Many systems vendors and microprocessor users find themselves forced into making a major decision: Should they invest in the current RISC upsurge, or should they ignore it?

Since the emergence of the first commercial reduced instruction-set computing processor, the Fairchild (now Intergraph) Clipper, our industry has witnessed increasingly sophisticated technological advances. Advances in silicon and processing technologies now give us clock speeds in excess of 40 MHz and chips with 1 million transistors! The quest for high performance and increased functionality, not just raw speed, led to sophisticated architectural techniques, specifically three- to four-stage pipelining and large instruction and data caches. As a result, we can achieve single-cycle execution for all instructions, one of the traditional RISC principles. Added functionality, such as floating-point units and graphical processors, also contributed to the high-performance race.

Paralleling these explosive technological advances is an equally important milestone: the development and growth of microprocessor software and peripheral-support infrastructure. In essence, the microprocessor industry has matured! From the first 4-bit processor produced in 1971 by Intel Corp., the technology has evolved and contributed significantly to our Information Age. We have effectively unleashed the power of micro-mainframes on desktop machines, proliferating distributed and networked computing via local area networking, personal computers, and workstations.

To retain and increase market share, leading CISC (complex instruction-set computers) vendors, such as Intel and Motorola, concentrated their strategic efforts on nurturing their own infrastructure of software development, peripheral support, bus standards, and single-board and subsystems vendors. These efforts resulted in substantial embedded bases of users. Software and applications have in fact forced de facto standards on the industry, notably MS-DOS in the PC market dominated by the Intel 80x86 series.

Users, when selecting microprocessors, find themselves faced with the RISC option. If they choose a RISC for high-performance computing, they might be unable to take advantage of the embedded applications-software base due to compatibility and porting issues. If they take the more conservative hybrid path (complex reduced instruction-set processor), they could lead themselves into technological obsolescence should the future prove to be dominated by RISCs.

Observing lessons learnt from the CISC evolution trends, users understand that having a large applications software base and forming strategic alliances with innovative and large systems houses are crucial to the success and survival of RISC vendors. However, they also realize that a major constraint exists: Systems houses are reluctant to commit to a RISC platform without users to develop more software, while users shy away from new systems unless there is a sufficient software base. This Catch-22 situation has created a new playing field in the microprocessor industry. Now, RISC silicon and software vendors compete with the established CISC/RISC houses.

As it turns out, this Catch 22 can be resolved. The systems houses' willingness to adapt and migrate to a new software platform seems to depend on two factors. RISCs offer substantially higher performance over CISCs, and a standard software/operating systems environment cuts across architectural boundaries. Such an opportunity was aggressively pursued by a leading workstation vendor, for example. This vendor advocated a high-performance, open software-standard platform via RISC (for performance) and Unix (for an open systems environment).

Now, industry pundits seem to project RISC as the wave of the future. Their predictions depend on three industry trends converging to a true open systems environment: high-performance computing through RISCs, semiconductor and circuit design advances allowing complete systems on a chip, and Unix—the operating system of choice of all RISC processors.

Events in the industry seem to bear this prediction out. In establishing open systems and standards, large Unix consortiums (Open Software Foundation, Unix International, X/Open) and strategic alliances between systems houses and RISC vendors (Sparc/Toshiba, DEC/MIPS) have formed. Following this trend, consortiums designed to propagate RISC processors as open standards are also cropping up (Sparc International, 88open). These consortiums encourage rapid applications and software development, establish applications binary interfaces (ABIs), and ensure compatibility and portability.

Industry observers believe a shakeout is imminent, with the RISC technology undoubtedly following its
Guest Editor's Introduction

CISC predecessors in its technological evolution converging on main market vendors. But stakes are high: Observers fully expect RISCs to dominate CISCs in the workstation market in the 1990s. This prognosis is further reinforced by the actions of the market leaders, Intel and Motorola. Both companies have announced RISC products. Other strong contenders are Sun Microsystems Inc. with its Sparc architecture (produced by Bipolar Integrated Technology, LSI Logic, Cypress, Fujitsu, and Texas Instruments) and the MIPS Computer System's architecture (produced by LSI Logic, Integrated Device Technology, Performance Semiconductor, NEC, and Siemens). In terms of volume, though, the Intergraph Clipper still leads the market with volume production in 1988 that garnered impressive design wins based on availability.

Current technological breakthroughs contribute in two ways: speed and density. At a recent PC Expo (May 1989), Intel Vice President David House predicted that we will see 100 million transistors on a chip by the year 2000. House claimed we would see these chips offering 60-MHz clock speeds, four CPUs, and a digital video interactive processing unit. This possibility would definitely allow CISC vendors the capabilities to provide RISC features, blurring the distinction between the two. It would also enable them to remain compatible with their embedded base. Don't count the CISC vendors out yet!!

The speed breakthroughs are just as impressive. Bipolar ECL (emitter-coupled logic) and BiCMOS (CMOS input transistors and bipolar output transistors) technologies resulted in bipolar RISC processors (newly nicknamed BRISCs). These processors push clock rates upwards of 100 MHz and offer a projected throughput of 200 million instructions per second by 1993.

All of the major players participate in the speed advances. They've used bipolar ECL as the technology of choice to produce the Sparc (by BIT), the 88000 (by Motorola and Data General), and the MIPS (by NEC). In the BiCMOS version, Cypress and Fujitsu backed the Sparc, and IDT produced the MIPS. Fujitsu also plans a bipolar Clipper. Interestingly enough, these high-performance RISC machines are not targeted at present CMOS RISC markets, but at high-end workstations, minicomputers, and superminis. Trends at this level of applications include open architectures and standardized operating systems such as Unix. And, these developers are willing to shift from traditional CISC machines for substantive performance enhancement and scale of integration—both objectives that bipolar RISC vendors are intent on fulfilling.

These are but some of the issues facing many vendors and users in the strategic positioning of their products and influencing their processor-selection process. With this background, you will find that this special issue on high-performance processors brings you a snapshot of some of the latest in today's available technology. This issue features Intel's entry in the RISC race. Les Kohn and Neal Margulis discuss the i860 processor in detail. Motorola's RISC entry, the 88000 processor, was featured in IEEE Micro's April issue; now we offer their MC68332, a high-performance microcontroller for real-time control applications. Joe Jelemensky and crew discuss how VLSI (very large scale integration) technology brings high-performance microprocessor capability to meet the specific needs of a specific industry (real-time control).

In addition, we are indeed fortunate to present in this special issue a discussion of architectural feature comparisons of three RISC processors. Rich Piepho and Bill Wu of AT&T discuss the i860, 88000, and Sun Microsystems' architecture (produced by LSI Logic, and the MIPS Computer System's architecture). Renton and Bill Wu of the University of Virginia and the Industrial Electronics Society, respectively, discuss how VLSI (very large scale integration) technology brings high-performance microprocessor capability to meet the specific needs of a specific industry (real-time control).

We hope the articles presented here will provide our readers with better guidance and renewed awareness of the high-performance processors. I have particularly enjoyed guest editing this issue as we are right in the middle of this relentless march in technology. In fact, the frequency with which advancements are moving warrants another high-performance issue very soon.

References

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