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The Right Intel Platform for the Right Job:

Making a Sound Choice Between 32 and 64 Bits

A META Group White Paper

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As application support for Intel's Itanium family of 64-bit processors grows, users must understand the relative benefits of the 32- and 64-bit architectures on the Intel road map. The choice of processor platform will be dependent not only on application/operating system support but also on the distinct value and performance propositions offered by the two architectures.

With the introduction of its Itanium processor family, Intel dramatically increased the potential penetration of high-performance 64-bit computing. Once the preserve of "high-end" Unix-based solutions, Itanium architecture has opened the possibility of much increased performance for packaged and custom applications, based on commoditized hardware components growing slowly at a lower cost to end users.

End-user consumption of the Itanium processor has been growing slowly while operating system and application vendors tune their software to support the new processor architecture. End users have also been exploring the EPIC/IA-64 architecture for their near- and medium-term infrastructure planning.

During 2002, most Intel-based servers will be shipped with 32-bit Intel Xeon processors, which will offer good performance and the widest range of application and operating system support. But by 2Q03, the default to Xeon for corporate Intel-based server infrastructure will not necessarily increase performance or deliver the best investment value for every application. During 1H03, we expect the next-generation member of the Itanium processor family (code-named "McKinley") to begin volume shipment.

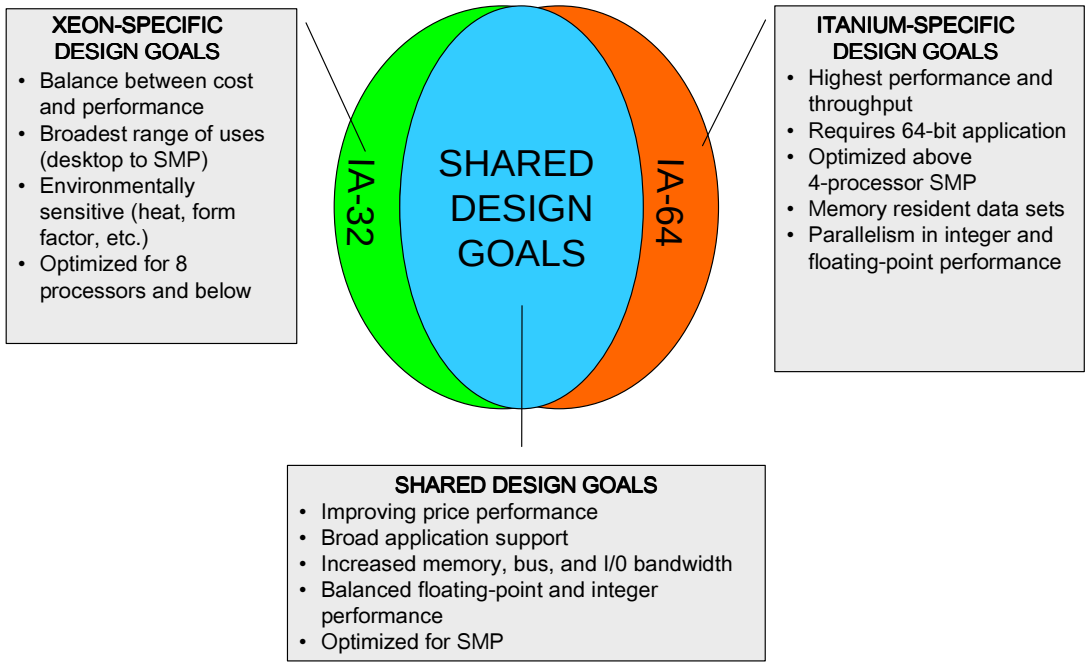
By YE02, there will be significant weight behind the Intel 64-bit architecture via more widespread and better-optimized application support and (most importantly) full compatibility with Microsoft's next-generation server operating environment — .Net Server. These factors mean that, for the first time, users will have a real choice in the Intel architecture they adopt for corporate server and workstation investments.

Common Design Principles

During the next three to five years, the road maps for the Intel Xeon and Itanium processor families will share many common elements and design goals: improved throughput, better on-chip cache management, improved multiprocessor performance, and increased on-die optimization for specific tasks such as data encryption (see Figure 1). Although META Group estimates that around 60% of the design goals between the two families will be common, approximately 40% will be unique. Indeed, our research indicates that Intel will continue to strongly develop both architectures for servers and workstations in parallel for at least four years. The distinct processor qualities will have significant value or performance

benefits to users and will be reflected in a clear price differentiation between Xeon- and Itanium-based systems. Given this sustained differentiation in both functional delivery and systems cost (partly driven by increased memory specification for Itanium-based systems), users must decide between 32- and 64-bit systems to gain the most appropriate architecture and best value (see Figures 2 and 3).

Figure 1 — Design Goals for IA-32 and IA-64



Source META Group

Figure 2 — Characteristics of Intel Processor Families

Xeon Family	IA-64 Family
• Volume optimized • Ease of use • Multipurpose • Widest application acceptance • 32-bit • Multithread processing (Hyper-Threading Technology) for higher levels of transaction throughput	• Performance and scalability optimized • Application tuned • Task optimized (with increased task-specific features introduced over time) • Application support dependent • 64-bit • Extended on-chip memory • Parallel processing • Floating point performance

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Figure 3 — Uses of Intel Processor Families

Xeon Family	IA-64 Family
• Application and Web servers • 32-bit applications • Small and medium databases (dependent on volume, users, complexity) • N-way load-balanced servers • High-density servers (bricks/blades) • Simple and moderately complex data sets • Up to 8-processor SMP (with some niche systems beyond 8 way) • Multithread processing • Limited and well-defined scale	• Technical and high-performance servers and workstations • 64-bit applications focus (32-bit compatible) • Large databases, especially those constrained by memory residence • N-way clustered servers • Up to 32-processor SMP • Complex data sets • Multitask processing • High or unpredictable scalability • Memory hungry

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Xeon: Ease of Use and Flexibility

The starting point for this decision is the personalities of the two processor families: Xeon and Itanium. Xeon will be optimized through design and delivery to meet the broadest range of end-user requirements in both function and form. This will range from midtier workstations to database servers, and from 8-way servers (with some niche suppliers offering beyond 8-way SMP) and eventually to single-processor workstations and ultrathin dual-processor "blade" servers. Environmental features such as lower power consumption, heat emissions, processor and board size, and the flexibility to be used across many system types will be critical Intel design points.

In the short and medium term, our research indicates that Intel will continue to add features to the Xeon processor family that will improve its performance for specific user workloads. This will include technologies such as Hyper-Threading, which enables multithreaded server software to execute tasks in parallel within each processor and results in more efficient, simultaneous use of processor resources. In addition, the Intel NetBurst architecture will improve overall performance by increasing front-side bus speed (to 400MHz) and bandwidth (to 3.2 Gb/s), memory capacity and bandwidth (to 64 Gb and 6.4 Gb/s), and I/O speed (to 1.6 Gb/s). A third-level on-chip cache will be implemented in Xeon processors optimized for 4-processor (or above) systems.

Xeon will be optimized through numerous iterations to support specific system configurations. Principally, these will be workstation, midtier application or database server, volume departmental server, and ultradense Web server. It will be designed to support single- through to 8-processor systems (with some niche systems going beyond 8-way).

Typical Xeon applications will target Web or application servers (e.g., Microsoft IIS, Apache), application layers of n-tier architectures in midsized deployments (e.g., SAP, Siebel, PeopleSoft), firewalls, departmental or business unit databases, and general-purpose systems (not requiring 64-bit applications or ultrahigh performance).

Itanium Processor Family: Enterprise-Level Performance

Our research indicates that, by volume delivery of Intel's second-generation 64-bit processor (McKinley) in early 2003, there will be reasonable support from code-optimized enterprise applications and operating systems (Windows .Net Server, Linux, HP-UX). This will give many users the ability to specify a 64-bit architecture for new server or workstation infrastructure. The choice of IA-64 will primarily be driven by application availability, but this may not justify its use given the comparatively higher price point and the ever-improving performance and function of the 32-bit Xeon family. Users will align deployment of IA-64-based servers with

the functional strengths of the architecture. These strengths revolve around five categories of application workload:

- High-end technical computing
- Large data sets, where performance would be enhanced by enabling large volumes to reside in processor cache and main memory
- Applications that involve multiple threads of work, where performance would be enhanced by true parallelism on the processor
- Data mining against large volumes requiring complex computations
- Workloads that require between 4 and 32 processors in an SMP configuration

In these application areas, users will see substantial benefits from deploying IA-64 processors over IA-32. Moreover, with improvements in design and performance for these application types planned for the McKinley and Madison generations of the Itanium processor family, the functional gap against Xeon will remain stable or even widen through 2003. Users will identify a range of technical features in the Itanium processor family, which either are unique to the architecture or are noted for enhanced performance compared with Xeon (see Figure 4).

Figure 4 — Itanium/McKinley Technical Features

Feature	Application Usage	Benefit	Availability in Xeon
64-bit address space	Any application recompiled to support 64-bit addressing; primarily valuable for large and/or complex applications and databases; in addition, it supports 32 applications	Improved performance	Not available
Larger and multi-tiered cache	Data handling in database or application	Faster data access and redundancy	Smaller cache across two rather than three tiers; third-level cache introduced in Xeon MP 1Q02
Large memory support (16Tb)	Large and complex databases with high memory resident volumes	Improved performance	Smaller memory support (4Gb); price/performance leadership
Parallel instruction issue	Complex applications with multiple threads (e.g., encryption algorithms)	Improved performance for complex tasks; can be run in parallel to other tasks	Hyper-Threading Technology (simultaneous execution of two threads)
128 floating-point registers; total of 328 onboard registers	Technical applications, data mining	Ability to run technical and/or commercial applications	Relies on integer-optimized design for technical applications; 144 new instructions improve response times
SMP to 32+ processors	Very large applications or databases	Scale up applications or databases within a single server	Up to 8-way SMP (some niche suppliers — e.g., Unisys ships up to 32-way systems)

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User Decision Process

Any decision between the Intel Xeon and Itanium processor families begins with current and future application availability. Although Itanium will run 32-bit applications at the hardware level, performance will be suboptimized, and there will not be substantial benefits above lower-cost Xeon-based servers. Users may choose to implement the 64-bit processor for 32-bit applications as a tactical move, where increased on-chip I/O and memory would benefit performance or where migration to a 64-bit application is planned in the near future.

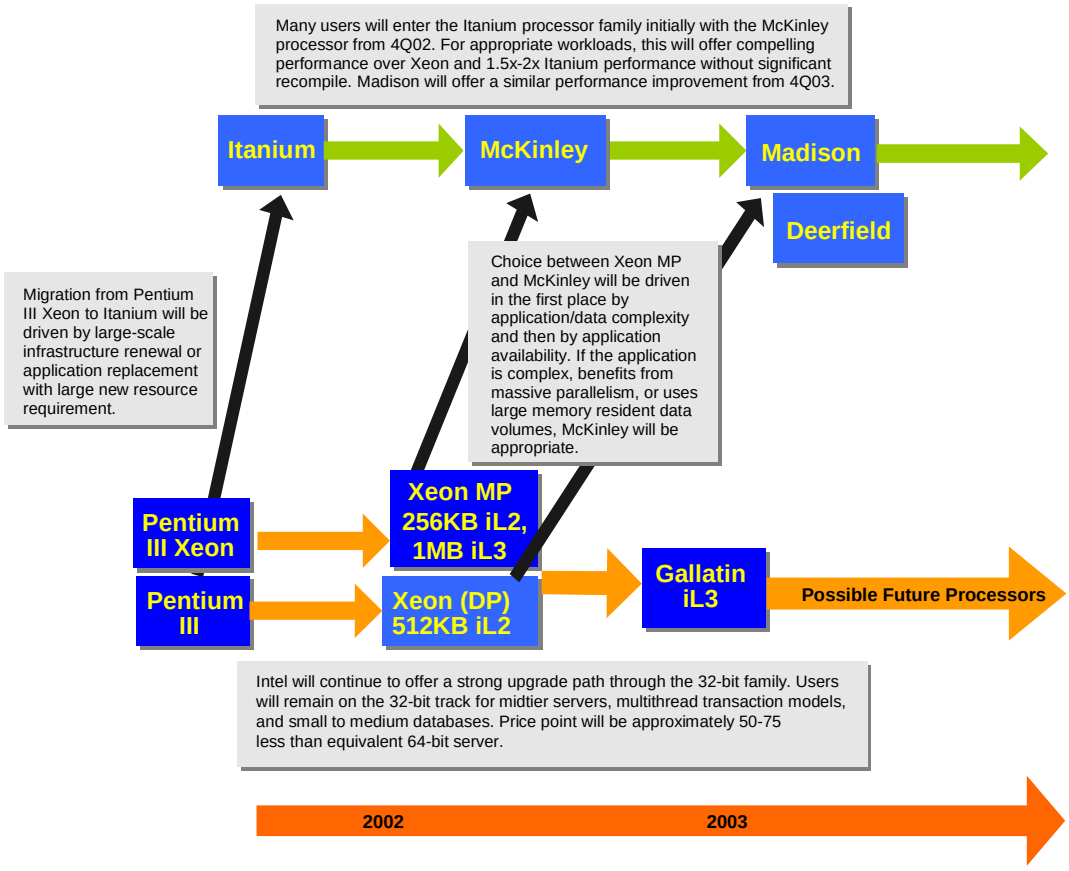
If a 64-bit application is available and certified to be resilient by the supplier or application development group, the Itanium processor family becomes a viable option if the workload profile is aligned with the processor benefits outlined in Figures 3 and 4. If there is not strong alignment between workload type and the design benefits of IA-64, it is unlikely that users will get value from choosing a 64-bit platform above 32 bits.

Users should ask the following questions regarding the application platform. If the answer is yes to Questions 1 and 2 plus one other, then it is likely that a 64-bit platform would deliver value and performance benefits:

1. Have the applications been compiled and optimized for the IA-64 architecture in accordance with Intel's guidelines?
2. Have the applications been proven as scalable and reliable on the 64-bit platform?
3. Is there a need for scalability beyond 8 processors in a single SMP system?
4. Does the application or database use large memory sets held in processor memory?
5. Are the applications primarily using compute-intensive floating-point calculations?
6. If the applications are of the commercial transaction processing type, would multiple threads of the code running in parallel improve performance?
7. Is the server for use as a security gateway where complex encryption algorithms must be processed in real time?

The migration between the Intel Xeon processor and Itanium processor architectures is likely to be driven by new application investment or long-planned upgrades of existing packages (see Figure 5). Applications that are currently running on a 32-bit platform and that are well within their scalability and performance service levels are unlikely candidates for migration to 64-bit unless there are major changes in the requirements from the business (e.g., rollout to additional users). However, if the application is underperforming, is reaching the edge of the potential of its current servers, and is available in a 64-bit optimized version, a migration would in many cases be beneficial. It will usually be easier to migrate to a 64-bit platform than to split monolithic applications or databases across multiple 32-bit servers.

Figure 5 — Migration Paths



Source META Group

Bottom Line

Our research indicates increased uptake of Intel Itanium processors (McKinley and forward) during the next 12-24 months, as applications and operating systems prove their scalability and reliability in a 64-bit environment. However, this is only the starting point for users considering Xeon or a move to the Itanium architecture. Given Intel's aggressive road map for Xeon enhancements during the next 24 months, users must evaluate the alignment between their proposed workload for the 64-bit platform and the features offered by the processor family. Without this, users are at risk of not choosing the right server infrastructure for their present and future workloads. If this evaluation process is rigorously followed, users will find that a decision between Xeon and Itanium architecture is relatively simple, and those responsible for server deployment will correctly align the value and performance of their investments with business objectives.