An inside job

It's what's diffused that makes the difference. By **Philip Ling**.

You have to hand it to fpga companies: they are not afraid to try something different. And, in a conservative industry like semiconductor fabrication, trying something different isn't always encouraged – especially when it involves a lot of NRE cost and effort. But that is exactly what the fpga companies did when they chose to integrate microprocessor cores in their fpga fabrics.

In truth, when the first fpgas with diffused processors started to appear, it seemed like we'd been waiting forever to see them. Professional observers thought it such an obvious direction to move in that they couldn't understand the delay. When at last they were revealed, they were received with enthusiasm and great expectations.

But the industry didn't seem to share that enthusiasm and expectations failed to be met. Although all mainstream fpga vendors bought into the idea of embedded cores in one way or another, they have in similar fashion abandoned the concept to a greater or lesser extent.

For instance, Altera still supplies Excalibur devices – essentially an APEX20KE with an ARM9 core diffused in it – but they aren't recommended for new designs. Instead, Altera recommends the adoption of its proprietary soft core NIOS, which isn't restricted to the APEX family.

Likewise, Atmel still offers its FPSLIC (field programmable system level integrated circuit), which is based on an 8bit AVR microcontroller embedded in an AT40K fpga. But it hasn't developed the family beyond the AT94S secure version of the standard AT94K. Only Xilinx stands resolute in its continued diffusion of PowerPC cores into its Virtex II Pro and Virtex4 FX families. However, when Virtex II was first announced, there were plans to offer variants with one, two and four PowerPC cores, which has since been restricted to a maximum of two. Similarly, Virtex4 is available with up to two PowerPC405 cores.

The aggressive pace of development of fpga technology would imply that a similar development curve could be applied to diffused processor cores. Yet there has been little or no development to the cores themselves since they were first introduced to the fpgas. Worse still, in some cases, they seem to have almost become an embarrassment.

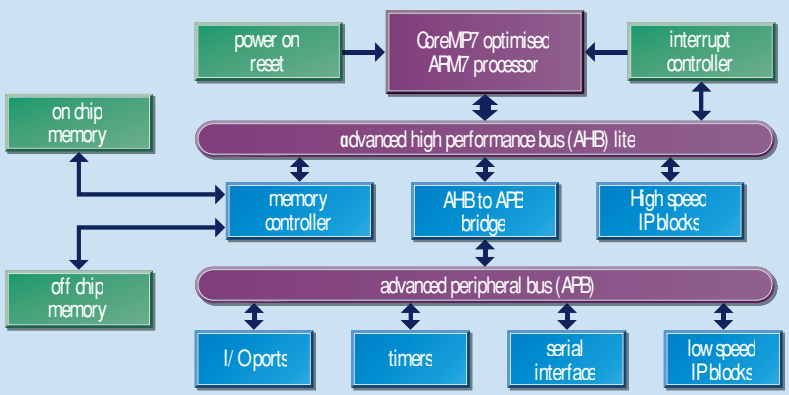
It isn't really a case of what went wrong, but of what went right: the technology. The reason the cores were diffused in the first place was more to do with the performance limitation of the fpga fabric than it was the industry's fondness for a familiar architecture.

What went wrong?

Thanks to the aggressive pace of development of fpga technology – which remains at the forefront of lithographical advancements – any performance deficit was soon removed. That meant the fabric could now accommodate a soft core performing as well as a diffused core. Instantly, the benefits of a programmable device were restored; no longer was the choice of processor core fixed by the architecture, it could be implemented if needed and left out if not. In short, the benefits of a diffused core no longer outweighed the penalties.

It gave rise to another wave of adoption – proprietary soft cores – after all,

Figure 1: CoreMP7 brings an ARM processor to fpgas



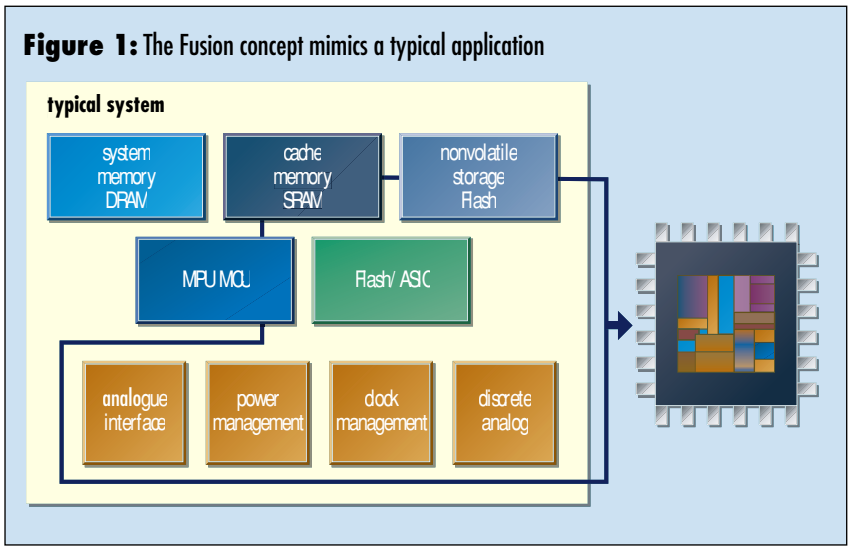


Figure 1: The Fusion concept mimics a typical application

why licence a core if you could provide your own at no extra cost to the customer? For Altera, this took the form of Nios I and II; for Xilinx, it is MicroBlaze and PicoBlaze. Lattice has its own Mico8 microcontroller as well as an 8051 core, whilst the venerable 8051 remains a firm favourite for Atmel and Actel.

The next phase

While the 8051 is the undisputed champion of 8bit architectures, it remains no match for 32bit heavyweights. To this end, Actel has recently announced it is can now offer an fpga with a soft ARM7 core; itself the people's favourite 32bit variant.

Optimised for Actel's ProASIC3 family of FPGAs, the core runs up to 25MHz in devices offering up to 3million system gates. Actel claims it lowers the barriers to adoption by obscuring any license arrangements with ARM from the customer; as far as the engineer is concerned the product offering – which goes by the name of CoreMP7 – just comes with an ARM7 core at no additional charge.

"Actel is living up to its promise to bring the ARM7 to the masses," said Dennis Kish, vice president of marketing at Actel. "With the release of CoreMP7, we are extending the reach of the ARM architecture to include markets that could not previously afford individual access to this technology. Actel, in close collaboration with ARM, has combined the flexibility of Actel FPGAs with ARM's industry standard ARM7 processor family to produce a complete and powerful – yet easy to use – product for every designer."

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"The unrivalled security features of Actel's non volatile FPGAs have enables a soft IP version of the ARM7 architecture to be made available in a programmable logic device for the first time," said Mike Inglis, executive vice president of marketing, ARM. "In addition, the unique synergy between the ARM7 and Actel's ProASIC3 family has opened the opportunity to extend this technology to an even wider range of applications and volume points."

Mixing it up

Ever the innovators, fpga vendors are now turning their attention to mixed signal functionality and Actel is forging ahead here, too. Fusion programmable system chips combine fpga gates with integrated digital logic and analogue functionality and have been launched with a library of IP that supports power and thermal management applications. As figure 2 shows, it can also accommodate an ARM soft core.

"The Fusion PSC device, with its high level of system integration, enables designers to quickly move from concept to completed design," said Yankin Tanurhan, senior director of applications and IP solutions at Actel. "The Fusion ecosystem simplifies and accelerates design with exceptional application support. Actel will continue to improve this support while cultivating a network of partners to help improve the adoption of Fusion in the marketplace."

The key to Fusion seems to be a complex, multistage a/d converter with front end signal conditioning, as opposed to the more fundamental approach taken in the past by others, such as a switched capacitor network supporting an array of general purpose operational amplifiers. In essence, converting the signal to a digital format as soon as possible without losing any accuracy seems more rugged and more flexible than trying to remain in the analogue domain.

This isn't the first time an fpga vendor has tackled mixed signal and it is unlikely to be the last. The question is, has creating a viable mixed signal programmable device replaced the 'dream' of producing an fpga with a diffused processor? Is programmable analogue destined to remain a niche application area?

Despite Fusion being the latest in a relatively long line of (largely failed) attempts to master the programmable analogue device, it's still too early to tell. But first impressions are encouraging.