BITTWARE: HIGH PERFORMANCE FPGA-BASED SOLUTIONS

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Q. **First of all, tell us a little bit about yourself and your responsibilities at Bittware.**

A. I started out as a sensor physicist, but early on figured out that we could sense more than we could process. So I started working on processing the signals, found it exhilarating, and never looked back. I believe that my low-level appreciation of the underlying requirements have given me unique perspective on signal processing.

Recognizing a need for standard signal processing engines, I started a company named Ixthos in the early 1990s. Interestingly, we competed with BittWare. After Ixthos was acquired, Jim Bittman, BittWare's founder who wanted to get back to his engineering roots, asked me to take over the company. Loving the innovative spirit I found there, I joined as President and CEO, and look forward to celebrating my 10th anniversary this coming January.

Q. **Bittware has long been a leader in high performance DSP boards and subsequently in Altera-based boards. What is your product strategy? Briefly, can outline your product offerings?**

A. We always focus on providing general purpose, high-performance signal processing building blocks. We consciously shy away from trying to create complete solutions targeted at specific applications, knowing full well that this stuff is extremely complicated and that we can't possibly understand any given application as well as a customer who is focused on it. Fortunately for us, virtually all signal processing applications require high-performance, low-latency, deterministic processing coupled with fast memories, and a variety of I/O for everything from sensor interfacing, to multi-processor communications, to host interface, command and control. Therefore, our strategy is to identify the common core architectural components that span a variety of applications and implement them as modular building blocks that enable our customers to create their specific signal processing solution for their specific application.

To this end, our products offerings are centered around board-level signal processing engines featuring DSPs, Altera FPGAs, or a hybrid of both, on standard COTS board formats such as CompactPCI, PMC, VME/VXS, VPX, and AdvancedMC. Of course, these engines are supported by a wide range of memory and I/O support, and are available for commercial or rugged environments. In addition, we offer a complete set of software tools for development, algorithmic implementation, and run-time control, as well as a growing portfolio of IP frameworks and blocks for FPGAs.

Q. **In what situations do you recommend customers use DSPs and in what situations do you recommend they use FPGAs or a hybrid solution, speaking broadly? How do you leverage your expertise to help customers make these design choices?**

A. DSPs and FPGAs are quite different beasts, with very different strengths, weaknesses, and development requirements. At the risk of oversimplification, it is generally understood that FPGAs are better for high data rates, parallelism, processing densities, and I/O flexibility, while DSP have advantages in code reuse, ease-of-development, and floating point. DSPs used to be known for using less power for a given application, but that's not always true anymore. Put another way, FPGAs tend to be better at solving straight forward, well defined, high-speed problems while DSPs are probably better for implementing complicated algorithms that may evolve, involve decision making, or can benefit from the use of floating-point.

Most real-world embedded signal processing applications have components that exhibit both of these natures. Therefore, rather than competing these technologies against one another, it is often better to constructively embrace these differences by leveraging the strengths of both technologies while mitigating their respective weaknesses in what we call a hybrid architecture, featuring both DSPs and FPGAs. Of course, creating an effective hybrid solution is more complicated than simply putting down an FPGA next to a DSP. We've had to wrestle with major issues including I/O interfacing, interprocessor communication, memory configuration, host interface, and control, along with creating an FPGA framework and unifying software that makes it all accessible to the user.

Often, customers already have a strong preference for one approach or another. When they don't, we spend time educating them on the technology options, and educating ourselves on their application. We then take some time to discuss system design tradeoffs, and a specific signal processing technology will frequently emerge as a clear winner. If that doesn't happen, the final decision is usually made based on the customer's development expertise and experience. When the technologies are roughly equivalent, and they've got a bunch of bright FPGA developers and no one who's coded a DSP, or visa-versa, the decision is pretty easy.

Q. **Using FPGAs is not always easy, and manufacturers like Altera provide their own tools. What tools does Bittware provide for your customers so that they can customize the board application? What features are unique to your own software offerings?**

A. Making FPGA more easy to use has dominated our development efforts for a while now, and I feel we've really made some great strides recently.

The almost unlimited flexibility of FPGAs is a double-edged sword. On the one side, it's enticing for all the possibilities and promises that high speed, high-density logic holds; on the other side, it's an array of gates and undefined I/O that has no inherent functionality. Thus, the user must build every mundane and minute piece of functionality to implement any solution. Any other processing device already has I/O interfaces, internal data buses, address generators, DMA engines, resource arbitration, etc... in addition to the processing resources. Any one of those pre-defined functions can be a limitation to the user, but at least they are done.

Therefore, we believe that our key added value to FPGA users is our *ATLANTiS*™ FrameWork. This integrated system framework allows the Altera FPGAs to be abstracted to act like a system-on-chip with peripheral support, which facilitates a microprocessor/software-like approach to FPGA development. Specifically, *A FRAMEWORK* provides fully validated physical interfaces to board I/O and memory, data moving engines, resource arbitrators, and a wide range of other low-level modules, along with standard dataflow interconnect and control fabrics that allow the *ATLANTiS* modules to be easily connected, coordinated, and controlled. Using *ATLANTiS*™ FrameWork, customers don't have to start with a blank sea of gates, and spend precious time and money re-inventing wheels, users only have to develop their unique IP and added value.

Furthermore, *ATLANTiS*™ FrameWork is implemented using Altera's Avalon buses and structures so that it all plays very nicely with Altera's Quartus tools. We even provide all the verification and simulation environments. Better yet, the *ATLANTiS* modules themselves are

not static, and can be tailored by the user so that they don't limit the imagination of the developer.

We still have a ways to go towards fulfilling our complete vision of more function modules and processing blocks all tightly integrated with GUI development tools, but as I said earlier, I think we've made great strides recently and that *ATLANTIS FRAMEWORK* is a truly valuable tool which can greatly simplify the implementation of complex signal processing solutions on FPGAs.

Q. **I noticed from your website that Bittware has supported form factors like AdvancedMC, VPX, VME, and even PC/104. What is the importance of these form factors to your customers? Are there any special challenges here vis-à-vis FPGAs? Any ways you can help customers choose among them?**

A. For the first time in many years, there has been a major upheaval in the COTS/open standard form factor world. Until recently, all of them used parallel busses, and there was basically just VME and the various incarnations of PCI such as CompactPCI, PMC, and PC/104+. As you've noticed, we've supported them all. For a long time these formats were tweaked, patched, and upgraded, but in general they have retained their basic integrity and backward compatibility. Many standard formats, notably VME/VXS, PMC/XMC, and CompactPCI, then added-on high-speed serial options as sort of a 'toe in the water'. Keeping with the water theme, this opened a floodgate that could not be closed – parallel buses are now underwater and drowning, and the COTS/open standard world is now dominated by high-speed serial and switched fabrics. Obviously, this is a bit of an oversimplification and some concessions are still being made to legacy support, but its clear to me that these new formats for switched fabrics are a very positive step forward for an industry that has renewed an aging set of system building standards.

Given this new landscape carved out by the raging waters, with the exception of a few isolated legacy upgrades, BittWare is no longer developing for VME, CompactPCI, PMC, or PC/104. All of our new products are focused on leveraging high-speed serial and switched fabrics as the primary interconnect. These interconnects greatly reduce size and bandwidth constraints, thereby opening up a great deal of options for the system designer. The clear winners of the new high-speed serial formats are AdvancedMC, also known as AMC, and VPX.

AdvancedMC was developed by and for the communications market for use on AdcancedTCA blades, but has grown far beyond that with the emergence of MicroTCA boxes and backplanes. VPX, also known as VITA46/48 came out of the VME community, but really has nothing in common with VME except for mechanicals and an optional extension that facilitates legacy support. From a board architecture perspective, these formats are remarkably similar – some common power and control plane interfaces, and a bunch of high-speed serial ports that are often called fat pipes.

We feel that FPGAs are a natural fit for these new formats since they enable our products to be extremely adaptable, which allows us to take a single common architecture and focus on adding value to it rather than having to continuously re-architect it for different formats. Regarding choosing between AMC and VPX, AMC's much larger product availability has made it very attractive for most customers, especially the commercial space, while VPX is a better fit for those applications that have special requirements such as ruggedization, extended temperatures, and very long life-cycles.

Q. **Another area that has been very challenging for customers is the transition to new high performance switch fabrics. In what ways can Bittware (and FPGAs) help customers transition to and choose between technologies like PCI Express, RapidIO, 10GE, etc.?**

A. You're absolutely correct that this is a very challenging and daunting issue for most of our customers. None of the big three high-speed serial switched fabric protocols - PCIexp, SerialRapidIO, and Ethernet - have emerged as a dominant technology for building embedded computing systems – nor do I think any of them will, since they represent three very different approaches. Each of them is good for some things, and bad for others. Further complicating the issue is that most chips, boards, and systems only support one of the three.

Our conviction is that system designers shouldn't have to choose; they should be able to easily use the right protocol in the right place. Leveraging the inherent flexibility of Altera's FPGAs, our boards not only support all of these switched fabrics, we can do it simultaneously and even bridge between them. So go ahead and use that great SBC that uses PCIexp, and those network processors that only talk GigE, and take advantage of SerialRapidIO to communicate between signal processors – we can do it all. Of course, the implementation details are not trivial either at the FPGA or the system backplane, but the results can be liberating for the system designer, and this flexibility is one of the reason customers use our products.

Q. **What challenges and opportunities do you see for FPGA-based boards going into 2009? What do you find exciting these days?**

A. I think your previous questions addressed the top 3 challenges: easing development complexity, COTS form factor chaos, and confusion surrounding switch fabrics. As I've previously discussed, we are addressing the first challenge with our *ATLANTiS*™ FrameWork, and see the adaptability of FPGAs as a distinct advantage in combating the challenges of this chaos and confusion.

Additional challenges include maintaining signal integrity at higher and higher speeds, managing power supplies, and thermal/cooling - all while supporting harsh environments and extended temperatures.

While I should caution that I'm pretty geeky, and therefore easily excited by this stuff, I have to say that I haven't been quite this excited about our markets and products for a very long time. The new switched fabrics and system formats, which support them, are fueling a new cycle of innovation for system design. System designers are able to be more creative, and I think we'll see some great new ideas and applications emerging soon. I'm also excited that Altera's new *Stratix IV* FPGAs have achieved such large densities and high performance with such moderate power consumption; I believe these FPGAs have crossed some critical mass threshold that will make it possible to more easily implement complete solutions using FPGAs. Finally, I'm excited that BittWare's new *ATLANTiS*™ FrameWork will significantly reduce the development time for FPGA development in embedded systems.

I believe that the combination of Altera's new FPGAs with BittWare's *ATLANTiS*™ FrameWork will lead to a much greater acceptance of FPGAs in the COTS world. Hopefully, we can shift the landscape for signal processing just as effectively as high-speed serial interconnects did for standard bus formats.

Q. **Thank you for this interview.**