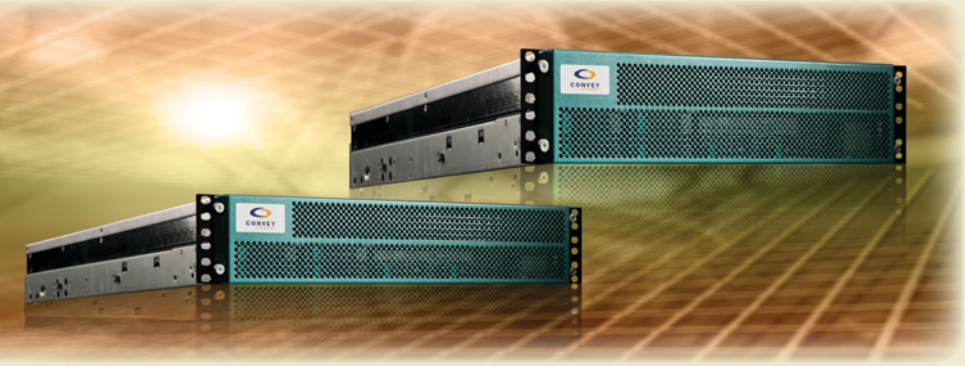
Convey's hybrid-core technology: the HC-1 and the HC-1^{ex}

CONVEY computer™



The world's first hybrid-core computer: the Convey HC-1 and HC-1^{ex} deliver blindingly fast application performance increases, ease of programming, and energy efficiency.

If you're a computer researcher, engineer, or IT manager, you expect the highest possible computational performance available to help you or your customers get the job done. Increased performance means you can research more thoroughly, compete more effectively, and succeed more decisively.

The laws of physics are currently standing in the way of continued performance improvements. Increasing processor frequencies and semiconductor densities have created a heat and power brick wall.

Today's ordinary technology can offer only incremental performance improvements. To achieve order of magnitude performance increases, you need something beyond ordinary. You need extraordinary. Convey gives you extraordinary with ground-breaking hybrid-core technology.

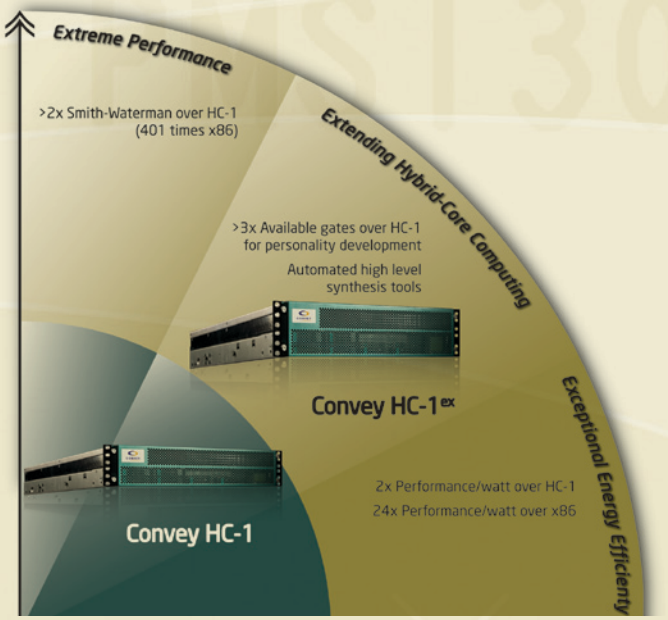
EXTREME PERFORMANCE

Hybrid-core is a revolutionary technology that breaks through the heat and power brick wall—increasing application performance and saving money in power and maintenance costs. By circumventing the power limitations of today's commodity processors, Convey is propelling innovation forward at breakneck speeds.

Hybrid-core computing is based on a heterogeneous architecture that combines the economies and programmability of industry standard processors with the performance and efficiency of a hardware-based, application-specific design. Convey hybrid-core servers employ a highly parallel coprocessor that augments the capabilities of a commodity processor with processing elements optimized for performance-critical operations. Instructions executed by the coprocessor appear as extensions to the x86 instruction set and can contain both x86 and coprocessor instructions in a single instruction stream.

The Convey coprocessor is based on standard Field Programmable Gate Arrays (FPGAs), coupled with a standard multi-core Intel® Xeon® processor. Physically, each processor has its own local memory, logically, memory is globally addressable and cache-coherent, making software development as easy as that of a standard x86 environment.

The World's First Hybrid-Core Computer.



The Convey HC-1 and HC-1ex provide extreme performance, extended functionality, and exceptional energy efficiency over commodity x86 servers.

CONVEY HC-1: ORDER OF MAGNITUDE PERFORMANCE INCREASES

Using the Convey HC-1 server, customers are enjoying order of magnitude performance increases never before achieved.

- Convey's implementation of the Smith-Waterman algorithm (widely used in life sciences applications for aligning DNA and protein sequences) is 172 times faster than conventional methods.[1]
- With the installation of HC-1 servers at the University of California, San Diego (UCSD), the engineering team is achieving substantial performance gains, cost savings, and a reduction in the environmental impact. On a widely used bioinformatics application, UCSD is reducing the time to completion by two orders of magnitude.
- Scientists at the Stanford Center of Computational Earth and Environmental Science (CEES) are using the Convey HC-1 to develop new seismic-imaging and reservoir-simulation algorithms for modern computer architectures.

CONVEY HC-1EX: EXTENDING THE REACH OF HYBRID-CORE COMPUTING

Convey's recently introduced server, the HC-1ex, extends the reach of hybrid-core computing by providing higher absolute performance, increased functionality, and improved efficiency. Compared to the Convey HC-1, the HC-1ex provides three times the number of usable logic gates, which offers multiple benefits to the user. One of the most important benefits is increased parallelism, which directly translates into higher absolute performance.

For example, the HC-1ex achieved more than two times the performance of the HC-1 running the Smith-Waterman algorithm. Compared to a typical x86 system, the HC-1ex achieves 401 times the performance.[2] With such extraordinary performance increases in Smith-Waterman and other algorithms, bioinformatics and computational biology researchers can now discover more information about genes, which will ultimately lead to new ways to cure and manage disease.

EXTENDED FUNCTIONALITY

The Convey HC-1 and HC-1ex adapt to different workloads through personalities—instruction sets specifically designed to achieve orders of magnitude acceleration in a variety of applications, including bioinformatics, data intensive computing, seismic processing, scientific research, automatic speech recognition, and more.

Personalities are extensions to the x86 instruction set that are implemented in hardware and are designed to optimize specific portions of an application. For example, a personality designed for seismic processing may implement 32-bit complex arithmetic instructions—and at performance levels well beyond that of commodity processors.

Through Convey's proprietary adaptive architecture, servers dynamically and transparently reload different personalities that are optimized for different applications. The ability to adapt the architecture to different applications means that the Convey servers can be repurposed "on the fly"— making them flexible and extremely cost-effective in mixed-use environments.

[1] According to Convey's internal benchmarking, the Smith-Waterman algorithm runs 172 times faster on the HC-1 than a software implementation on an Intel Nehalem core.

[2] According to Convey's internal benchmarking, the Smith-Waterman algorithm runs 401 times faster on the HC-1ex than a software implementation on an Intel Nehalem core.

The HC-1^{ex} offers additional functionality compared with the HC-1 due to the increase in available gates. Because the HC-1^{ex} provides three times the number of usable logic gates, you enjoy more hardware real estate to create personalities. Additional space means that you can implement more functions and more complex portions of your applications in the coprocessor, further increasing opportunities for application acceleration.

Complementing the highly parallel computational capabilities of the coprocessor in both Convey systems is an extremely high-bandwidth memory subsystem. Based on 8 memory controllers, supporting 16 memory channels, the subsystem provides over 80 GB/second of bandwidth, obliterating the bandwidth limitations of commodity multi-core processors.

Convey's memory controllers support standard DIMMs, as well as Convey designed Scatter-Gather DIMMs. Convey Scatter-Gather DIMMs are optimized for random transfers of 8-byte bursts, providing near peak bandwidth for non-sequential 8-byte accesses. Consequently, the coprocessor not only provides a higher peak bandwidth than what is available to commodity processors, but it also delivers a much higher percentage of that peak for non-sequential access.

The Convey software environments are based on the Linux® operating system, making the Convey HC-1 and HC-1^{ex} systems easy to integrate into an existing clustered environment. Application development, including coding, debugging, and deployment, takes place using ANSI standard FORTRAN, C, and C++ development tools— reducing the need for any specialized talent to deploy or maintain applications.

Beyond the personalities already created for specific applications, Convey provides tools in a "personality development kit" (PDK) that allow for the creation of new application-oriented architectures for existing and emerging applications.

The large number of logic gates available in the coprocessor creates opportunities for automated personality development. For example, the Riverside Optimizing Compiler for Configurable Computing (ROCCC), an open source C-to-VHDL compiler infrastructure tool, is a high-level synthesis tool that simplifies the design of personalities. Using ROCCC, Convey personalities can be developed much faster, allowing for a broader use of the hybrid-core technology that benefits more applications and industries.

One rack of Convey HC-1 servers can replace as many as 10 racks of commodity servers.[3]

- Reduces floor space by 86%
- Reduces data center watts by 91%.
- Reduces 3-year TCO by 75%.
- Reduces 3-year TCO with power rebate 82%

One rack of Convey HC-1^{ex} servers achieves even greater energy efficiency. One rack can replace as many as 16 racks of commodity servers.[4]

- Reduces floor space by 94%
- Reduces data center watts by 93%.
- Reduces 3-year TCO by 90%.
- Reduces 3-year TCO with power rebate 94%

EXCEPTIONAL ENERGY EFFICIENCY

Using hybrid-core computing technology, you not only achieve order of magnitude performance increases, you save money in power and maintenance costs. When used as nodes in a HPC cluster, the HC-1 and HC-1^{ex} deliver higher per-node performance, providing substantially better performance per watt than conventional clusters. Just one rack of Convey systems can quickly and easily replace numerous racks of commodity servers. You can increase the performance of your data center while cutting power consumption and saving money.

Not only does power savings mean you are saving money, you are also helping to save the environment. The Convey hybrid-core servers allow you to "go green" by reducing the number of servers in your HPC environment, without sacrificing performance.

[3] "Convey Computer™ Corporation Ships to First Customer: University of California, San Diego," June 23, 2009.
[4] Based on University of California, San Diego analysis and internal Convey benchmarks

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SPECIFICATIONS

	HC-1	HC-1^{ex}
HOST	Intel® Xeon® 2.13 GHz dual-core processor Maximum Memory: 128 GB	Intel® Xeon® 2.13 GHz quad-core processor Maximum Memory: 128 GB
CONVEY COPROCESSOR	4 x Xilinx® Virtex® 5 LX330 FPGA Maximum Memory: 128 GB (Standard DDR2 DIMMs) 64 GB (Convey SG-DIMMs)	4 x Xilinx® Virtex® 6 LX760 FPGA Maximum Memory: 128 GB (Standard DDR2 DIMMs) 64 GB (Convey SG-DIMMs)
I/O	1 full-height PCI-Express Gen 2 x16 Integrated ESB2-E 3 Gb/s SATA 1-3 hot swap SATA drives One slim-line IDE optical drive Dual Gigabit Ethernet	1 full-height PCI-Express Gen 2 x16 Integrated ESB2-E 3 Gb/s SATA 1-3 hot swap SATA drives One slim-line IDE optical drive Dual Gigabit Ethernet
POWER	Two non-redundant auto-switching 110/220 volt power supplies (1320 watts total)	Two non-redundant auto-switching 110/220 volt power supplies (1520 watts total)
CHASSIS	2U rack mountable H: 87.6mm (3.45"), W: 430mm (16.93"), D: 692mm (27.24") Rack weight 25kg (55 lbs)	3U rack mountable H: 107.2mm (4.22"), W: 430mm (16.93"), D: 692mm (27.24") Rack weight 28.2kg (62 lbs)

For example, the University of California, San Diego (UCSD) realized substantial performance gains and lower environmental impact using the Convey HC-1. UCSD found that one rack of HC-1 servers could replace ten racks of other servers, corresponding to a 91% reduction in energy requirements. Additionally, they reduced the time to completion by two orders of magnitude on their InsPecT/MS-Alignment bioinformatics application.

EXPERIENCE THE THRILL!

Don't settle for ordinary performance improvements. Experience the thrill of extraordinary innovation using the Convey HC-1 and HC-1^{ex}— extreme performance, extended functionality, and exceptional energy efficiency.

The World's First Hybrid-Core Computer.

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