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Itanium's State of the Union

Research Note

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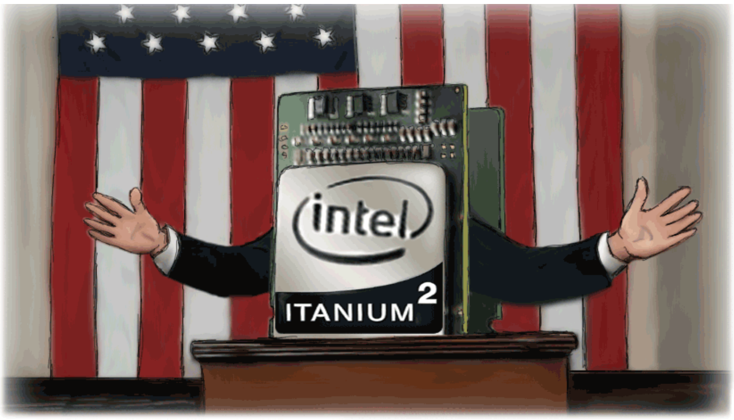
If Itanium were to give an accounting of its accomplishments over the past year, it could point to tangible progress. A new dual-core iteration ("Montecito") shipped.[1] Its applications portfolio continues to grow. HP's NonStop line has been switching over to the newer Itanium-based Integrity flavor at an almost remarkable rate. SGI, perhaps the most important purveyor of Itanium servers in the US other than HP, emerged from bankruptcy. And Itanium platforms from a variety of non-US vendors, mostly in Japan, continue to proliferate.[2] Itanium would rightly expect acknowledgment and applause for these successes.

Yet, it would be understandable if the applause were polite and at least a bit muted from all but its most partisan supporters. Yes, Montecito shipped, but it shipped late. HP's NonStop is moving quickly to Itanium, but its PA-RISC and Alpha business has transitioned much more slowly. And, for all their intriguingly differentiated designs, non-HP Itanium product accounts for but little revenue on a worldwide basis. Don't expect to see *The Register* retire its "Itanic" moniker anytime soon.



If we put aside the partisan cheers and catcalls, the state of Itanium is neither heavenly nor hellish. It's still extant—in itself an accomplishment, if one were to believe its noisy detractors. And it's also making continuing advances, albeit on a stage much smaller and less grandiose than it once aspired to.

Past as Prologue

Once, Itanium aspired to be the sole future of 64-bit computing. It was born into a fragmented Unix market. In the eyes of many, Wintel—the Microsoft Windows operating system (OS) running on Intel processors—seemed poised to become the dominant OS and processor combo for the server as it had for the desktop. Whether or not one subscribed to Windows literally conquering all, it was clear that powerful economic forces were at work to constrict OS and microprocessor variants. Software vendors were strongly pulling back from the proliferation of

1 See our *Itanium's Heavyweight Contender*.

2 See our *Hitachi's Symphony of Blades* and *Fujitsu's Mainframe Zeitgeist*.

versions that they had to port and support in the days of minicomputers and the Unix wars. And even if ISV support could be gained, the increasing billions required to play the semiconductor design and fabrication game made sure that fewer and fewer vendors could play it—an economic reality sometimes dubbed “Moore’s Second Law.”

These trends collectively suggested to many that a single 64-bit processor running Windows and (perhaps) a united Unix would emerge victorious when the time came to move beyond the increasingly restrictive memory limits imposed by 32-bit processors. Even those RISC vendors who hadn’t fully jumped on the Itanium bandwagon[3] covered their bases at some level. IBM had Project Monterey for both Power and Intel architectures. Sun (Sun!) dabbled with a Solaris-on-Itanium strategy. Intel certainly expected that, over time, “IA-64” (as Itanium was known at the time) would inevitably replace the “IA-32” architecture—better known as x86[4]—that was increasingly dominating the volume market.

Furthermore, Itanium was promised as a huge step forward relative to RISC—to say nothing of Intel’s own CISC x86 processors. At the time Itanium was conceived in the first half of the 1990s, microprocessor development was focused on increasing frequency and otherwise maximizing the performance of a single thread on instructions—an approach known as instruction-level parallelism (ILP). However, it was widely recognized that the approaches taken by existing processors weren’t ideal. For example, one of the methods that RISC processors used to maximize ILP was to make “guesses” about upcoming branches in code and to speculatively execute based on the guess. However, they couldn’t always guess right and performance took a hit when they guessed incorrectly.

The Itanium architecture was HP’s and Intel’s response. The thinking went that traditional processor designs were hampered because they didn’t really know anything about any parallel structures inherent in the original source code. The processor just saw a stream of sequential instructions, which it then had to deal with in real time. In effect, compilers often understood parallelism in the original source code, but had no language to pass that information to the processor, forcing the processor to try to rediscover parallelism on its own, on the fly.

Therefore, the Itanium designers decided to attack the problem from a different angle, under an overarching design philosophy called EPIC (Explicitly Parallel Instruction Computing). Rather than leaving the hardware to extract parallelism from the instruction stream on its own, the Itanium instruction architecture provides mechanisms and flexibility that enable compilers to pass detailed execution instructions to processors. While Itanium proponents don’t like to emphasize the similarities, this EPIC approach closely resembles VLIW (Very Long Instruction Word) and “horizontal microcode” processor designs. Itanium’s instruction bundle format and associated methods of explicitly expressing parallel execution instructions to the hardware are examples of this design philosophy.

Both the market view and the technical approach were coherent, neat, and—at least mostly—wrong.[5]

Mispredictions and Miscues

What happened? It’s a complicated and convoluted history, but it boils down to four major factors.

The Market Failed Itanium. It launched into one of the biggest industry retrenchments in high-tech history, following the meltdown of the dot-coms and the subsequent deflation of the IT vendors who had come to depend on their profligate spending on technology. In a sudden IT-spending drought, it took more to make a new processor successful than an Intel label and vague promises of a 64-bit

3 As a co-designer of Itanium, HP planned to replace its own PA-RISC with Itanium, of course. Compaq, even before it was acquired by HP, later took the same route rather than continuing to develop Alpha.

4 Or these days, x64 in its 64-bit variants.

5 See our *HP/Intel Announces "End of Decade" Architecture*.

revolution. Incrementalism was in vogue. Nor did it help that the raft of largish but second-tier server vendors, for whom Itanium would have served as a standard "Big Iron" processor, had largely gone out of business or been absorbed—at least in most of the world.

Itanium Failed the Market. Yet, Itanium can't totally blame the "big bad world." After all, whose fault was it that Itanium launched into the deflating bubble? It was years late. Had it met initial schedules (variously stated as 1997-1999), it would have come to market at just about the best possible time, rather than at just about the worst. Furthermore, the performance of the initial Itanium iteration, "Merced," was… well, *putrid* would perhaps be too strong a descriptor, but "not very good" would be heroically nice. While it did shine on some floating point code, its "integer performance"—what most applications consume—was no better than then-current (and much better established) alternatives, including both RISC and even Intel's own x86. The performance of Itanium's x86 emulation, a cornerstone of Intel's migration plan, was even more disappointing—thereby making an already wrenching transition from x86 that much more abrupt.

The Rebirth of x86. During the years that the Itanium team labored to get product to market, x86 kept improving year after year after year—an improvement rewarded by steadily increasing deployments by enterprises and service operators alike. A much better x86 created a much higher bar for Itanium to clear. As if that weren't enough, AMD supplied the final body blow to any Itanium hopes for a mass market win. Intel had long suggested that adding 64-bit extensions to x86 would be a kluge, and a poorly performing one at that. AMD begged to differ—and it put its money where its mouth was. The resulting performance numbers from AMD's Opteron proved Intel's "you need to break with x86" assertions false. Although Itanium 2 processors have ramped up performance quite nicely, they haven't pulled away from x86—nor, indeed, from other competitors such as IBM's POWER. As a result, x86 with 64-bit extensions from both AMD and Intel (who was ultimately forced to follow AMD's lead) is well-established as the volume instruction set architecture.

The End of ILP. Finally, even had Itanium more convincingly delivered on its promises of being fundamentally better than x86 and RISC, it would still have been largely focused on solving the wrong problem. Itanium was fundamentally conceived to be the ultimate ILP engine—using software techniques to better wring parallelism out of a single stream of instructions. However, no matter how efficient ILP, it does little to mask the problem of threads waiting for data to arrive from relatively slow memory.[6] Furthermore, speeding up the processing of single threads also tends to imply cranking up the clock as well—an approach that the past couple of years have amply demonstrated runs right into limits of power and semiconductor physics.

All that said, and competitive snipes by IBM and Sun notwithstanding, Itanium remains very much alive with new iterations continuing to advance in performance and capabilities.

Healthy at HP

We see Itanium most commonly in the company of HP; some estimates have HP accounting for 90 percent of Itanium server units and over 80 percent of the revenue.[7] Itanium's continued viability is vastly important to HP because software support is still directly tied to operating systems and processor instruction sets—despite the industry's slow evolution towards (mostly) machine independent code such as Java and .NET. Putting HP-UX, OpenVMS, and NonStop customers and ISVs through yet another migration to x64 would simply be unthinkable. But just because Itanium remains a critical component of HP's Integrity lineup doesn't make it the star or the defining feature. We've seen HP increasingly highlight its own Integrity brand and speak of the processor, when at all, as a secondary supporting element.

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6 See our *Gradations of Threading* and *Breaking Up The Microprocessor Monolith*.

7 http://www.theregister.co.uk/2006/06/01/itanic_q1_gartner/

In part, HP is doing so because of Itanium's historical baggage. Certainly IBM doesn't cloak POWER when it speaks of the System p servers based on that processor family. However, it's not *just* about de-emphasizing Itanium *qua* Itanium; it also reflects that other system attributes are more relevant to buyers than the particular flavor of processor that powers a server lineup—especially when you're talking about the sort of mission-critical servers that constitute much of the Integrity lineup.

Given that HP sells the majority of Itanium chips, Itanium's fortunes are tightly tied to HP—even if Intel is now the processor's sole developer.[8] Thus, HP's resurgence under Mark Hurd is welcome news for the processor. Equally propitious is that Mark Hurd was the head of NCR's Teradata data warehousing division and then the company's CEO. He's someone with the strongest enterprise computing credentials, and therefore unlikely to cut loose Integrity and Itanium with it.

To be sure, HP's Business Critical Servers (BCS)—which includes the Integrity lineup—hasn't seen the same consistent growth or profitability of other groups such as the x86-based ProLiants. And Itanium's rollout even here has been gradual. Itanium takeoff has been almost shockingly rapid on NonStop—up to 38 percent of the total in just 18 months.[9] However, within the rest of the BCS lineup, Itanium still hasn't hit the 50 percent of revenue milestone after something more like five years, depending upon how you count, and despite HP's having repeatedly predicted they would hit that point in "a year or two." Yes, it's getting close, but it's been slow, albeit largely steady, progress.

8 See our *Hi-Ho, Hi-Ho, It's Off To Intel We Go*.

9 See our *Itanium Goes NonStop at HP*. Not only because NonStop is designed and managed for non-disruptive upgrades, but also perhaps because the MIPS processor that previously powered the systems was decidedly long of tooth. In addition, HP has been making a concerted effort to revitalize and extend a line that has unique technologies and a blue-chip customer set—but which Compaq, and then HP, for years didn't seem to know what to do with.

Still, overall, Itanium does a competent job for HP, and HP for Itanium. And, perhaps, with Intel as a whole seemingly back on track after some serious stumbling, delays such as Montecito's—which hurt HP as well as Intel—are largely a thing of the past.

Working Alone

However, while linchpins of the Itanium ecosystem, HP and Intel don't stand alone. Other vendors have also been developing products and working to generally increase the market's awareness of Itanium from the very beginning. Even more important, they've been working to increase support by independent software vendors (ISV) as well as to enhance the various tools, such as compilers, needed to create the application software.

Much of this work has been undertaken by individual companies pursuing their own interests. For example, HP has been the obvious force behind HP-UX and OpenVMS ecosystem development, given that it is the only vendor who sells those operating systems. For its part, SGI has contributed significant resources to developing an Itanium footprint in HPC in support of its Altix line.[10] Unisys drove much of the early scale-up Windows work with Microsoft—although NEC's Express 5800/1160 Xa, more commonly known by its original "AzusA" codename, was actually the first 64-bit Big Iron Wintel system to market.[11]

Also notable is the cluster of large Japanese electronics manufacturers—Fujitsu, Hitachi, and NEC—who have made substantial Itanium investments. These three Japanese vendors are collectively reminiscent of the larger collection of vendors including Data General, Sequent, and ICL that seemed a likely Itanium opportunity in the 1990s. For Fujitsu, Hitachi, and NEC, Itanium provides a common high-performance processor—with Linux the standard Unix-like operating system. However, unlike the norm with x86, there's still plenty of differentiation on top of that basic canvas—for example, Hitachi's homegrown Virtage

10 See our *SGI Brings Big Iron to Linux* and *Altix Goes Modular*.

11 See our *The Odd Couple: Windows Meets Big Iron*.

Major Itanium OEMs

Vendor	*Major Itanium Offerings*	*Comments*
Bull	NovaScale Intensive Line	Some run GCOS (Bull proprietary OS) in addition to Linux and Windows
Fujitsu	PRIMEQUEST	Although not fully fault tolerant, allows system board mirroring
Hitachi	BladeSymphony	Includes built-in firmware-based virtualization; can connect multiple blades in an SMP
HP	Integrity & Integrity NonStop	Broadest lineup of products from blades to scalable rackmount servers to NonStop fault-tolerant systems
NEC	Express5800 1000	Leverages NEC's vector supercomputer and mainframe technology for A3 crossbar interconnect
SGI	Altix	Exclusive focus on HPC (including commercial analytics)
Unisys	ES7000	Legacy ClearPath mainframe OS can now run in a dedicated partition

hypervisor in firmware or Fujitsu's system mirrors on PRIMEQUEST.[12] This degree of proprietary extension is more reminiscent of historic Big Iron than today's "industry standard" servers. It comes from a different mindset, and addresses different priorities and preferences of both vendors and their customers. And it has helped to fuel Itanium's relatively broad update in the Pacific Rim.

The center of Itanium's gravity remains, to a significant degree, an HP processor running HP operating systems such as HP-UX. However, the availability of Linux and Windows across multiple vendors' systems has led to activities and organizations that more formally coordinate and support broader-based application development.

Working Together

Consider the Itanium Solutions Alliance (ISA). Launched in September of 2005, it has about one hundred members—although it is the nine founding sponsors (all hardware OEMs of one sort or another) who provide most of the funding. Although the ISA aims to accelerate the development of Itanium solutions regardless of operating system, in practice it's mostly oriented toward operating systems than run on gear from multiple vendors. That means that Windows and Linux get the brunt of the ISA's attention, in the form of developer days, road shows, a solutions catalog, and the general corralling of what would otherwise be tiny server product lines into a larger, and hopefully more critical mass, to encourage the interest of ISVs and go-to-market partners. Collectively, ISA's backers pledged $10 billion to boost the Itanium ecosystem—an impressive number even if, in the manner of such announcements, it double-counts all manner of moneys that would have been spent anyway, ISA or no ISA.[13]

In practice, ISA appears to have had a greater influence on capturing applications, especially Open Source ones, for Linux rather than for Windows. This probably partially reflects ISA's membership and their priorities. For example, Fujitsu originally introduced its Itanium-based PRIMEQUEST line as a Linux-only product and SGI's Altix lineup still runs only Linux—reflecting its high performance computing (HPC) orientation. In addition, Windows for Itanium is quite narrowly

12 See our *Fujitsu's PrimeQuest - Big Itanium Iron*.

13 See our *Itanium's Latest Alliance* and *ISA Makes a Real Play*.

concentrated on the SQL Server database and a few other back-end applications—a focus that will explicitly continue with Windows Longhorn. As a result, there's not nearly as much demand for Itanium application breadth on Windows as there is on Linux.

On the Linux front, ISA is complemented by the Gelato Federation, an earlier and more academically-oriented group. Gelato is currently most focused on improving the Open Source Gnu C Compiler (GCC) that is used pervasively on Linux, with the goal to bring it up to performance parity with proprietary compilers such as Intel's. The first step is "superblock scheduling" work being completed by the University of Illinois at Urbana-Champaign (UIUC), one of Gelato's founding members. This will allow optimizations to be performed over larger blocks of code—thereby increasing performance. Other areas of the Gelato GCC work include alias analysis, instruction scheduling and data prefetching.

Looking Forward

Itanium is certainly not an "industry standard" in any sense of the word understood in the volume segment of the industry—its multi-vendor adoption and "Manufactured by Intel" notwithstanding. And, while there are probably a few Itanium true believers out there who think that the architecture still has an opportunity to fulfill all its early promises, that seems…unlikely. Even strong backers admit as much in moments of candor; Pat Gelsinger, Senior VP of Intel's digital enterprise group, in an interview last summer, said, "If we could unwind the clock, I would have just built a RAS version of Xeon to attack the market."[14]

That doesn't make Itanium a dead chip, nor a bad one. Indeed, it's alive and kicking. It is turning in good performance, and multiple vendors, many of them important in the markets they serve, have crafted intriguing platforms atop Itanium. Specifications and other hardware aside, there are other even more important signs of Itanium's health. For example, although the availability of applications has long been cited as an Itanium weakness, the count has now risen to over 10,000 applications from over 2,000 vendors.[15] Itanium-based systems are also widely deployed in all manner of mission-critical roles. The rapid adoption of Itanium in HP's NonStop line—which, among other roles, handles most of the world's securities transactions—is one data point. Itanium is likewise the foundation for some of the world's largest SAP R/3 installations and other essential applications across the Fortune 500 and the Global 1000.

These successes may not match Itanium's youthful ambitions to utterly dominate the 64-bit world, but Itanium continues to make progress and establish itself as a capable, multi-OEM foundation for enterprise and high-performance applications.

14 http://www.informationweek.com/story/showArticle.jhtml?articleID=190500823

15 These numbers are from the Itanium Solutions Alliance. While we're always a bit skeptical about the size of any platform's solutions catalog (How do you count an application? How many are current versions?), it does seem clear that the Itanium application count is a very respectable list that continues to grow.