo/2 GHz                       1:14
```

```
iMac Core Duo/2GHz with one processor    2:04
Art of Illusion 2.2: Render
iMac Core Duo/2 GHz                      1:55
iMac Core Duo/2GHz with one processor    3:37
iDVD 6: Save as Disk Image
iMac Core Duo/2 GHz                     13:55
iMac Core Duo/2GHz with one processor   18:39
ROSETTA
iTunes 6.0.1 MP3 Encode
iMac Core Duo/2 GHz                      3:41
iMac Core Duo/2GHz with one processor    6:26
Adobe Photoshop CS2: Suite
iMac Core Duo/2 GHz                      2:50
iMac Core Duo/2GHz with one processor    3:35
Microsoft Word: Scroll
iMac Core Duo/2 GHz                      1:58
iMac Core Duo/2GHz with one processor    2:03
BEST RESULTS IN BOLD
All scores are in minutes: seconds, except Doom results, which are
 in frames per Second. All systems were running Mac OS X 10.4.4
 and had 512MB of RAM We used the same settings as in our standard
 tests (see "iMac Core Duo: Universal Tests"). We used Apple's
 CHUD performance tools to disable the second processor for the
 tests with one processor. — MACWORLD LAB TESTING BY JAMES
 GALBRAITH AND JLERRY JUNG
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iMac Core Duo: Rosetta Tests: Running PowerPC applications on the Intel-based iMacs

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iTunes 6.0.1 : MP3 Encode
iMac Core Dap/2GHz       3:41
iMac Core Dap/1.83GHz    3:59
iMac G5/2, 1GHz          1:16
eMac G4/1.42GHz          2:15
iMac G4/700MHz           5:08
Adobe PhotoShop CS2: Suite
iMac Core Dap/2GHz       2:50
iMac Core Dap/1.83GHz    3:02
iMac G5/2, 1GHz          1:16
eMac G4/1.42GHz          1:49
iMac G4/700MHz           3:33
Microsoft Word: Scroll
iMac Core Dap/2GHz       1:58
iMac Core Dap/1.83GHz    2:05
iMac G5/2, 1GHz          0:57
eMac G4/1.42GHz          1:29
iMac G4/700MHz           3:07
BEST RESULTS IN BOLD REFERENCE SYSTEMS IN ITALICS.
All scores are in minutes: seconds. All systems were running Mac OS X
 10,4.4 and had 512MB of RAM. except the G4 iMac. which was tested
 with 640MB of RAM. We set the G5's processor performance to Highest
 m the Energy Saver preference pane, We convened 45 minutes of AAC
 audio files to MP3 using iTunes' High Quality setting. The Photoshop
 Suite test is a set of 14 scripted tasks using 0 50MB file. We
 set Photoshop's memory to 70 percent, except for on the G4 iMac,
 where we set it to 56 percent; we set History to Minimum. We
 used Microsoft Word to scroll through a 500-page document. —
 MACWORLD LAB TESTING BY JAMES GALBRAITH AND JERRY JUNG.
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PHOTO (COLOR)

PHOTO (COLOR)

PHOTO (COLOR)

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By Jason Snell

PHOTOGRAPHY BY Peter Belanger

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