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THE EDITORIAL VIEW

INTEL'S EMBEDDED FUTURE

By Tom R. Halfhill {7/31/06-01}

Only two weeks after AMD announced the sale of its Alchemy business unit to Raza Microelectronics (RMI), Intel announced that it's selling most of its XScale business unit to Marvell Technology Group. Both PC-processor giants are divesting embedded-processor businesses in the same month. What's going on?

The obvious explanation is that AMD and Intel are refocusing on their core business—x86 processors for PCs. It's a heavily contested market that has grown even more competitive in the past two years. Certainly, both companies need to pay more attention to their foundations. But what makes sense for AMD doesn't necessarily make the same sense for Intel.

Both AMD and Intel have had difficulty establishing embedded RISC architectures and duplicating the success of the x86 in the PC market. In the 1990s, both companies introduced original 32-bit embedded RISC architectures and enjoyed some success at first. AMD's architecture was the 29000 (29K); Intel's was the i960. But declining sales and profitability led to their demise. AMD announced the end of the 29K in 1995 (see *MPR 12/4/95-02*, "AMD Kills 29000 Development"), and Intel recently discontinued the i960.

After AMD and Intel got nowhere with their native-born embedded RISC architectures, both companies acquired embedded RISC processors invented elsewhere. Intel moved first, gaining StrongARM as part of a legal settlement with DEC in 1997. (See *MPR 11/17/97-01*, "Digital Sells Its Chip Business.") Intel improved the StrongARM microarchitecture and renamed it XScale. In 2002, AMD acquired Alchemy, which had designed an impressive custom implementation of the MIPS32 architecture. (See *MPR 3/4/02-01*, "AMD Acquires Alchemy to Make Gold in Embedded Markets.") AMD has introduced a few new Alchemy processors since 2002.

Unfortunately, neither AMD nor Intel found much success with those ventures. Now, AMD is selling the entire Alchemy unit to RMI, another MIPS licensee. And Intel is selling the portion of its XScale business devoted to communications and applications processors to Marvell, another ARM licensee. (Intel is retaining the smaller portion of its XScale unit devoted to networking and storage processors.) Among the XScale chips that Intel is selling to Marvell are the PXA9xx "Hermon" communications processor, which powers Research in Motion's Blackberry 8700, and the PXA27x "Bulverde" applications processor, which is found in the Palm Treo smart phone, the Motorola Q, and other devices. (See *MPR 7/26/04-01*, "Bulverde and Marathon Turn Cellphones Into PCs.")

In last month's editorial, we applauded AMD's deal with RMI, because we think it's good for Alchemy and will allow AMD to focus on the x86. (See *MPR 6/26/06-03*, "Alchemy's Third Chance.") However, Intel's deal with Marvell has different ramifications. It's easier to understand why AMD divested itself of Alchemy. AMD is a smaller company than Intel and is better off concentrating on the PC market. Indeed, we think AMD will have its hands full trying to keep up with Intel's aggressive new development of multicore processors for the entire spectrum of that market, from

notebooks to servers. AMD's engineering resources will soon be stretched to the limit.

Intel is different. To maintain its industry leadership position, Intel needs a broader strategy, one that includes the largest and fastest-growing markets for microprocessors. And the fact is that the largest and fastest-growing markets are in the realm of personal embedded systems. Selling a business unit that makes processors for PDAs, mobile communicators, and other handheld devices seems shortsighted when those product categories are clearly the wave of the future. In contrast, desktop PCs look more and more like tomorrow's mainframes. They are big, bulky systems, fixed in place and reserved for computing tasks deemed too heavy for new-age "personal computers," which are highly portable or even wearable.

Right now, the new Intel of the embedded-processor industry is ARM. By embracing an intellectual-property (IP) licensing model instead of making chips, ARM has seeded its low-power RISC architecture in scores of companies over the past 12 years. (From tiny acorns do mighty oaks grow.) ARM licensees will ship more than two billion ARM-based processors this year—an astounding total that outpaces Intel's x86 shipments by more than ten to one. Although ARM's revenues and profits don't come close to matching Intel's—licensing IP doesn't generate as much cash as selling chips—ARM is clearly exploiting a gigantic market that Intel can't afford to ignore.

Looking Beyond XScale

Of course, jettisoning a few XScale chips doesn't mean Intel is ignoring the embedded-processor market. Intel remains strongly committed to embedded processors and is revising its embedded strategy. (Stay tuned for more information about that.) This is an opportune moment to speculate about Intel's next move and to offer our two cents' worth of friendly advice.

Intel probably has good business reasons for selling the 1,400-person communications/applications XScale unit to Marvell. Faced with a surprisingly resurgent AMD and other challenges, Intel is rapidly cutting costs and reorganizing. XScale's financial performance was lackluster, so the unit was an obvious candidate for a selloff. And Marvell is paying $600 million in cash, which isn't chump change, even for Intel.

Another reason for Intel to reduce its commitment to XScale is that it's not an Intel-native CPU architecture. XScale isn't protected by the same financial and emotional capital that Intel has invested in, say, the IA-64 (Itanium) architecture. Indeed, XScale is ARM compatible, so every design win strengthens ARM.

As we see it, Intel now has three options: create an entirely new embedded-processor architecture; acquire another embedded-processor architecture from an outside company; or renew its commitment to developing the x86 as an embedded architecture.

Creating a new architecture is the least likely option. The world already has plenty of CPU architectures, and *MPR* covers new ones all the time. We don't think Intel will embark on an expensive, risky project that could turn into another i432, i960, or IA-64.

Acquiring an outside CPU architecture is only slightly more likely than creating one from scratch. Of course, the hottest acquisition target would be ARM, but such a bid is doubtful. Even if Intel could make the deal work financially, ARM might fight it with poison pills, and government regulatory bodies on both sides of the Atlantic would worry about creating another Microsoft monopoly.

Smaller acquisition targets would be less controversial, but also less rewarding: perhaps ARC International, MIPS Technologies, or Tensilica. Those companies are processor-IP vendors, like ARM. So far, Intel hasn't displayed any interest in that business model, despite ARM's spectacular success with it.

If Intel doesn't want to become a processor-IP vendor, the alternative is to acquire a fellow chip manufacturer specializing in embedded processors. However, acquiring a major semiconductor company looks like too large a bite for Intel right now, even if the deal could clear regulatory hurdles. In addition, we doubt Intel has much enthusiasm for inheriting the plethora of alien CPU architectures that such an acquisition would probably bring. Intel has too many architectures already.

Streamline the x86 for Low Power

Intel's third option is to develop new, low-power x86 embedded processors. Yes, we know, Intel is already doing that. Two weeks ago, Intel announced that Senior Vice President Anand Chandrasekher will manage a new business unit focused on the ultramobile PC (UMPC) and low-power x86 products. The new unit will almost certainly use technology developed by Intel's Low Power on Intel Architecture research project at the System Technology Labs (*www.intel.com/technology/systems/lpia/*). But Intel needs to step up the pace of this project and send clearer signals about its embedded x86 strategy.

Recall that a year ago, Intel CEO Paul Otellini promised to deliver by 2010 a 500mW x86 processor capable of running an operating system like Microsoft's Vista, the next version of Windows. Otellini's goal is to bring desktop performance to PDA-size UMPCs. Achieving that goal would be an impressive feat. But by 2010, cellphones with ARM processors might subsume the functions that Otellini envisions for x86-based UMPCs. Future derivatives of Apple's ARM-based iPods are another source of potential competition. Even the XScale-based Blackberry communicators that Intel has discarded might evolve into versatile palmtop computers. Maybe none of those devices will run Vista, but maybe by 2010, it won't matter.

Meanwhile, Intel is sending mixed signals about its commitment to embedded x86 by halting production of venerable processors in the 186, 386, and 486 families. Intel says demand for those chips is dwindling—not surprising for products that have scarcely been updated in 20 years. (Intel is

also discontinuing the 8-bit 8051, MCS90, and MCS251 families, as well as the 32-bit i960, but that's less worrisome. The 8051 is widely available from other sources, and the other castoffs are waning.)

We hope Intel is pruning its catalog to make room for a new generation of low-power x86 processors. We believe Intel can do much more with the x86. For years, it's been almost gospel that the x86 architecture is unsuitable for very low-power designs. It's time to revisit that notion.

What if Intel created a new subset of the x86 architecture specifically for low-power processors? Think of it as Intel's twist on ARM's Thumb. Backward compatibility with old x86 software is less important in embedded applications, and Intel could significantly streamline the architecture while maintaining easy code portability.

In 1994, Motorola took a similar approach with its popular 68000 architecture by creating ColdFire. (See *MPR 10/24/94-05*, "Motorola Redefines 68K Instruction Set.") Although ColdFire hasn't set the embedded world aflame, it's still a viable architecture, and Intel could almost certainly do better with an overhauled x86. Such a project would be easier and less risky than creating a wholly new embedded architecture, and it would inspire more support within the company than acquiring one from outside.

Use Licensing to Compete With ARM

To make this embedded x86 strategy work, Intel should also design licensable x86 embedded-processor cores, especially synthesizable cores. It's not enough for Intel to make chips. To compete effectively with ARM, whose licensing model is what the military calls a force multiplier, Intel would need to spread the revamped x86 architecture far and wide. Imaginative x86 licensees would create chips that Intel might never think of. Young, aggressive licensees would pursue markets that Intel considers unattractive. And licensable x86 cores from Intel could move the x86 into FPGAs, which are gaining ground on ASICs and SoCs.

The standard argument against Intel adopting an IP-licensing model is that ARM's business is small potatoes compared with Intel's. True enough. Last year, ARM's revenues were £232 million, while Intel raked in $38.8 billion. That disparity is persuasive for bean counters. However, we think there's something to be said for owning the world's most popular microprocessor architecture in the fastest-growing microprocessor market.

Furthermore, we think Intel should make licensable x86 cores that are user configurable, like the configurable processors from ARC, MIPS, and Tensilica. By working with a customizable instruction-set architecture, licensees could optimize Intel's embedded x86 cores for specific applications, vastly improving performance. Developers could add new instructions Intel didn't include or remove unneeded instructions. In addition, an IP-licensing model would help solve Intel's problem of keeping embedded x86 chips in production for long periods of time. Customers could bring their chip designs to any foundry for manufacturing and keep them in production as long as they want.

Now that it's clear Itanium will never replace the x86 in PCs, Intel should recognize the great value of the x86 and exploit it everywhere. Recall that Intel nearly lost its grip on the x86 a few years ago by not realizing its 64-bit potential. AMD rushed into that vacuum and inflicted significant pain on Intel. To avoid making a similar mistake, Intel should rapidly develop the low-power embedded potential of the x86 before another competitor seizes the opportunity. Other architectures come and go, but the x86 has been Intel's bedrock foundation for almost 30 years. Build on it!