

The 64-Bit Question:

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The 64-Bit Question: Are You Ready For The Athlon 64?

Ladies and gentlemen, welcome to the Athlon 64 show. AMD's eighth-generation architecture, a hot topic since late 2000, is finally available in high-end server trim (Opteron), gaming-oriented enthusiast form (Athlon 64 FX), and in a toned-down, less expensive package (Athlon 64). All versions feature an integrated memory controller and the SSE2 (Streaming SIMD Extensions) support needed to contest Intel's dominance in content-creation applications, while the most powerful models support a 128-bit memory bus. Benchmarks indicate AMD may be on the verge of another blitzkrieg assault, the kind it executed in 1999 when the original Athlon materialized. And with Intel preparing its 90nm Prescott core, the end of 2003 promises to be a white-knuckle shootout.

Paving the way for 64-bit computing has been a struggle for AMD, though. Timely as its launches may seem, the desktop Athlon 64 and server-based Opteron products were initially intended to appear early in 2001. Granted, the K8 micro-architecture gains its heritage from the K7 design before it, but the combination of 130nm manufacturing and innovative silicon-on-insulator enhancements has certainly affected the platform's readiness. And that's just on the hardware side.

Perhaps the most-discussed attribute of AMD's K8 architecture is its 64-bit software support. Equipped with 32-bit backward compatibility, Athlon 64 promises to bolster performance in today's popular software titles without the performance penalty of translating x86 code, ala Intel's Itanium. However, the addition of 64-bit extensions is what has pundits buzzing, and exposing that capability requires a robust software infrastructure consisting of a 64-bit operating system, compliant device drivers, and recompiled apps. Thus, AMD has dedicated significant resources to ensure developers are equipped to lay the foundation for 64-bit computing.

The Benefits

Before exploring the ramifications of AMD's 64-bit vision, let's discuss the technology's potential and where it will and won't exert an influence on your computing experience. The most compelling reason to adopt 64-bit computing is to move beyond the 4GB virtual-address space ceiling 32-bit systems impose. Many apps, such as databases, content creation, mechanical CAD, and design-automation tools are capable of pushing that boundary. There are ways for 32-bit platforms to work around the 4GB limitation, but they typically sacrifice performance. Address Windowing Extensions extend virtual address space, for example, while Physical Address Extensions raise the bar for adding more than 4GB of RAM. AMD's Athlon 64 implementation circumvents both constraints, allowing as much as 256TB of virtual-address space and as much as 1TB of physical memory without a performance penalty



Moreover, the AMD64 ISA enables twice as many registers (highspeed memory locations) compared to the standard x86 instruction set. Athlon 64 makes eight registers visible to programmers in 32-bit mode, just like the Pentium 4 and Athlon XP, while apps running in 64-bit long mode have access to 16 64-bit GPRs (generalpurpose registers), reducing the number of calls to memory and simultaneously augmenting performance. There are also eight more XMM (Extended Memory Manager) registers for SSE and SSE2 code. And because the GPRs are 64-bits wide, they support 64-bit integer mathematic operations. Most apps won't actively utilize 64-bit arithmetic, but AMD claims encryption and compression algorithms both stand to benefit.

There are, of course, other benefits to the AMD64 ISA, many that don't necessarily correlate to 64-bit computing. Case in point: Athlon 64's native 32-bit compatibility is a tremendous boon to mainstream users who may not have an immediate desire to adopt the latest software technologies. Further, the ability to run 32- and 64-bit apps under the umbrella of a 64-bit OS lets power users enjoy the benefits of both worlds.

The Foundation

Not everyone with an Athlon 64 will immediately migrate to a 64-bit environment, though. There are certain requirements to fulfill first, and many of the enabling technologies are still in development. For example, availability of 64-bit OSes is still somewhat sparse. SuSE Linux Enterprise Server 8 is out, however, as are Mandrake Linux 9.0, Turbolinux 8 for AMD64, and NetBSD.

Holger Dyroff, SuSE's general manager, says SuSE has been working with AMD since mid-2000 to implement proper support into the kernel; the kernel port was quick and easy, but device driver porting and platform support required more time and careful interaction with hardware vendors. Red Hat's Linux distribution is still in a beta stage, and Windows XP for AMD64 (also in beta) won't materialize until early 2004. At least initially, power users will probably find themselves installing the 32-bit version of WinXP, forgoing 64-bit support, and enjoying the performance enhancements attributable to Athlon 64's integrated memory controller.

When Windows for AMD64 eventually does emerge, it will require complimentary 64-bit device drivers. Porting drivers is reportedly not difficult because the AMD64 ISA is an extension to x86. NVIDIA claims to have ported its DirectX 9 graphics driver in three steps. The first involved recompiling for AMD64 and concurrently eliminating in-line assembly language, which 64-bit Windows doesn't support. The next step was to achieve stability by disabling optimizations. Finally, NVIDIA's driver team tweaked the code path for AMD-64, paving the way for future performance optimizations, such as utilizing the 64-bit GPRs. The AMD64 Linux driver is now publicly available at <u>www.nvidia.com</u>.

Richard Brunner, an AMD fellow, is confident that the drivers for other common devices—USB controllers, storage devices, and sound cards—will also be finished by the time Windows ships. "Microsoft has already ported many of them," he says, "using driver code that the vendors have shared with Microsoft." For vendors that haven't yet recompiled, AMD has a team of "relationship specialists" dedicated to helping driver teams.

Fortunately, application compatibility is a much more flexible issue. The Athlon 64 can run in two operating modes: Legacy mode supports 16- and 32-bit OSes and apps, while long mode enables 64-bit OSes to accommodate both 32- and 64-bit apps. Those who buy an Athlon 64 and immediately install WinXP will be running in legacy mode. In such cases, an OS, device drivers, and apps will run exactly as they did prior to upgrading.

If, however, the 64-bit version of SuSE Linux is used (or even Windows for AMD64 early next year), long mode is invoked, exposing another fork in the road. Servers and high-end workstations that employ a 64-bit OS, driver package, and application suite run in 64-bit mode. Of course, drivers and apps have to be recompiled, so software selection will be limited, at least initially.

The more likely scenario is a 64-bit OS with 64-bit drivers, running a mixture of 32- and 64-bit apps in compatibility mode. AMD agrees and is actively testing 32-bit programs on 64-bit OSes to

ensure they operate symbiotically.

64-bit: Areas Of Expertise

It's important to realize that not every piece of software will emerge as a 64-bit title. The main reason to port an app to AMD64 is if it would benefit from the increased virtual and physical address space, according to AMD's own white papers.

Several heavy-duty enterprise apps have already made the transition. IBM's DB2 Universal Database is one, and Oracle's 9i enterprise database is another. Other titles offer Web serving, distributed computing management, yield analysis, and parallel debugging; it's not exactly a list rife with productivity apps and antivirus software, is it?



Although it may be true that AMD's push for 64-bit software development has yet to turn out a plethora of desktop apps, AMD believes its initiative is an evolving process, drawing parallels to Intel's 386. In a presentation at ClusterWorld Con- ference & Expo in June, AMD's Brunner said, "The transition will occur at the pace of demand for its benefits." According to the presentation, the 386 successfully established 32-bit computing, concurrently endowing early adopters with the best 16-bit performance as well. OS and app development took time; the same will hold true for the move to 64-bit.

When desktop software does emerge, AMD anticipates 3D graphics, animation, and digital content creation will benefit the most. Codecs, encryption schemes, compression algorithms, and games may also demonstrate an improvement via the added registers and more complex math. Meanwhile, AMD continues to provide software developers with tools needed to work with the AMD64 ISA.

Developers Do 64-bit

Game development is one area where 64-bit capabilities promise to make a profound impact. A presentation by AMD's Mike Wall at Game Developers Conference GDC 2003 highlights a few of the most significant points, including faster compilation time for games, faster modeling, animation, and rendering.

"Because of our new content tools, we're already feeling a very strong need for 64-bit internally right now," says Epic's Tim Sweeny. "And by year's end, I expect we'll look at 64-bit as something that we couldn't possibly do our jobs without. We expect this sentiment to carry over to other game developers in the next 12 months, to high-end consumers over the next 24 months, and the wide mainstream all the way down to the lowest end of the market within 36 months. So, overall, we've found 32-bit adequate for prototyping new content, but serious development will only be possible with 64-bit." Valve Software is also backing AMD64 with a 64-bit build of its Counter-Strike server, available immediately. According to Valve, the new build runs as much as 30% faster than the 32-bit version.

To accelerate the development process Epic and Valve are tackling, AMD has published a complete resource kit, including documentation, a 400-page software optimization guide, a core math library, and a performance analyzer capable of simulating and profiling software performance. It also references third-party tools, from Win32/Linux compilers to proprietary development platforms for device drivers to open-source Linux profilers.

Patiently Waiting

If you look at AMD's 64-bit initiative as a glass of water, it could appear either half empty or half full. On one hand, the most highly touted feature of Athlon 64's architecture is, for the most part,

unexposed. There are a limited number of uses for 64-bit computing in a desktop environment, and even if there were more, who says software developers would readily adopt AMD's vision?

That's a dismally pessimistic point of view, and the Athlon 64 is more than just 64-bit computing. Its updated architecture offers immediate gratification to performance enthusiasts who will undoubtedly compare it to the P4 in 32-bit benchmarks. And of course, the ability to migrate to a 64-bit OS in the future carries merit. Early Opteron adopters are recognizing the value of buying a 64-bit server that costs less than \$25,000. As that technology propagates down into the mainstream, Athlon 64 will also become more attractive.

Furthermore, AMD has secured endorsements from a fair number of hardware vendors and software developers. Even Microsoft is committed to backing AMD64. Yet those who expected a library of 64-bit software are now wondering what to do with Athlon 64. AMD's message is that you can do anything you would have done with an Athlon XP, only faster. AMD knows its eighth-generation chip is plenty fast, but Athlon 64's redeeming characteristic will have to be a robust foundation of 64-bit desktop apps that exhibit a tangible performance improvement.

"When can we expect that?" you ask. In the words of Juba from "Gladiator," ". . . soon, but not yet. Not yet."

by Chris Angelini

64-bit Is In The House

Your business might be using dual Opteron servers equipped with SuSE Linux Enterprise Server 8 and IBM's DB2 Universal Database. Or maybe you run statistical analysis with Stata 8 software specially ported for 64-bit addressing. Either way, the uses for AMD's latest technology are highly specialized. There's not a lot of selection, and those apps that do exist are very much work-related. What role, then, does 64-bit computing play in your home?

It may surprise you to hear that AMD doesn't expect immediate 64-bit migration. Simply, there aren't many desktop apps capable of pushing the 4GB memory limitation, and even if there were, none of the apps currently available are intended for general consumption. But because Athlon 64 features twice as many registers and complex math in 64-bit mode, AMD anticipates codecs, simulators, compression algorithms, encryption schemes, and games all have a future in 64bit computing.

"AMD knows that it needs games, Internet content-creation apps, and videoediting software to compel home users," says AMD Fellow Richard Brunner. "Without them, we'll lose. We are working with all of the big names to expose the benefits of AMD64 on the desktop."

AMD has already demonstrated Unreal Tournament 2003 running on a 64-bit platform, and Epic's Tim Sweeny anticipates a 64-bit beta patch will emerge shortly after Athlon 64 hits store shelves. "Performance on AMD64 will be great," Sweeny says. "But don't expect a big difference in performance when running in 64-bit mode vs. 32-bit mode. For UT2003, this is primarily a 'Look, it works!' sort of release."

Perhaps more data-intensive apps, such as video editing, will enable a more tangible gain.

AMD's Infrastructure Partners

Reportedly, several 64-bit apps are in development, but AMD can't name names until they are ready for prime time. Here are a few of AMD's infrastructure partners, however, that have already committed to AMD64. Windows OS: Microsoft (currently developing a 64-bit extension to the Windows OS, now in beta)

Enterprise database: Computer Associates, IBM, and OSA Technologies Linux OS: Caldera, Red Hat, SuSE, UnitedLinux, and Wasabi Web server: Apache, Zeus, and Red Hat StrongHold eSecurity: RSA Tool vendors: AMD Core Math Libraries, Atlas, GNU, Blackdown Java, Perl,

MPICH, Compuware, Etnus, Grammar Engine, MigraTEC, NAG, Pallas GmbH, PGI, Scyld Computing, and STMicroelectronics

64-bit In The Home

AMD believes the following apps stand to benefit the most from its architecture, once 64-bit becomes a viable option in the home.

- ·3D gaming
- -Codecs
- Compression algorithms
- Encryption
- Internet content serving
- Rendering

Opening Up Opteron AMD hopes that Opteron will build on the relative success of its Athlon MP processor. Though the two architectures are fundamentally similar, there are distinct differences between the flagships from each family. (Source: AMD)

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View the chart that

accompanies this article. (NOTE: These pages are PDF (Portable Document Format) files. You will need Adobe Acrobat to view these pages. Download Adobe Acrobat Reader)

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Getting Along In Athlon 64

Athlon 64 is capable of running in any number of modes, depending on its complimentary software package. This chart depicts the various combinations of OSes, drivers, and apps that can run concurrently on Athlon 64. (Source: AMD)

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