Chapter 1

Digital Signal Processing Design Challenges

Our insatiable hunger for electronic gadgets that provide high-quality audio, video, data or all three, is spiraling up the processing power that is needed to process these signals. Digital signal processing (DSP) systems, within both infrastructure and customer premise equipment must provide increasing levels of performance and flexibility to handle the new requirements yet provide greater scalability for achieving higher economies of scale.

The Performance Gap

Algorithmic complexity increases as application demands increase. Figure 1-1 illustrates performance demands over time. In order to process these new algorithms, higher-performance signal processing engines are required. Typical fixed architecture DSP processors cannot keep pace on their own. A DSP co-processor is often needed to handle the highest performance portions of these ever increasingly complex algorithms. The "performance gap" in Figure 1-1 illustrates this expanding co-processing requirement.

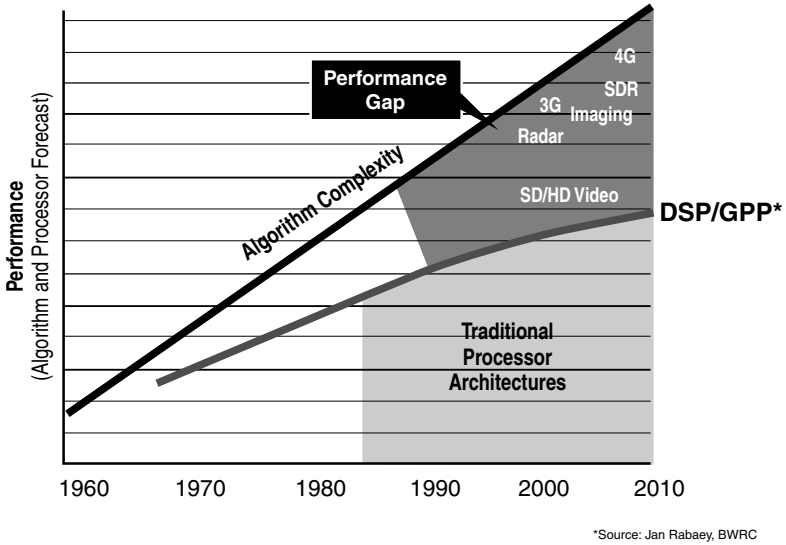

Figure 1-1: **The Performance Gap**

Field Programmable Gate Arrays (FPGAs) are very well suited to fill the performance gap for a variety of reasons:

- They offer extremely high-performance signal processing capability through parallelism.
- They provide very low risk due to the flexible architecture.
- They allow design migration to handle changing standards.
- Developers can use them to create a customized and differentiated solution.
- They are quickly coming down in price. In fact, it is possible to find FPGAs for less then $2 per device.
- They provide very low power per function.

The Ideal Solution

With the revolutionary XtremeDSP™ Slices, Xilinx Virtex™-4 FPGAs deliver the ideal solution for high-performance digital signal processing. They satisfy high-performance signal processing tasks traditionally serviced by an ASIC or ASSP. They allow you to create high-performance DSP engines that can boost the signal processing performance of your system for a host of applications including digital communications and video/imaging. And they are the ideal choice to increase system level performance by complementing a programmable DSP system as either a pre- or co-processor.

XtremeDSP Slice Delivers Maximum Performance, Minimum Power, and Best Economy

The XtremeDSP™ Slice—operating at a blazing 500 MHz—lies at the heart of Virtex-4 FPGA's XtremeDSP performance. As the most powerful addition to the Xilinx XtremeDSP took kit, it is a unique piece of hard coded IP embedded in each Virtex-4 device. It provides industry-leading DSP processing performance, unrivalled economy, and the lowest power consumption of any device in this performance range.

Simplicity and Efficiency of the Cascade Logic

The built-in cascade logic of the XtremeDSP Slice allows multiple slices to be connected together to implement complex filters and multi-precision functions while operating at full speed. And the cascade logic provides tremendous cost advantage. Other solutions require additional FPGA resources to build costly and inefficient adder trees to implement this common function. They require a much larger FPGA to implement the same level of functionality that can be attained in an XtremeDSP-enabled Virtex-4 FPGA. The result is a tremendous performance and cost advantage of the Virtex-4 device over other FPGA DSP solutions.

Extremely Low Power Consumption

Each XtremeDSP Slice consumes only 2.3 mW/100 MHz in a typical system implementation. This extremely low power is enabled by the optimized hard implementation of the XtremeDSP Slice. Also, the programmable logic fabric of the Virtex-4 family has a significant power advantage. For example, power-per-CLB has been cut in half, with static power reduced by 40% and dynamic power reduced by 50%. In addition, certain hard-logic silicon functions in the Virtex-4 FPGA reduce consumption by approximately 90%. This results in a lower power budget and all its associated benefits—higher reliability, smaller power devices, smaller fans, and so on.

Increased Flexibility for Cost Effectiveness

The Virtex-4 FPGA flexibility boosts cost effectiveness for all application designs. For example, Virtex-4 FPGAs enable you to buy a customer device that supports two applications—one for diagnostic testing and one for the application. Here, Virtex-4 FPGAs can be tested for two designs or two variations of the same design. Savings are realized right down the line, from inventory costs, to design costs, to system costs, to consumer costs.

Easy to Use

Xilinx and its partners provide the easiest-to-use design solutions for FPGA-based DSP solutions with features such as:

- System Generator for DSP reduces design time.
- A rich DSP IP library implements fast, highly optimized algorithms.
- Award-winning technical support and DSP services enable you to bring products to market much faster.

Whether you are working with spread-spectrum, multi-carrier, or narrowband communication systems, Virtex-4 FPGAs are the ideal choice for ease of use.

Virtex-4 FPGAs —A Platform for Every Application

All Virtex-4 platforms offer XtremeDSP capabilities. Choose the device that provides the optimal DSP performance for your application:

- Virtex-4 SX devices offer the most cost-effective implementation of ultra-high performance DSP functionality for high-end DSP applications. They provide the highest ratio of XtremeDSP slices—up to 512—and deliver up to 256 GMACS (18x18-bit multiply, 48-bit addition/accumulation) performance.
- Virtex-4 LX devices offer ample XtremeDSP slices and include more logic, memory, and I/O resources for logic applications.
- Virtex-4 FX devices include embedded PowerPC™ processors and RocketIO™ multi-gigabit transceivers for embedded processing and high-speed serial applications.

XtremeDSP platform solutions accelerate your products' time-to-market through superior design, design tools, intellectual property cores, and design services. They provide the fastest means of designing, verifying, and deploying your DSP algorithms and systems in FPGAs.

Reduce Time-to-Market with World-Class Xilinx Support

Xilinx supplies a host of support functions to designers including DSP training courses, award winning technical support, technical data, implementation data, and design consulting.

A Must-Read

This book is a must-read for DSP designers who want to tap the power of the Virtex-4 XtremeDSP Slice. It provides a detailed description of the multiple features of the slice as well as providing multiple examples that show you how to harness the power and flexibility of this powerful IP block. Tap into the XtremeDSP Slice and reap the rewards of highest performance, lowest power at the lowest cost.