



# QLogic® InfiniBand Technology in HP BladeSystem

## HPC Performance Results for ANSYS FLUENT 12

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## Executive summary

Today's engineering, research, and development applications demand an ever increasing amount of processing power, which in many cases can only be met with the latest in high-performance computing (HPC) clustering technologies. A well designed and implemented HPC cluster can mean the difference in getting a product properly designed and to market on time, thereby improving a business' overall competitive position in the marketplace. HPC clusters that combine the latest in server, processor, and interconnect technologies will provide the optimal architecture for achieving the following business objectives:

Business objective	HPC cluster capabilities
Improve time-to-solution	Performance to significantly reduce elapsed time for simulation completion
Better product design	Resources and performance to run models with higher accuracy in a compressed period of time
Reduce the need and costs for physical prototyping	Ability to efficiently scale a cluster to more fully simulate a final design
Improve an engineering team's productivity	Cluster performance and ability to simultaneously run multiple simulations

## Introduction

Working in concert, ANSYS, Intel®, HP, and QLogic have implemented a test environment at the QLogic NETrack Developer Center in Shakopee, Minnesota, specifically to understand performance and workload characterizations of commercial software for research and development environments. This paper summarizes the ANSYS FLUENT r12 performance results for the latest generation of Intel processors, compared to its previous generation, as well as the impact of the interconnect technology that is used to build the HPC cluster.

## Key findings

### Improve time-to-solutions by completing simulations faster

- HP BladeSystem with the latest Intel Xeon® 5500 "Nehalem" processors and QLogic TrueScale™ InfiniBand cluster running ANSYS FLUENT is 86% faster than a similar cluster using the previous generation processor from Intel.
- TrueScale InfiniBand provides 426% better performance than the same cluster connected with Gigabit Ethernet.

### Better designs through speed and scalability

- Obtain up to 99% more performance from each additional blade/server added to the HP BladeSystem cluster by utilizing TrueScale InfiniBand instead of Gigabit Ethernet as the interconnect.
- HP BladeSystem cluster with TrueScale InfiniBand interconnect achieved a 93% scaling efficiency for the three largest/complex FLUENT models. The same cluster with Gigabit Ethernet interconnect achieves only 30% scaling efficiency.

### Reduced product development costs

- Reduce the need for physical prototyping by leveraging more complex models in a compressed time frame. A large 111 million cell model runs up to 100% faster on the BladeSystem cluster with the latest Intel Xeon processors compared to previous generations of Intel processors.

## ANSYS FLUENT benchmark overview

HP and QLogic used the new set of ANSYS benchmark cases, which are designed to cover a large range of problem sizes, physical models, and solvers representing typical industry usage. QLogic ran the five largest benchmark cases that range in size from two million cells to more than 100 million cells. Both the segregated and coupled implicit solvers are involved, as well as hexahedral, mixed, and polyhedral cell cases. This broad coverage is expected to demonstrate the breadth of FLUENT software performance on a variety of hardware platforms/interconnects and test cases.

The FLUENT benchmark cases were run on two different HPC clusters. The first cluster, called the Harpertown cluster, consists of 32 Intel servers, each with dual quad-core Intel Xeon™ 5472 processors running at 3.0 GHz, providing a total of 256 cores for the cluster. The cluster gets its name from the code name for the Intel Xeon 5400 processors—Harpertown. Each node is configured with 16 GB of memory, providing a total of 512 GB for the Harpertown cluster.

The second cluster, named the HP BladeSystem cluster, consisted of an HP BladeSystem c7000 Enclosure with 16 blades and one NFS server node. Each blade has dual quad-core Intel Xeon 5570 “Nehalem” 2.93 GHz processors and 24 GB of memory. The Intel Xeon 5570—Nehalem—processor represents the latest in Intel processor technology. The HP BladeSystem cluster had a total of 128 cores and 384 GB of memory.

Both clusters have TrueScale InfiniBand interconnect for MPI and file system I/O traffic. The HP BladeSystem’s standard on-board Gigabit Ethernet interconnects were also used/tested for comparison purposes.

ANSYS FLUENT 12.0.15 using HP MPI was used to execute the following benchmark tests:

Test name	Benchmark name
External flow over an aircraft wing	aircraft_2M
External flow over a passenger sedan	sedan_4M
External flow over a truck body #1	truck_14M
External flow over a truck body with a polyhedral flow mesh	truck_poly_14M
External flow over a truck body #2	Truck_111m

The primary metric used to report FLUENT software performance results is the Rating measurement. It is defined as the number of benchmarks that can be run on a given machine (in sequence) in a 24-hour period. It is computed by dividing the number of seconds in a day (86,400 seconds) by the number of seconds required to run the benchmark. **A higher rating means faster performance.**

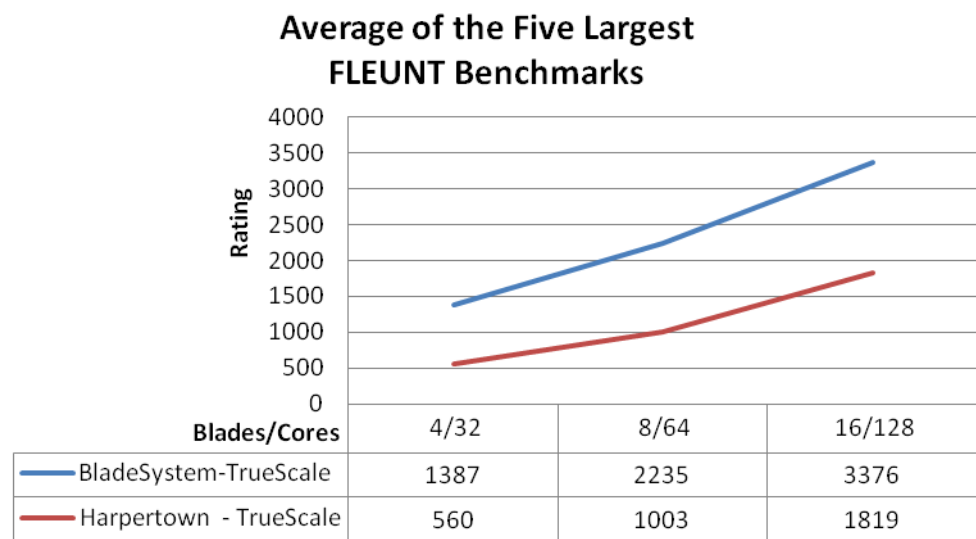
## Results for ANSYS FLUENT benchmark tests

The following sections and charts summarize the results for FLUENT testing on the Harpertown and HP BladeSystem clusters.

### HP BladeSystem with Xeon 5500 and TrueScale InfiniBand performance

The HP BladeSystem cluster with TrueScale InfiniBand interconnect provides sizable performance benefits over the predecessor Intel Xeon 5400 “Harpertown” processing architecture. The following chart represents the average of all 5 FLUENT tests and shows the HP cluster having an 86% performance advantage over the Harpertown cluster at 16 nodes/128 cores (Figure 1).

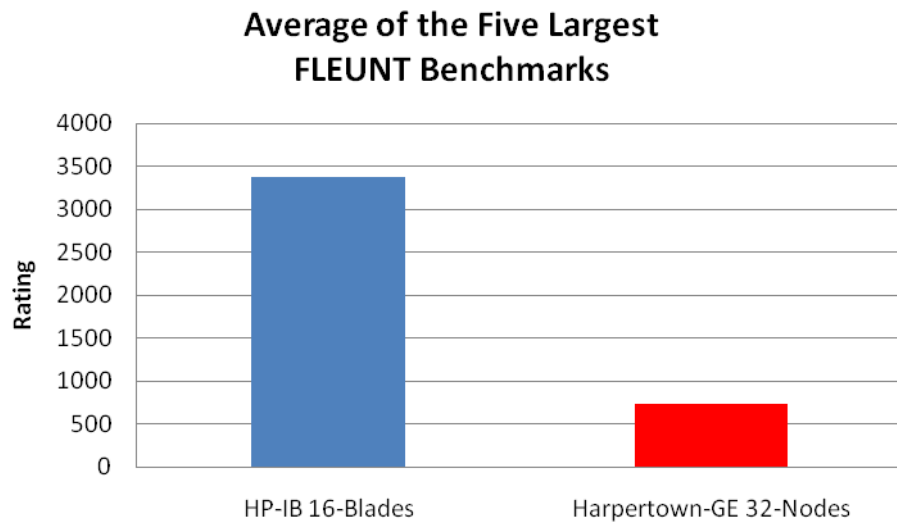
Figure 1: Processor performance comparison



## Upgrade to high-performance processors and interconnect cluster

Moving from the previous generation of processor and interconnect technologies can mean a substantial increase in performance for your models and simulations. For example, the HP BladeSystem cluster with 16 nodes and TrueScale InfiniBand achieved more than 3.58 times the performance of a Harpertown cluster interconnected with Gigabit Ethernet (Figure 2). The additional performance gains with the latest processor and interconnect technologies means that greater performance can be obtained with a smaller number of blades/servers in the cluster. Thus, additional savings in power, air conditioning, administrative/management, and application licensing fees can be obtained without sacrificing performance. Implementing a cluster built around the latest and fastest HPC technologies—Nehalem processors and TrueScale interconnect—will make a difference at both the top and bottom lines for your business.

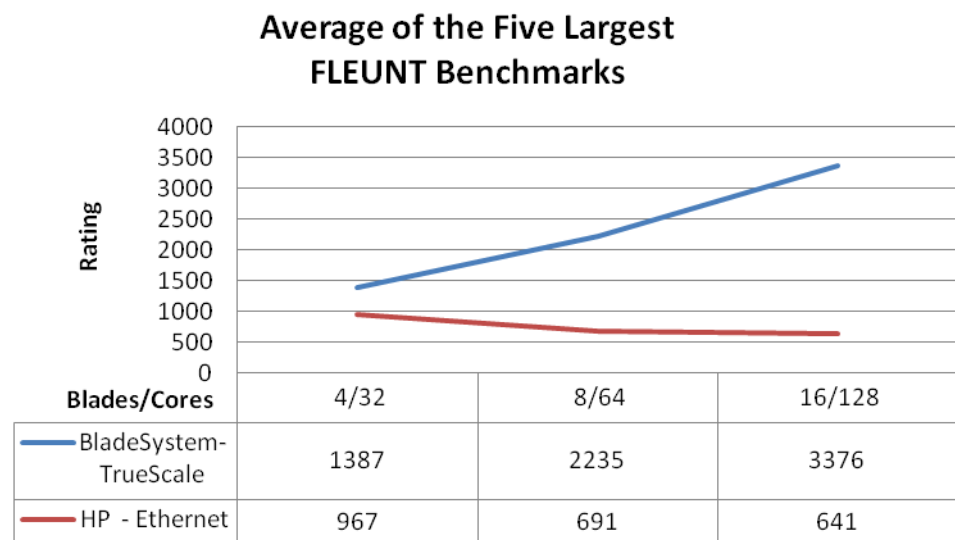
Figure 2: Processor generation and interconnect comparison



## TrueScale InfiniBand maximizes Intel Xeon 5500 “Nehalem” performance

The cluster interconnect used to connect each node of the cluster can make a profound difference in total performance of the cluster. To obtain maximum performance benefit from the latest Intel Xeon 5500 Nehalem processors requires a cluster interconnect to be able to match Nehalem’s performance capabilities. Otherwise, the interconnect becomes a “bottleneck” that impedes the cluster’s performance and results in suboptimal application results. The TrueScale InfiniBand interconnect with its high bandwidth and very low latency can support the Nehalem processors contained in each node of the cluster. The HP BladeSystem cluster when run with TrueScale InfiniBand achieved 426% better performance at 16 nodes/128 cores than the same cluster connected with Gigabit Ethernet (Figure 3). In fact, the BladeSystem/TrueScale-based 4-node/32-core cluster performs as well as the 16-node/128-core BladeSystem/Gigabit Ethernet connected cluster. The right interconnect will maximize the performance capabilities of the Nehalem processor while optimizing the size of the cluster required to obtain a certain level of performance.

Figure 3: Interconnect performance comparison



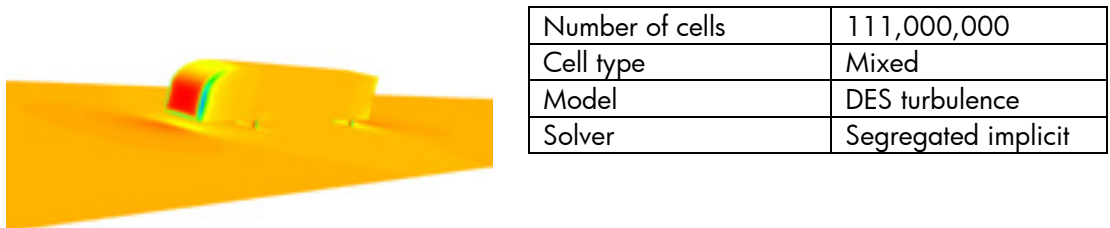
## Maximizing the benefits from each additional blade/server

The ability for the cluster performance to scale is another important consideration when choosing processor and interconnect technologies. The performance gain from an increase in cluster size is represented by its scaling efficiency percentage; the higher the percentage the better. The HP cluster with TrueScale InfiniBand shows excellent scaling efficiency, especially as the FLUENT model complexity increases. The average scaling efficiency for the three largest/complex FLUENT models (Truck 14M, Truck\_Poly 14M, and Truck 111M) is over 94%. The same comparison with Gigabit Ethernet achieves only a 46% scaling efficiency. Thus, each additional blade/server connected together with TrueScale InfiniBand provides twice the performance of Gigabit Ethernet connected servers.

## Performance to scale simulation complexity

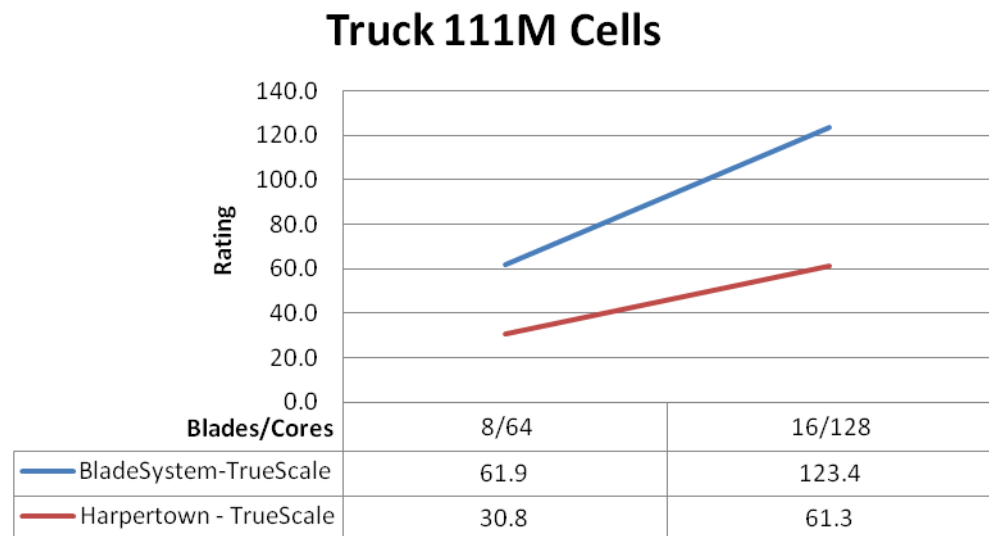
The Truck 111M External Flow Over a Truck Body model is the largest and most complex of the FLUENT test cases. It simulates an external air flow over a truck body. The case has 111 million cells of mixed type and uses the DES model with the segregated implicit solver.

Figure 4.



This benchmark demonstrated that time-to-solution for more complex models can be cut in half by moving to the latest Intel Xeon processor 5500 technology matched with TrueScale InfiniBand vs. earlier Intel processor technologies. The HP cluster runs the Truck 111M cell model more than 100% faster than the Harpertown cluster.

Figure 5: Processor performance for External Flow Over a Truck Body model



## Key solution technologies

The following summarizes the key technologies that comprised this high-performance solution for maximizing the performance of engineering applications like computational fluid dynamics.

### ANSYS FLUENT—computational fluid dynamics (CFD) software

The ANSYS FLUENT 12 software takes advantage of the latest advancements in today's HPC architectures, from individual desktop through scale-out environments. The advances in processor technology coupled with high-speed interconnects become an important consideration for maximizing the new features and benefits of ANSYS FLUENT 12 for gains in

- Performance
- Price/Performance
- Scalability
- Scalable bandwidth
- Capacity

The broad physical modeling capabilities of FLUENT have been applied to industrial applications ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to glass production, from blood flow to semiconductor manufacturing, and from clean room design to wastewater treatment plants. The ability of the software to model in-cylinder engines, aeroacoustics, turbomachinery, and multi-phase systems has served to broaden its reach. Today, thousands of companies throughout the world benefit from the use of this important engineering design and analysis tool. Its extensive range of multi-physics capabilities makes it one of the most comprehensive software tools available to the CFD community. With its longstanding reputation of being user-friendly and robust, FLUENT makes it easy for new users to come up to productive speed.

### HP Cluster Platforms—high-performance cluster technology

HP is the market leader in high-performance computing, offering the broadest spectrum of high-performance computing solutions, from workgroup and departmental servers to systems designed for the engineering enterprise and supercomputing centers. HP delivers innovative, industry-standard servers that are optimized for scalability, price/performance, and performance/watt to reduce your capital and operating expenses.

Clustering is simple and fast with HP Cluster Platforms, the foundation of the [Unified Cluster Portfolio](#). These systems combine the flexibility of a custom solution with the simplicity, reliability, and value of a preconfigured, factory-built product. Get started with HP [Cluster Platforms](#).

- Broad choice of servers, cluster interconnects, and middleware
- Factory integrated and tested, with final onsite installation
- Choice of packaging styles—dense or expandable modular design up to 1024 nodes
- Backed by HP warranty and support, and built to uniform, worldwide specifications
- Comprehensive software selection, tested and verified by HP and/or its partners
- Rapid deployment services, including optional software installation, onsite training, and implementation support

## Intel Xeon processor 5500 series

The Intel Xeon processor 5500 series automatically and intelligently adjusts server performance according to your application needs for up to 9x performance gain over single-core servers at 18% less operating power. This enables you to achieve a 9:1 server consolidation ratio, reducing operating costs by up to 90% and resulting in an estimated eight-month return on a new server investment. Two-processor servers based on the Intel Xeon processor 5500 series have up to eight computation engines, 16 threads per two-socket platform with Intel Hyper-Threading Technology, and as much as 3.5x more bandwidth than previous generations. With intelligent performance technology and a new high-bandwidth interconnect architecture, the Intel Xeon processor 5500 series delivers up to 4x greater performance for HPC applications than Intel dual-core processors. Intel recognizes that the need for performance increases all the time. That's why Intel provides platform-based solutions that maximize performance, improve throughput, and add new embedded technologies that give business, creative, and scientific professionals the tools to solve problems faster, process larger data sets, and meet bigger challenges. That's why 75% of the Supercomputing Top 500 results are on Intel processor based platforms.

The Intel microarchitecture "Nehalem" boosts performance even further for critical workloads. Intel Turbo Boost Technology increases core frequency to improve execution speed as needed while Intelligent Power Technology conserves power on cores when there is less demand. For applications that lend themselves to parallel, multithreaded execution, Intel Hyper-Threading Technology reduces computational latency, making optimal use of every cycle.

Technical compute platforms based on the Intel Xeon processor 5500 series support up to 16 simultaneous threads, with 32- and 64-bit processing capabilities, up to 144 GB of memory and a new, inclusive shared L3 cache that boosts performance while reducing traffic to the processor cores. The Xeon 5500 based multi-core servers help maximize productivity, enhance visualization, and improve flexibility to help researchers, engineers, and developers achieve more in less time.

## QLogic InfiniBand solutions

QLogic offers a comprehensive end-to-end InfiniBand product portfolio that includes multi-protocol fabric directors, edge fabric switches, InfiniBand adapters, and a complete software suite to install, operate, and maintain your high-performance interconnect fabric. QLogic InfiniBand adapters offer one of the industry's highest message rate. Combining the low MPI latency and the high effective bandwidth enables HPC applications to scale to thousands of nodes with unprecedented price/performance. QLogic offers the most comprehensive and flexible interconnect fabric solutions on the market. Applications needing 12–864 InfiniBand ports can be supported in a single chassis. Multi-chassis fabrics supporting thousands of host nodes can be constructed to meet the most demanding compute cluster requirements. The QLogic offering, which combines with comprehensive fabric management tools, helps to satisfy the growing demand for high-performance computational clusters and grids.

## For more information

### Web resources

[www.hp.com/go/hpc](http://www.hp.com/go/hpc)

[www.qlogic.com/go/hp](http://www.qlogic.com/go/hp)

## Disclaimer

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