MICROPROCESSOR REPORT
www.MPRonline.com
Vol 16, Issue 43 October 28, 2002

The End of x86

By Peter N. Glaskowsky

The following is an adaptation of remarks delivered as my introduction to Microprocessor Forum 2002.

Welcome to **Microprocessor Forum 2002**, our fifteenth annual fall event. Those of you who attended our first conference in 1988 may recall that it was a RISC-centric affair. There were no x86 processors in the program that year. In 1989, we had our first x86 presentation, and x86 has been a major part of the Forum ever since. But not this year. For the first time in fourteen years, no x86 processor will be announced here. We have come full circle; the market has moved on.

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MICROPROCESSOR REPORT

THE INSIDERS' GUIDE TO MICROPROCESSOR HARDWARE

VOLUME 8 NUMBER 8 JUNE 20, 1994

Intel Jilts HP, Buys Digital Semiconductor

Alpha New CPU of Choice for Server, Workstation Systems

by Linley Gwennap

In a move likely forced on it by threatened litigation, Intel has agreed to buy Digital Semiconductor and adopt the Alpha processor architecture for the server and workstation markets. Intel also receives Digital's StrongARM processor, its portfolio of communications products, and Digital's Hudson (Mass.) fab in the $700 million deal.

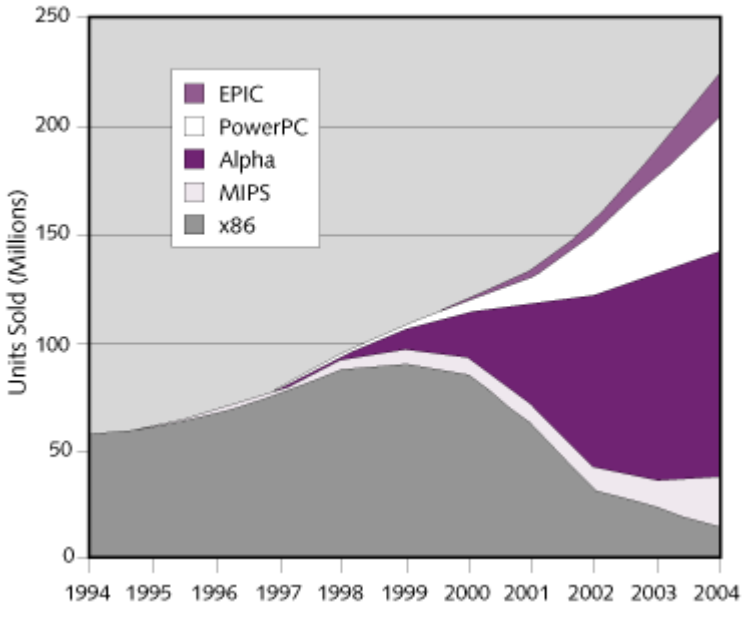
With this announcement, Intel for the first time has admitted that the x86 architecture will run out of steam around the end of the decade. At the same time, the company revealed its plan to solve this problem by switching to an established RISC architecture that should deliver performance superior to other processor designs in that timeframe.

Intel was rumored to be working with HP to develop an x86-compatible VLIW processor. At HP, Josh Fisher, Bob Rau, and others have been working on VLIW designs for a couple of years after pioneering this technology in the 1980s at startups such as Multiflow and Cydrome. We expect HP to seek another partner to support continued development of this technology.

By acquiring Alpha, an architecture that is already the fastest on the market and appears to have tremendous room for growth, Intel has achieved a stunning coup. Combined with Intel's legendary manufacturing and marketing ability and its enormous bankroll, such a processor should deeply worry the competition.

Intel has apparently learned from the fiasco of the 860, its first foray into RISC (see MPR 3/89, p. 1). That

X86 might still be a major part of our program if not for Intel's 1994 decision to purchase Digital Semiconductor and adopt the Alpha processor as Intel's workstation and server processor of choice. Though the purchase may have been forced on Intel by Digital's threat of litigation, Intel got a great deal. Along with Alpha, Intel acquired the StrongARM processor, a substantial portfolio of communications products, and Digital's unmatched circuit-design talent. We can see today that Intel's decision to support Alpha was a turning point in our industry. With Intel's considerable resources behind it, RISC-based Windows NT took off immediately.



By 1999, RISC-based Windows NT systems had moved out of server rooms to take over the corporate desktop. The transition to NT in home systems has taken longer than expected, but Microsoft's decision to release only the 64-bit RISC version of Windows XP means the eventual end of x86 PCs. Intel and AMD will sell over 30 million x86 processors into low-end home computers this year—almost 20% of the total PC market—but few Tier One OEMs are likely to introduce new x86 PCs in 2003.

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PENTIUM REACHES END OF ROAD

Citing Lack of Desktop Demand, Intel Drops Pentium 5 Plans

By Kevin Krewell {1/28/02-01}

The world's fastest x86 processor will be Intel's last. With Alpha now representing 80% of Intel's shipments into PC desktop, server, and workstation systems, the company has shelved release plans for the Pentium 5 processor now under development and will transition its x86 developers to new mobile and desktop Alpha processors. Elements of the Pentium 5 design are likely to be reused, including its cache structure and bus interface, but there is little in the processor core that can be applied to an Alpha design.

The Pentium 4 design, although technically impressive, failed to recoup Intel's investment. Even at 1GHz, a speed no other CISC processor could approach with current process technology, Pentium 4 has been unable to compete effectively

The OEM and end-user preference for Windows XP is behind Intel's decision, announced early this year, to stop further development of Pentium processors for PCs. Though the 1GHz Pentium 4 is an impressive accomplishment, no amount of tweaking will let an x86 core compete against the 8GHz RISC designs we'll see today. Intel continues to offer low-end x86 chips for low-margin applications such as information appliances, but we wouldn't be surprised to see Intel sell off the last of its x86 business within the next year or two.

We have a remarkable variety of presentations for you today, but I'd like to highlight just three. I'm sure you're all eagerly waiting to hear about Intel's Alpha EV11, the world's first massively multithreaded processor architecture. This new design, which will be made in variants supporting from 8 to 32 threads and up to 24 execution units, depending on the target market segment, could very well account for over half of all Intel-based PCs and servers sold in 2004.

MICROPROCESSOR REPORT
THE INSIDERS' GUIDE TO MICROPROCESSOR HARDWARE
VOLUME 9 NUMBER 15 NOVEMBER 13, 1995

AMD Picks PowerPC Over NexGen

$400M License Fee Puts AMD in RISC Game

by Michael Slater

After nearly a year of negotiation, AMD has persuaded Apple, IBM, and Motorola to let it join the PowerPC team. AMD agreed to pay an unprecedented $400M license fee, and will pay further royalties on the PowerPC 604 and 620 processors, which AMD will put into production next year.

AMD's action is a response to Intel's decision last year to adopt the Alpha processor architecture (see MPR 6/20/94, p. 1). Intel has already gained a substantial share of the market for RISC-based Windows NT servers and workstations, and AMD's own K5 processor cannot compete with the vastly faster Alpha.

AMD considered acquiring NexGen, but ultimately

New Cores to Arrive in 1998

AMD will begin work on its own proprietary PowerPC chips, which should reach the market in 1998. We expect to see derivatives of the 604 (for PCs and high-end embedded systems) and the 620 (for servers and workstations). AMD may also be working on its own PowerPC core for embedded systems, giving it an alternative to the company's 29000 family, which has lost its market momentum.

AMD already has engineers at the Somerset design center, learning about the existing PowerPC chips and preparing to develop their own. AMD's injection of an independent viewpoint into the sometimes contentious Somerset environment could be good or bad, depending

As a Mac user, I'm also looking forward to AMD's disclosure of the PowerPC 680. AMD's 1995 decision to license the PowerPC architecture certainly paid off. Though most of AMD's production goes into Windows XP systems, the company competes strongly with both Motorola and IBM for sales into the low-volume but high-prestige Apple Macintosh market.

MICROPROCESSOR REPORT
VOLUME 10, NUMBER 13
OCTOBER 7, 1996
THE INSIDERS' GUIDE TO MICROPROCESSOR HARDWARE

EPIC Bundles SPARC Instructions

HP, Sun To Co-Develop VLIW Processor By 1999

by Linley Gwennap

Hewlett Packard and Sun Microsystems have agreed to co-develop EPIC, a new microprocessor architecture based on HP's work with very long instruction word (VLIW) technology. EPIC stands for explicitly parallel instruction-set computing, referring to the way multiple instructions are bundled together to be executed at the same time. EPIC will use extended SPARC opcodes along with prefix bits in each bundle that describe how the instructions can be executed.

If this all sounds familiar, it's because HP was previously rumored to be working with Intel on an x86-based version of the same concept (see MPR 6/20/93, p. 1). Details of that effort were never released, but we believe that the x86 instruction set proved inappropriate for such an approach.

Other changes to the SPARC instruction set build on key features of the SPARC architecture. EPIC will provide four times as many directly addressable registers, though register windowing is still available. The larger register set eliminates the need for register renaming and reduces time-consuming cache accesses. When cache accesses are required, speculative loads can hide cache latency even when branches are in the way. Some of these branches can be eliminated entirely with predicated execution, reducing opportunities for onerous branch mispredictions.

Speaking at the recent Microprocessor Forum, architects Jerry Huck (HP) and Gary Lauterbach (Sun) disclosed these key features of EPIC but did not provide a description of the new architecture's execution model. Details of the prefix bits, bundling rules, and other elements of EPIC will

We're also happy to have HP-Sun here to present its next-generation EPIC III processor, the latest VLIW implementation of the SPARC instruction-set architecture. As you know, 2002 will see the final shipments of HP-Sun's PA-RISC and SPARC systems. This commitment to EPIC was a major component

of the merger of the two companies in 2001. The new EPIC III processor being announced here today will provide an excellent platform for both technical computing in the HP division and business systems under the Sun brand.

You may remember the rumors from 1994 that Intel was negotiating with HP to co-design EPIC as an x86-compatible VLIW machine. How different the world would be today if that deal hadn't fallen through...

Okay. Back to reality.

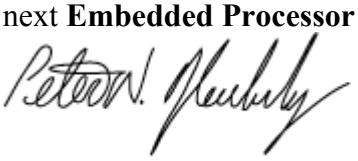
Obviously, that's not how the world turned out. Aside from the details of corporate alliances, the most striking difference between my little fantasy and the real world today is the strength of x86. Not only is Pentium 4 the fastest and most successful PC processor in the world, but AMD's plan to extend the x86 architecture for 64-bit computing means we could be looking at another 20 years of x86 PCs and servers. So, for the foreseeable future, x86 will continue to play a major role at Microprocessor Forum. In fact, we had several important x86 presentations at the Forum this year.

All of the RISC architectures that vied for Windows NT system sales in the mid-1990s are still around, but not in PCs. Some still contend for shares of the server business, but only IBM's Power and Sun's SPARC seem to have long-term prospects there. The Intel/HP Itanium project has cut the legs out from under Alpha, MIPS, and PA-RISC.

Itanium got off to a shaky start, but it's standing on its own two legs today and is likely to cover considerable ground over the next several years. Intel has hinted at some remarkable Itanium designs in the works, and we heard more hints in Forum presentations from Intel's John Crawford and Robert Yung.

In the embedded world, RISC has nothing to fear from x86. Both approaches have natural applications in embedded systems, as we heard on the second day of MPF 2002, but RISC owns most of the overall embedded market. Network processors, media processors, and the best low-power and high-performance embedded processors are all RISC designs.

Microprocessor Forum 2002 was a great success, and we hope to see you all at the next **Embedded Processor Forum** in June and at **MPF 2003** next October.



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Newton, MA 02458
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