Migrating to Industry-Standard 64-bit Architectures

Deployments of industry-standard servers have grown quickly in the past decade. With the emergence of industry-standard 64-bit computing, many IT organizations no longer are deciding whether to migrate to a 64-bit platform, but when and where to migrate. This article can help administrators evaluate and begin planning that migration.

BY JOHN FRUEHE

The Intel® Xeon™ processor with 64-bit extension technology is designed to provide standards-based 64-bit computing and large-memory addressability with complete 32-bit compatibility. This innovation, along with other core technology enhancements, enables administrators to run 64-bit and 32-bit applications simultaneously while improving the performance of 32-bit applications. In addition, 64-bit extension technology helps IT organizations that purchase Intel Xeon processor–based servers to protect their capital investments. Administrators can migrate to 64-bit applications on the same hardware platform when software support becomes available.

As organizations review their IT strategy, they face a new decision-making process. For many, it is no longer whether they migrate to 64-bit servers built on an industry-standard platform, but where and when they will make this move. Migration planning has assumed strategic importance now that administrators have several 64-bit environments from which to choose. Previously, most IT organizations had not considered 64-bit computing critical for the countless infrastructure, Web, and general business applications because of unclear performance gains and the sheer scope of work involved in a comprehensive migration. Soon 64-bit extension technology from Intel will help change the equation by bringing 64-bit computing to a new level of flexibility and price/performance.

Until now, cost and complexity have dictated how IT organizations deployed 32-bit and 64-bit systems: generally, infrastructure applications remained on 32-bit platforms while business logic applications ran on 64-bit platforms. Compared to proprietary RISC systems, a platform using industry-standard 64-bit Intel® Itanium® processors can offer compelling price/performance advantages for compute-intensive applications such as database transaction processing. As a result, many enterprises have conducted a cost/benefits analysis and decided to move business-critical applications to Itanium-based platforms.

Operating systems, drivers, and applications—the complete platform software stack—must be modified to take advantage of 64-bit computing. For this reason, IT administrators can benefit from a practical, methodical migration approach. To map out a successful strategy for migrating to 64-bit computing, administrators should consider the following:

- What applications are good candidates for migration? Database and heavy-workload business applications usually top the list.

- Which target architecture is best suited to the applications being migrated? Intel offers two industry-standard 64-bit architectures: the Intel Itanium 2 and Intel Xeon processors.
- Which operating system, applications, and drivers does the enterprise platform require—and are they all available in 64-bit versions? For example, the servers may run Microsoft® Windows® or Linux® operating systems; Microsoft SQL Server™, Oracle®, or SAP® databases; and RAID, Fibre Channel, or LAN storage environments.
- What services are required to assist in a successful transition?

The effect of processor architecture on applications

When choosing the most appropriate processor architecture, administrators first must determine the performance parameters of each application and how the application handles data. Memory size and data width of the processor execution path can be key performance factors for the overall system. However, their impact may vary from moderate to massive depending on the specific application and IT environment. Data-handling and memory size factors that help determine a suitable processor architecture include:

- **Sequential versus random requests:** Video decoding and streaming, for example, require a continuous set of sequential and structure calculations that take full advantage of 64-bit platform performance. In contrast, file-and-print sharing requires the processor to address multiple low-level requests from multiple users in a random fashion, making it less processor-dependent.
- **Logic-based versus load-based requests:** For example, life sciences applications tax the processor heavily by requiring large, complex algorithms and floating-point calculations. Domain Name System (DNS) and Secure Sockets Layer (SSL) applications use simpler algorithms but perform these calculations repeatedly.
- **Memory set:** The amount of memory that is utilized by the application can have a tremendous impact on overall system performance. For large memory requirements, 64-bit platforms help improve performance by providing a large addressable memory space.

Applications generally fall into three categories based on usage:

- **Compute-intensive:** Vertical and business-critical applications are included in this category, such as life sciences and high-performance computing; back-end database applications such as SQL Server, Oracle, and IBM DB2® software; business applications such as customer relationship management (CRM) and enterprise resource planning (ERP); and e-business applications such as online commerce stores. These applications can benefit from 64-bit processors.
- **Compute/load-balanced:** Infrastructure-based applications are included in this category, such as Internet caching, security, DNS, Dynamic Host Configuration Protocol (DHCP), SSL, and database front ends. These applications may or may not benefit from 64-bit processors, so IT administrators should evaluate the environment before deciding to migrate.
- **Standard infrastructure:** Simple file-and-print sharing, resource sharing, and less critical single-use/low-volume business applications are included in this category. In general, standard infrastructure applications are less processor-intensive and thus will not benefit as much from 64-bit processing as compute-intensive and compute/load-balanced applications.

Once administrators have categorized applications, they can determine which of the three architectural platforms—32-bit, 64-bit extension technology, or 64-bit—best suits their needs. Figure 1 describes the three Intel processors that correspond to these platforms.

The IA-32 platform

Although a large portion of the existing software based on 32-bit Intel Architecture (IA-32) will not be migrated to 64 bits for some time, the 64-bit extension technology that will be included in Intel Xeon processors will maintain compatibility with this 32-bit software.[1] Several performance-enhancing innovations that Intel has added with 64-bit extension technology include faster CPU frequency, faster frontside bus speed, PCI Express™ I/O and graphics, and support for next-generation double data rate (DDR2) memory. However, many commercial and internally developed server applications were written on and for 32-bit architectures and have inherent limits therein, such as 2 GB memory space. Even as server consolidation occurs, such applications derive little benefit from the wider execution paths and increased memory capacity of 64-bit computing. Although they may eventually move to 64-bit extended architectures, these applications most likely will remain in 32-bit mode.

The 64-bit Intel Itanium 2 architecture

The Intel Itanium 2 architecture provides the top raw TPC-C performance of any Intel processor at a compelling price relative to RISC platforms—offering a robust, mature 64-bit environment for standards-based systems.[2] These characteristics make Itanium 2–based servers an appealing alternative to more expensive, proprietary 64-bit architectures.

[1] The 32-bit applications will need to be recertified to run on a 64-bit operating system.

[2] Results for both performance and price/performance are based on TPC-C benchmarks as of February 17, 2004. Current results can be found at http://www.tpc.org.

	Intel Xeon processor (32 bits)	Intel Xeon processor with 64-bit extension technology	Intel Itanium 2 processor (64 bits)
32-bit mode	Native	Native	Through emulation layer
64-bit mode	No	Through extension technology	Native
System bus	533 MHz, 64 bits wide; up to 4.3 GB/sec bandwidth	800 MHz, 64 bits wide; up to 4.3 GB/sec bandwidth	400 MHz, 128 bits wide; up to 6.4 GB/sec bandwidth
Cache (level 2/level 3)	512 KB/up to 2 MB	512 KB/up to 2 MB	512 KB/up to 6 MB
Memory addressing	32 bits (4 GB)	36–40 bits (1 TB)	50 bits (1024 TB, or 1 PB)
Error recovery on data bus (error-correcting code or retry)	No	No	Yes
Lockstep support	No	No	Yes
Corrupted data containment	No	No	Yes
Support for IBM Chipkill™ memory feature, retry on double bit	Yes	Yes	Yes
Memory spares	Yes	Yes	Yes

Figure 1. Comparing three Intel architectures: 32-bit Intel Xeon processor, Intel Xeon processor with 64-bit extension technology, and 64-bit Intel Itanium 2 processor

High-performance computing applications such as technical computations, life sciences, oil and gas research, and graphical rendering can take advantage of Itanium 2 architecture, mostly in dual-processor configurations. Business applications, databases, and other compute-intensive applications now are available to run on Itanium 2 versions of both Linux and Microsoft Windows Server™ 2003 operating systems.[3] These applications have been developed and tuned specifically to run on Intel Itanium 2 processors and to take advantage of large 64-bit instructions and memory sets. Access to large amounts of memory helps these applications run faster because they use a flat memory address space and rely less on resource-intensive memory managers and paging to hard drives.

The Intel Xeon processor with 64-bit extension technology

By introducing 64-bit extension technology into the Intel Xeon processor family, Intel is creating a new class of 64-bit computing. This technology builds on the existing 32-bit Intel architecture and is expected to provide a more flexible, lower-cost platform than Itanium 2—supporting both 32-bit and 64-bit computing for applications that can benefit from features such as 64-bit operations and large addressable memory capacity.

The Intel Xeon architecture with 64-bit extension technology is designed to execute instructions at both 32-bit and 64-bit levels. As a result, it can be advantageous for mixed-purpose or infrastructure servers that are running a variety of applications on a single platform. Applications such as directory services, DNS, database front ends, and eventually messaging and groupware can benefit from 64-bit extension technology because it is expected to provide not only greater performance than the existing 32-bit Intel Xeon architecture but, more importantly, better price/performance relative to Itanium 2 for the large number of servers often required to deliver such services.

Software support for 64-bit platforms

The key advantage of 64-bit extension technology is the ability to move applications from a 32-bit environment to a 64-bit environment on existing hardware as soon as software support becomes available. Therefore, administrators should assess the availability of software support before committing to a migration timeline.

Although legacy 32-bit operating systems, applications, and drivers are supported seamlessly on 64-bit extended platforms, to run in true 64-bit mode the entire software stack must be recompiled for 64-bit extension. Today, most Linux variants are available for 64-bit extended systems. Microsoft has announced that it plans to release a version of Windows Server 2003 for 64-bit extended systems to complement its 32-bit and Itanium versions of Windows Server 2003. *Note:* Itanium-based software does not run on 64-bit extended systems, and 64-bit extended software does not run on Itanium-based systems. Applications also must be written to support 64-bit extended systems.

Once administrators have determined the hardware platform, ensuring that appropriate drivers exist for all peripherals is a critical step in the migration process. Device drivers that were written for 32-bit operating systems will not work on 64-bit operating systems, including Itanium and Intel Xeon in 64-bit mode. Any 64-bit operating system, including Windows and Linux, will require its own set of drivers and many of those drivers will not be delivered by the operating system vendor, but rather by the device manufacturer.

The future of 64-bit technology

Intel offers two industry-standard 64-bit architectures for extending the IT infrastructure: Itanium 2, which provides high raw performance, and Intel Xeon with 64-bit extension technology, which provides excellent price/performance. At the same time, 32-bit applications will continue to have a place in the IT environment, regardless of whether they run on 32-bit or 64-bit extended systems. The flexibility in 64-bit extended systems enables 32-bit applications to run in a mixed environment alongside 64-bit applications on the same server. Because these different platforms require different operating systems, drivers, and applications, administrators must consider software support when planning a migration. From the hardware platforms to the drivers, operating systems, and applications, everything must be designed to work in a 64-bit environment to maximize performance.

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[3] For a list of 64-bit applications certified to run on Intel Itanium 2 processors, visit http://www.intel.com/cd/ids/developer/asmo-na/eng/catalog/processor/itanium/index.htm.