

# Xilinx XtremeDSP Initiative Meets the Demand for Extreme Performance and Flexibility

An FPGA DSP solution boosts performance while conserving board space for demanding wireless, networking, and video applications.

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The rapid convergence of broadband communications – such as 3G and 4G (Third- and Fourth-Generation) wireless systems, high bandwidth networking, real-time video broadcasting, and high performance computing systems – is creating the demand for “extreme” DSP performance and flexibility. That demand is growing faster than what conventional DSP providers can deliver.

As the recognized world leader in programmable logic solutions, Xilinx is well established in digital signal processing technology, and hence, uniquely positioned to address the new DSP paradigm. As shown in Figure 1, Xilinx is already ahead of the competition – and will be extending its lead in the coming years.



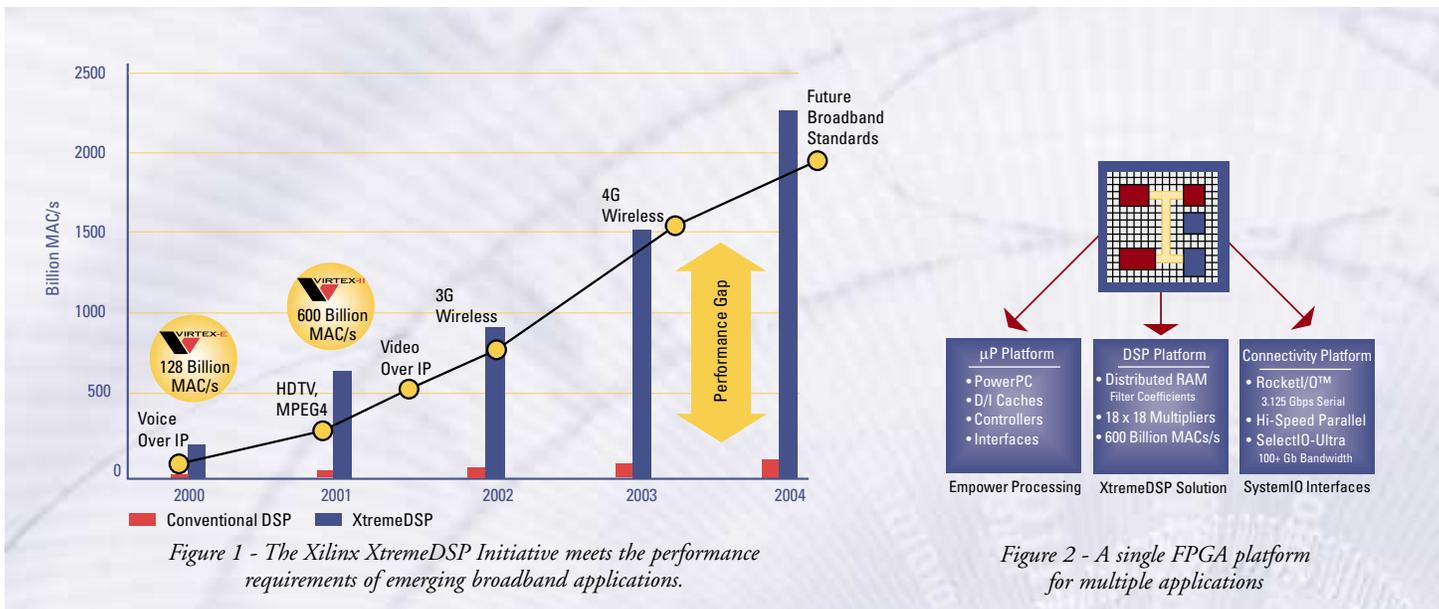


Figure 1 - The Xilinx XtremeDSP Initiative meets the performance requirements of emerging broadband applications.

Figure 2 - A single FPGA platform for multiple applications

### The Xilinx XtremeDSP Initiative

With the new Xilinx XtremeDSP™ Initiative, you now have flexible DSP solutions that you can optimize for numerous applications. Furthermore, under the initiative, you gain a wide range of integrated development tools that offer an added advantage when developing new products or upgrading existing ones. The XtremeDSP Initiative delivers:

- **Extreme Performance** – RAM-based Virtex® and Virtex-II series FPGAs.
- **Extreme Productivity** – easy to use system-level design tools, optimized DSP algorithms (IP cores), and world class DSP service and support program.
- **Extreme Flexibility** – maximized performance, minimized cost, reduced development time, and extended product life cycles.

### XtremeDSP Delivers Extreme Performance

Components such as hyper-fast adaptive filters, 3G turbo coders, and rake receivers used in next-generation communication products (like spread spectrum radios) require new high-performance and flexible DSP architectures. By exploiting the parallelism that is inherent in DSP mathematical models, Xilinx has

created the highest performance DSP platform ever. The vast logic resources present in Xilinx Virtex-II FPGAs enable the creation of fully parallel structures for the greatest possible computational power and bandwidth. These attributes give you the performance advantage of an ASIC (Application Specific Integrated Circuit) without the added expense of inflexibility, long lead times, and hefty NRE (Non-Recurring Engineering) costs.

The XtremeDSP Initiative delivers the highest performing programmable digital signal processing available today. Computing capability is approaching one trillion multiply-and-accumulate opera-

tions per second (1 Tera MACs/sec) – more than 100 times faster than conventional DSP solutions.

### Virtex-II Platform FPGA: Performance Leader

The Virtex-II platform (Figure 2) breaks new performance barriers with up to 600 billion MACs per second, compared to 8.8 billion MACs per second for conventional DSP solutions. This raw computational power allows you to implement the most complex designs imaginable, including multiple high speed channels on a single system – with reduced power consumption and less board space (Table 1).

Function	Industry's Fastest DSP Processor Core	Xilinx Virtex-E – 08	Xilinx Virtex-II
8x8 Multiply-and-Accumulate (MAC)	8.8 billion MACs/s	128 billion MACs/s	<b>600 billion MACs/s</b>
FIR filter 256-tap linear phase	17 MSPS*	160 MSPS	<b>180 MSPS</b>
16-bit data/coefficients	1.1 GHz	160 MHz	<b>180 MHz</b>
FFT 1024 point	7.7 μsec	41 μsec	<b>&lt;1 μsec</b>
16-bit data	800 MHz	100 MHz	<b>140 MHz</b>

Table 1 - DSP performance benchmarks

\*Mega Samples Per Second

Additionally, Virtex-II devices feature:

**Programmable Arrays**

- Up to 10 million system gates for tremendous parallel processing and highest possible DSP performance
- Tens of hundreds of channels per single device
- Fastest time to market with SRAM technology
- Easy reconfiguration during development and in the field.

**Data Storage**

- Up to 3.5 Megabits of True Dual-Port Block RAM for implementation of large FFTs (Fast Fourier Transforms), video line buffers, and other memory intensive DSP functions

- Up to 1.9 Megabits of distributed memory for storage of coefficients and data.

**Arithmetic Functions**

- Up to 192 18x18 embedded multipliers for optimal implementation of high speed, non-pipelined DSP functions
- Support up to 250 MHz, depending on bit width
- Multipliers usable as building blocks to create high speed 32-bit and 64-bit multipliers – ideal for high performance FFTs for xDSL/cable modems and equalizers for wireless modems, satellites, and Gigabit Ethernet
- Distributed arithmetic multipliers constructed from look-up tables for efficient pipelined data structures
- Fast carry chains for addition and subtraction carry look-ahead arithmetic pipelining – signals pipelined either through registers or memory.

**System Features**

- System features such as high speed I/Os, digitally controlled impedance technology, high-performance clock management circuitry, and DLLs (Delay-Locked Loops) for complete system

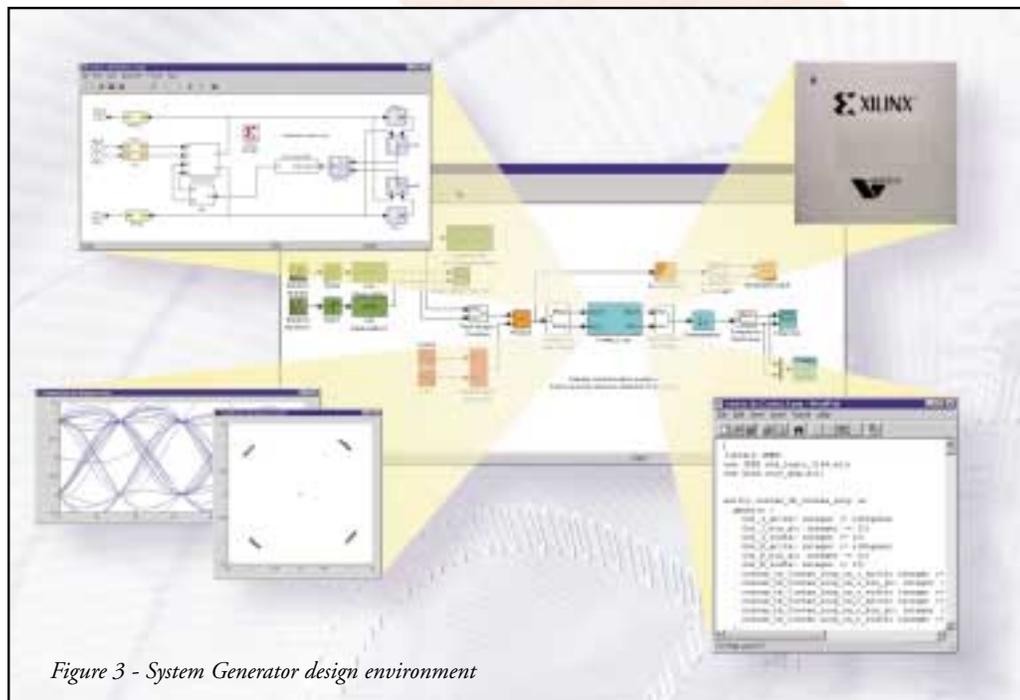


Figure 3 - System Generator design environment

integration – including DSP, memory interfaces, and control logic

- Up to 420 MHz internal clock speed
- 840+ Mbps I/O performance.

The Virtex-II architecture provides the unique Xilinx Active Interconnect technology, which actively drives segmented routing between each building block element on the FPGA. Combined with Xilinx Smart-IP™ technology, Active Interconnect ensures performance is consistent over the entire range of FPGA device sizes – and is independent of the surrounding user-logic and level of integration.

**XtremeDSP Delivers Extreme Productivity**

Having a high-performance processing platform is only part of the solution. Successfully implementing DSP functions in a design requires easy to use IP (Intellectual Property) cores and development tools. Thus, a complete solution incorporates tools to provide design time efficiency and the ability to customize data structures. Through the XtremeDSP Initiative, Xilinx provides a solution that allows you to produce the optimal implementation for any given application – or across numerous applications.

The XtremeDSP Initiative also provides a wide range of DSP algorithms (or IP cores) in the LogiCORE™ series to accelerate and simplify the design of communications and image processing applications. A new filter generator tool, for instance, allows you to work in MATLAB® (a high performance simulation program from The MathWorks Inc.). With this tool, you can automatically generate an optimized filter implementation for the FPGA.

Through an exclusive alliance, Xilinx and The MathWorks created the System Generator to bridge the gap between architectural system design and hardware implementation of FPGA-based DSP systems. Now you can build high performance FPGA applications using familiar DSP design and verification tools.

The Xilinx System Generator works in conjunction with the popular Simulink™ and MATLAB modeling tools from The MathWorks (Figure 4). The System Generator, combined with a library of parameterized and optimized algorithms from Xilinx, lets you automatically go from a behavior system model to an FPGA implementation. Using the System Generator significantly reduces development time, minimizes the risk of introducing errors, and eases

your learning curve. You can easily run experiments on the behavior of the DSP functions, enabling you to quickly determine algorithmic trade-offs between performance, power consumption, and silicon area.

### XPower Tools

The XtremeDSP Initiative also includes the new Xilinx XPower analysis tool and enhancements to the ChipScope ILA (Integrated Logic Analysis) debugging tool. These software tools shorten development time even further, which is critical in today's competitive marketplace.

XPower is interactive software that allows you to predict power dissipation, which is essential for power sensitive designs. XPower also offers trade-off analysis capabilities that are useful for developing high performance, high density designs.

The ChipScope ILA tool allows you to perform specific analysis on any of the internal nodes within an FPGA device, providing unprecedented access to nodes and the complete data bus at full system speed. Developed in partnership with Agilent Technologies, ChipScope allows you to view digital signals in real time and plot them on two-dimensional diagrams. While using the ChipScope software, you can quickly download to the FPGA, modify trigger and set-up functions, and display waveforms for the captured traces. This capability is a great enabler for design verification of devices using the latest complex pack-

ages, including those using leadless packaging.

HLL (High Level Language) design tools are currently under development that will further simplify the use of FPGAs for DSP designers. Through leveraging internal expertise and new technology acquisitions, the Xilinx roadmap to HLL design includes plans to introduce C++ and Java to FPGA solutions, as well as hardware/software partitioning and co-simulation.

### XtremeDSP Delivers Extreme Flexibility

Xilinx FPGAs provide a structure of building blocks – logic, memory, I/O, and other system features – to allow the integration of an entire system, not just the DSP algorithms. You can consolidate system features such as memory/bus interfaces, clock management, system control, and other support logic in the same package as the central DSP design to reduce overall product size and cost.

Unlike fixed-width general purpose DSP processors or ASSPs (Application Specific Standard Parts), Virtex-II FPGAs give you the freedom to create custom word lengths for different sections within the same design. The Xilinx DSP tool set supports different bit widths, pipeline stages, and implementation alternatives. For some channels that require more bits of precision compared to others, you can just change the IP

parameter, and the software accommodates the new data configuration.

With the Xilinx DSP tools, you can easily optimize for performance, silicon area, or power dissipation when realizing your design. By implementing the algorithm in a fully parallel structure, you can achieve the best possible data throughput. You can also employ this technique to save power by slowing the system clock.

Conversely, by implementing the algorithm in a fully serial mode, you can achieve the smallest possible silicon area and the lowest cost – and still meet the specified performance requirements. The Xilinx DSP tool set is the only available FPGA software that supports any number of bits processed in parallel, from one to all bits.

### Extreme Requirements Demand XtremeDSP Solutions

Designers are already using Xilinx FPGAs for high density, high performance DSP solutions in emerging 3G wireless base station, VoIP (Voice over Internet Protocol), HDTV set-top boxes, video on demand systems, and digital cinema applications.

Because the XtremeDSP Initiative offers a complete solution – DSP-enhanced FPGAs, development tools, and support – it provides a competitive advantage to system designers and OEMs who are ramping up product capabilities to satisfy the high bandwidth, high performance, low power, and low cost demands of the broadband market. By selecting a programmable solution, you can face changing protocols and shrinking product life cycles with more confidence, because field upgrades will be possible without replacing the device.

As designers take their applications to the next generation and beyond, a powerful yet flexible DSP enhanced solution can prove to be a significant advantage on the road to high performance, high density, and SOC (System On a Chip) solutions.

*For more information on the Xilinx XtremeDSP Initiative – including video on demand – go to [www.xilinx.com/dsp/](http://www.xilinx.com/dsp/).*

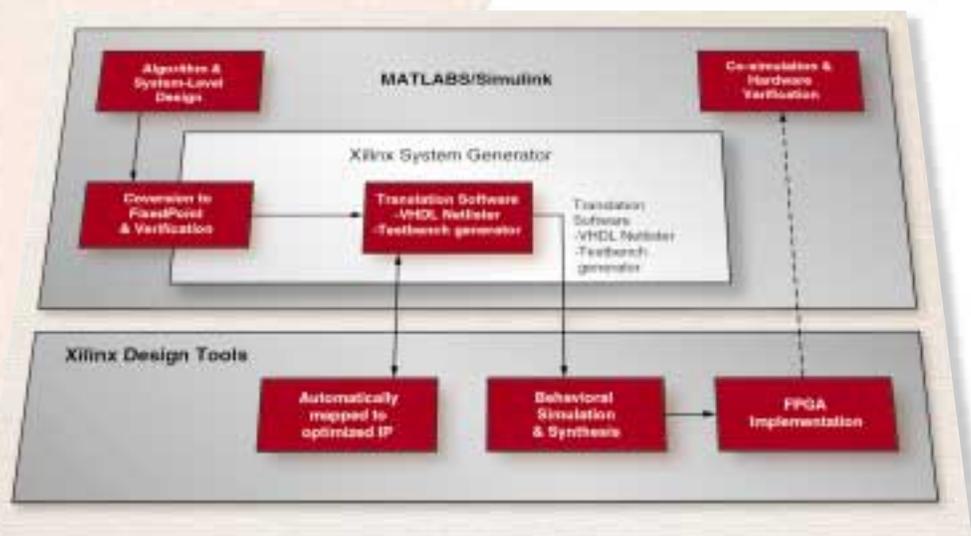


Figure 4 - The Xilinx System Generator takes you from design concept to FPGA implementation.