

Portable Software Threatens x86 Hegemony

Experts Debate Whether RISC Will Eventually Triumph

by Linley Gwennap



At the Microprocessor Forum this year, two experienced architects debated whether portable software will end the dominance of the x86 architecture. Supporting the proposition was Motorola's Keith Diefendorff, well-known architect of the 88110 and PowerPC. In opposition was AMD's Mike Johnson, author of the textbook *Superscalar Microprocessors*.

The two began by agreeing that RISC is, in fact, better than CISC, specifically the x86 architecture. Johnson, known as the architect of AMD's 29000 processors, even admitted, "I'm a RISC bigot," but then stated, "My argument is that RISC is not better by enough of a margin to win in the PC market, and that the x86 is too entrenched to be unseated."

Johnson is now managing AMD's K5 project (a Pentium-class x86 processor) and has spent considerable time studying the fundamental differences between RISC and x86 processors. He claimed, "If you factor out all the variables, I think RISC has an inherent 1.3x to 1.5x performance advantage over the x86."

Diefendorff, of course, feels that the advantage is much larger. To support this, he showed a chart comparing the number of transistors in the processor core (removing all transistors used in the caches) for Pentium and the leading RISC processors, which have roughly similar performance. The x86 processor requires twice as many transistors as any of the RISC cores and three times as many as some. Seeing these figures, Johnson quipped, "Another way of saying that is he has twice as much cache as a Pentium, and he doesn't get any more performance out of it."

Johnson admitted that his estimates of RISC's inherent performance advantage are not based on any published data and are only his personal beliefs, leaving the debate to be settled on other issues.

Diefendorff believes that the simpler cores of RISC processors make them simpler to design than x86 chips. "How long did it take [Intel] to design Pentium? I know that we just developed a couple of PowerPC microprocessors, each with roughly the same performance as Pentium, in less than 18 months. So I think there are ad-

vantages in design time. And I guarantee that there will be advantages when we do very high-end six- or eight-way superscalar designs. Personally, I can't imagine doing a six-way issue machine on the x86 architecture. That is not a problem with RISC machines."

This time, Johnson did not have a quick retort, but he did claim that the x86 architecture would quadruple in performance by "1996, 97, 98." Motorola, in contrast, claims that its PowerPC 620 will offer four times the performance of its current 601 by 1995.

Intel as the Evil Empire

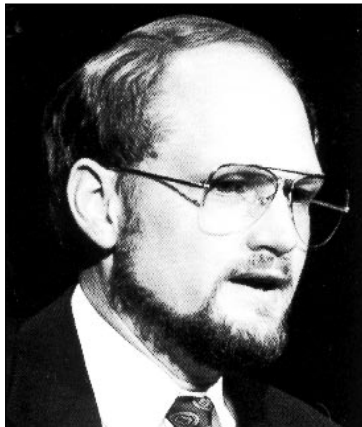
Both debaters agreed on a second point: Intel's dominance of the x86 market is bad. (This wasn't a surprise, given their corporate backgrounds.) Diefendorff was the first to raise the issue, saying, "The biggest push toward portable software is being provided by Intel, whose dominance has led to an unhealthy absence of competition for microprocessor sockets. I'd like to know who really believes that they can compete in the x86 market without being sued. Clearly, the list of people who have [done this] is very short."

He continued by asserting that Intel will always maintain control at the leading edge of performance. "You have to wait for [Intel] to figure out what the 64-bit extension is going to look like. You have to wait for them to figure out the bus.... You are always going to be behind at the leading edge."

Diefendorff relies on the invisible hand first identified by Adam Smith. "Capitalism moves to correct such atrocities. I know that Intel is a very wealthy company...but to underestimate the amount of effort and resources being spent on developing alternatives would be a major mistake. The level of corporate commitment behind the PowerPC alone is almost staggering."

Johnson agreed that alternatives are important, but he sees Intel's competition coming from other x86 processor vendors. As an example of the effects of such competition, he pointed to the 60% drop in 386 prices during the first twelve months after AMD entered the 386 market in 1991.

He also contested Intel's control of the leading edge. "Obviously, they've controlled it historically, but things are changing. AMD, TI, Cyrix, and IBM are attempting



"The main reason I decided to defend the x86 is that, when I debate, I like to win."

Mike Johnson, AMD

MICHAEL MUSTACCHI

to undermine that dominance. Now you can argue that several of us will fail, but it's hard to imagine that all of us will.... Note that IBM is playing both sides of this; they're not willing to bet everything on RISC....

"Power PC is a special case, because it has a chance to take some of Apple's 10-20% market share from the 68K over time. PowerPC can be successful to the extent that Mac OS is successful against Windows, but Apple has a tall order maintaining its value premium."

NT: The Ultimate Weapon for RISC

The crux of the debate was whether Windows NT, the most publicized portable software, will enable users to move from x86 platforms to RISC platforms. Diefendorff said that, even if NT does not take over the desktop, it clearly demonstrates the feasibility of portable software and indicates a trend away from fixed binaries.

He said, "The one remaining obstacle is the very large installed base of x86 binaries. Fortunately, there are a couple of technologies that mitigate this problem. One is instruction-set [binary] emulation, which is now a well-developed technology, coupled with native-mode implementation of the API [such as Wabi].... Also, binary recompilation provides a semi-automatic way of supporting code for which the source is no longer available."

Diefendorff also pointed out that most commercial applications are being developed in high-level languages that can easily be recompiled for other platforms. He noted that, "Even Intel has sanctioned the idea of recompiling applications to get full performance out of Pentium....and if [ISVs] do that, then it's not clear to me why they just don't recompile for a good architecture instead of the x86."

Johnson presented an eloquent counterargument. "Imagine that you're an ISV, and you have to decide whether to do a RISC port. Which one do you pick? Recompiling isn't free.... It doesn't help with the recurring cost to distribute, maintain, and support different binaries on different platforms. It's only worth it if you make money.

"Even if you manage to make this decision you'll likely do the x86 version first and do the RISC version later.... The most valuable and lowest-cost software will always be available on the x86 first. The only way to break this cycle is for users to pay a premium for the RISC applications, which adds to the cost of RISC.

"Emulation is the only credible vehicle for addressing the dearth of RISC applications, but emulation puts RISC at a permanent performance disadvantage. If

users want a slow PC, they'll buy a slow PC and save money."

Johnson also noted that NT is a high-end operating system but, "In the PC market, the action is at the low end, where the volume is. It's nearly impossible to target the low end with a new architecture, however, because there's a Catch 22: Without volume, it's impossible to achieve the lowest hardware and software costs, but without the lowest costs, you can't achieve volume.

"The x86 got in on the ground floor. With a new architecture, your only hope is to bomb the price and hope you get market share before you go bankrupt. But this strategy is out of the question against the x86 suppliers, because their pockets are too deep.

"No company or consortium has the resources or expertise required to topple the x86: not IBM, Digital, SGI, Apple, Motorola, or anyone else. It's not in the interests of users to change from an open, competitive standard that serves them to a limited, closed solution that serves only RISC proponents. Getting a little more performance is not good enough to make it happen."

Agreed to Disagree

Diefendorff summed up his side: "Portable software works; it can provide architectural independence. There are substantial market forces driving us to the use of it. There is no doubt that RISC is, in fact, worth the effort to use it, and there is already clear evidence of movement in that direction.

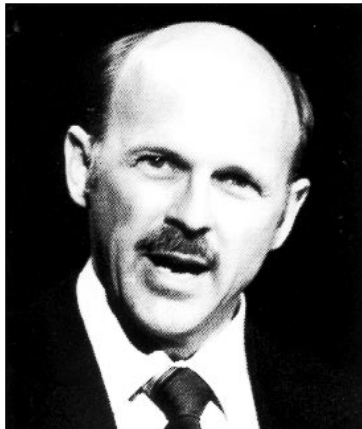
"The industry is tired of Intel dominance, and we will move toward portable software to get out from under that. So I think, over time, the Intel architecture

simply falls further and further behind. And it's over. I don't think there is really any doubt whether the x86 will be replaced or not. The only question is, 'When?'"

Johnson got the last word, noting that portable software has been around for at least a decade and hasn't made much of a difference: the most popular software continues to be available solely on the x86.

He concluded, "It's true that the industry is tired of Intel's dominance, but that's not the same as being tired of x86 dominance.... You have the option of recompiling to a RISC or just using the same old binaries and using a processor that may not be quite as good as a RISC, but it's good enough."

Even if we all agree that RISC is better, can these new processors open enough of an edge in price/performance to overcome the x86 software base? Will Windows NT ever have the volume to bring RISC into the mainstream? Only time will tell. ♦



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"By 1997, most software will be portable, and once that happens, the x86 is dead meat."

Keith Diefendorff, Mxotorola