

# QLogic TrueScale InfiniBand and Teraflop Simulations

## ANSYS FLUENT 12—High Performance Interconnect for ANSYS Computer-Aided Engineering Solutions

### Key Findings

#### Improve Time-to-Solutions by Completing Simulations Faster

- iDataplex™ with TrueScale InfiniBand running FLUENT is up to 18 times faster than a multi-core workstation/server.
- TrueScale InfiniBand is up to 1770-percent faster than gigabit Ethernet at scale (128 cores).

#### Better Designs through Speed and Scalability

- Twice as many large/complex simulations can be run in a given period of time versus Ethernet-based clusters.
- iDataplex with TrueScale InfiniBand performance scales well as nodes and cores are added to the cluster, with 99 or more scaling efficiency for large FLUENT models.

#### Reduced Product Development Costs

- Reduce the need for physical prototyping by leveraging more complex models in a compressed time frame.

#### Reduced Costs of Computing Infrastructure

- QLogic TrueScale-based iDataplex clusters reduce the number of servers needed to deliver the equivalent performance level of an Ethernet cluster.
- QLogic TrueScale InfiniBand protects the current cluster investment by delivering real performance when incremental computation resources are added. TrueScale InfiniBand is up to 1770-percent faster than gigabit Ethernet at scale (128 cores).

## Executive Summary

Designing and manufacturing products that arrive on time and within budget are the key challenges faced by every manufacturer in a global competitive marketplace. With shifting market trends, an increased emphasis on product safety and quality, and increased consumer desire for environmentally “green” products, today’s manufacturer has a lot to consider when creating products for the market. Add the current global economic climate to all of these challenges, and it makes lower manufacturing costs and improving time-to-market for new products even more critical than ever. How does today’s manufacturer compete in this market?

High performance computing clusters (HPCC) tools assist manufacturers in meeting these challenges. Simulations are increasingly replacing expensive physical testing, as more complex environments can be modeled and, in some cases, fully simulated. A well-designed and implemented HPCC environment improves a company’s ability to support increased model resolution and complexity, providing an

engineering team a more thorough insight into their designs. This virtual design review will allow engineers to identify issues earlier in the development cycle that might otherwise significantly delay a product’s introduction or quality. QLogic TrueScale InfiniBand®, paired with the latest in multi-core processor technology, is the foundation of a well-designed HPCC computing infrastructure.

IBM® and QLogic, working in concert with ANSYS®, tested FLUENT® 12 on a range of configurations and interconnects. The test results proved that ANSYS FLUENT with QLogic TrueScale™ InfiniBand allow a company to model and simulate complex designs in less time. QLogic’s TrueScale InfiniBand solutions are a critical success factor for creating HPCCs that maximizes FLUENT simulation performance. With the QLogic/ANSYS FLUENT solution, more design alternatives can be tested to polish product features, simplify use, and increase quality in a short time frame, all at a lower cost. More thorough simulations can reduce or even eliminate the cost of physical prototyping.

## Business Value of HPC Cluster

### Improve Time-to-Solutions by Completing Simulations Faster

Reducing the time-to-solution is one of the keys to success when running FLUENT simulations to refine a design. Interconnecting the iDataplex cluster with QLogic TrueScale InfiniBand dramatically improves this critical metric. The end result is faster time-to-market and higher product quality levels.

- An iDataplex 16-node HPC cluster is up to 18-times faster than a multi-core workstation/server for larger models.
- iDataplex is 84-to-1770% faster, depending on the test, when using TrueScale InfiniBand versus gigabit Ethernet at scale (128 cores).

### Better Designs Through Speed and Scalability

QLogic TrueScale InfiniBand solutions enable companies to effectively scale cluster configurations, run larger data sets, and expand simulation complexities in computer-aided design. These capabilities improve designs by running larger data sets without dramatic increases in run time.

- Run twice as many large/complex simulations in a given period of time versus Ethernet-based clusters.
- QLogic TrueScale InfiniBand performance scales well as nodes and cores are added to the cluster, with up to 99% scaling efficiency.

### Reduced Product Development Costs

An iDataplex cluster enables organizations to increase design complexity and perform more detailed simulations to verify and validate designs, which reduces the costs and time required for the development process.

The cluster reduces the need for physical prototyping by leveraging more complex models in a compressed time frame. This approach can reduce or eliminate the need for physical prototyping.

### Better Designs Through Speed and Scalability

By leveraging iDataplex’s management capabilities, industrial engineering customers can reduce the costs and complexities of deploying and operating HPC clusters.

TrueScale-based iDataplex clusters reduce the number of servers needed to deliver the equivalent performance level of an Ethernet cluster. For all of the FLUENT test cases, an iDataplex with 8 servers/64 cores utilizing TrueScale produced results equivalent to a 16-server/128-core cluster interconnected with gigabit Ethernet. In addition to the server savings, there are incremental ongoing savings in licensing costs, power, and cooling as a result of using fewer servers to achieve the same system throughput.

## ANSYS FLUENT—Computation Fluid Dynamics Software Description

ANSYS is a leading software provider for solving fluid flow problems. 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 attributes to its wide-spread use. Today, thousands of companies worldwide benefit from this engineering design and analysis tool. FLUENT’s extensive range of multi-physics capabilities makes it one of the most comprehensive software tools available to the computation fluid dynamics (CFD) community. With its long-standing reputation of being user-friendly and robust, FLUENT can be quickly installed and deployed, providing maximum benefits to its users in a minimum amount of time.

### ANSYS FLUENT Benchmark Overview

IBM and QLogic used a new set of ANSYS benchmark cases, covering a large range of problem sizes, physical models, and solvers representing typical industry usage. Six cases were run by QLogic, and ranged in size from a few 100,000 cell cases to more than 100 million cells. Both segregated and coupled, implicit solvers were used, as well as hexahedral, mixed, and polyhedral cell cases. This broad coverage demonstrated the breadth of FLUENT performance on a variety of hardware platforms, interconnects, and test cases.

The FLUENT benchmark cases were run on a Q-Blue cluster consisting of iDataplex with 16 servers and 1 network file system (NFS) server node. Each compute node had dual, quad-core Intel® Xeon® 5570 (Nehalem) 2.93GHz CPUs and 24GB of memory. The Intel Xeon 5570 processor is the latest in Intel processor technology. The Q-Blue cluster had a total of 128 cores and 384GB of memory, as well as TrueScale InfiniBand interconnect for MPI and file system I/O traffic. Standard onboard gigabit Ethernet interconnect was also used/tested for comparison purposes.

The following benchmark tests were run with ANSYS FLUENT 12.0.15 using HP-MPI:

| Test Name                            | Benchmark Name |
|--------------------------------------|----------------|
| External Flow Over an Aircraft Wing  | aircraft_2M    |
| External Flow Over a Passenger Sedan | sedan_4M       |

| Test Name  | Benchmark Name |
|--|----------------|
| External Flow Over a Truck Body                        | truck_14M      |
| External Flow Over a Truck Body with a Polyhedral Mesh | truck_poly_14M |
| External Flow Over a Truck Body                        | Truck_111m     |

The primary metric used to report FLUENT 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. The Rating measurement 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 each FLUENT case. QLogic ran the HPC cluster using both TrueScale InfiniBand and gigabit Ethernet interconnects for comparison purposes. The other InfiniBand results came from the ANSYS FLUENT benchmark results reported on the ANSYS site.

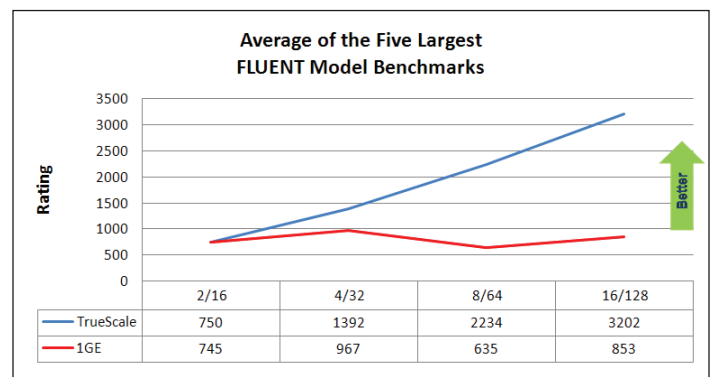
### Average of the Five Largest FLUENT Test Models

The following comparison is based on the average of the five largest FLUENT test models listed in the previous table.

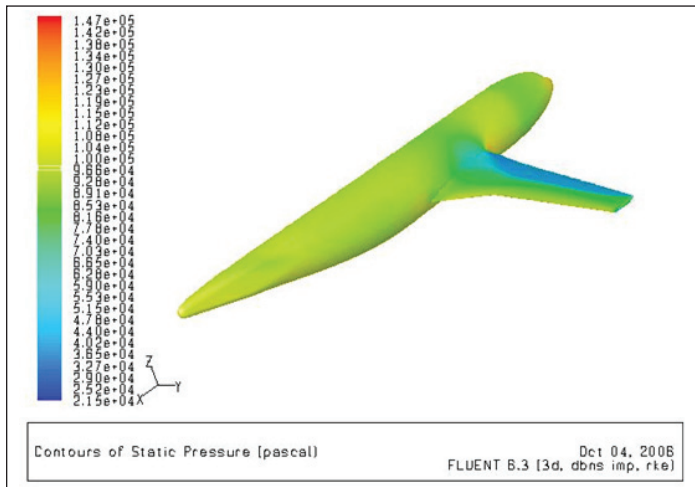
#### Test Findings

- The IBM iDataplex with QLogic TrueScale InfiniBand scaled very well through 16 nodes/128 cores. Conversely, gigabit Ethernet reached its point-of-diminishing return at 4 nodes/32 cores; after that, performance declined as more servers and cores were added to the cluster.
- Performance improved over 275% using iDataplex with TrueScale InfiniBand at 16 node/128 cores compared to gigabit Ethernet.

#### Rating Results



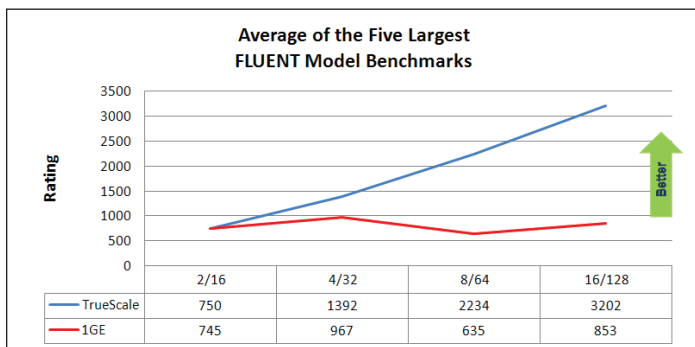
### External Flow Over an Aircraft Wing



This case has approximately 1.8 million hexahedral cells and uses the realizable k-epsilon model and the coupled implicit solver.

|                 |                             |
|-----------------|-----------------------------|
| Number of cells | 1,800,000                   |
| Cell type       | Hexahedral                  |
| Models          | Realizable k-eps turbulence |
| Solver          | Coupled implicit            |

### Rating Results

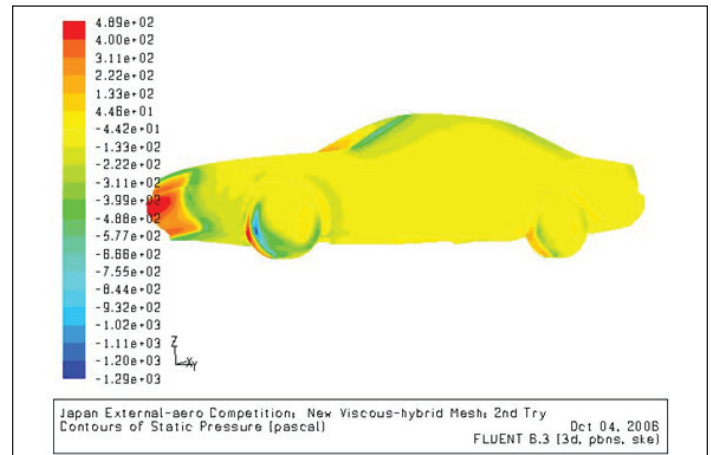


### Test Findings

QLogic TrueScale scaled better when compared to either gigabit Ethernet or other InfiniBand offerings.

- The iDataPlex with QLogic TrueScale continued to scale as more servers and cores were added to the cluster. The performance of iDataPlex with gigabit Ethernet began to decline at 4 nodes/32 cores.
- iDataPlex with TrueScale achieved almost 500% better performance than gigabit Ethernet at 16 nodes/128 cores.

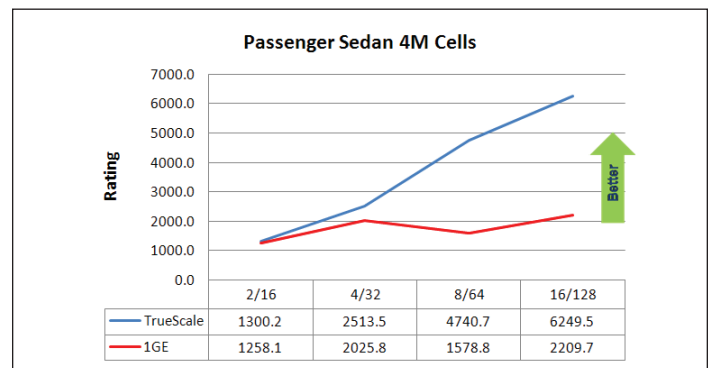
### External Flow Over Passenger Sedan



This is an external flow over a passenger sedan test. The case has approximately 3.6 million cells of mixed type and uses a k-epsilon model with the pressure-based coupled solver.

|                 |                                 |
|-----------------|---------------------------------|
| Number of cells | 3,600,000                       |
| Cell type       | Mixed                           |
| Models          | k-eps turbulence                |
| Solver          | Pressure-based coupled implicit |

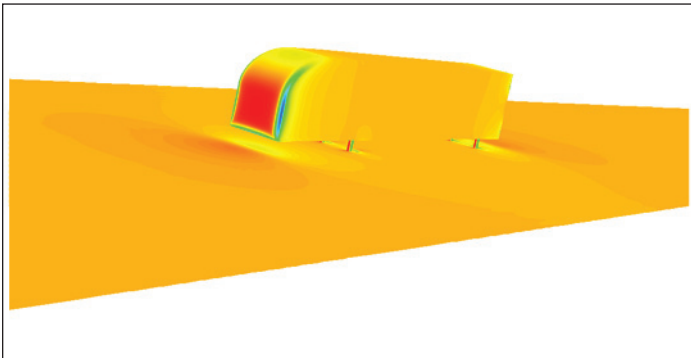
### Rating Results



### Test Findings

- iDataPlex with TrueScale InfiniBand interconnects showed consistent performance gains as additional nodes and cores were added to the cluster.
- A TrueScale-based iDataPlex cluster provided better performance at 4 nodes/32 cores than the iDataPlex nodes interconnected with gigabit Ethernet at 16 nodes/128 cores.
- TrueScale showed 24% better performance than gigabit Ethernet at 4 nodes/32 cores. The performance difference increased to 183% at 16 nodes/128 cores.

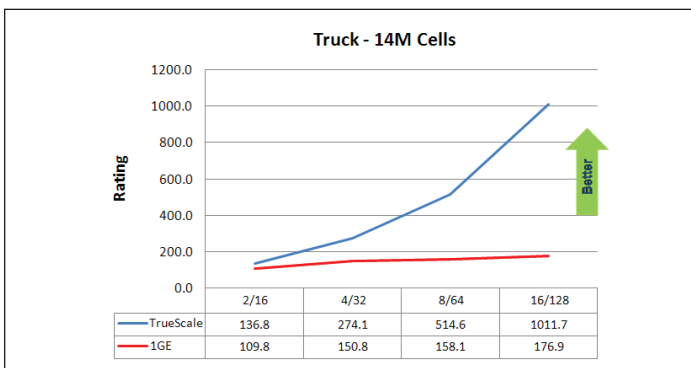
### External Flow Over a Truck Body



The external flow case over a truck body has approximately 14 million cells of mixed type and uses the DES model with the segregated implicit solver.

|                 |                     |
|-----------------|---------------------|
| Number of cells | 14,000,000          |
| Cell type       | Mixed               |
| Models          | DES turbulence      |
| Solver          | Segregated implicit |

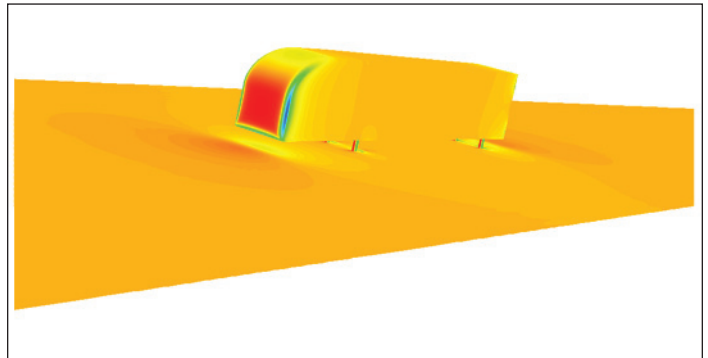
### Rating Results



### Test Findings

- iDataplex with TrueScale InfiniBand had a scaling efficiency of 92% when scaling from 16 cores to 128 cores.
- As an interconnect, TrueScale provided consistent scaling and performance results. Gigabit Ethernet exhibited a performance anomaly at 8 nodes/64 cores. The Ethernet test at 8 nodes was rerun 5 times and produced a consistent rating of 68% ( $\pm 1$  %).
- The TrueScale-based iDataplex cluster provided better performance at 8 nodes/64 cores than a gigabit Ethernet cluster with 16 nodes/128 cores.
- At 128 cores, the iDataPlex/TrueScale solution performed 200-percent better than gigabit Ethernet at 128 cores.

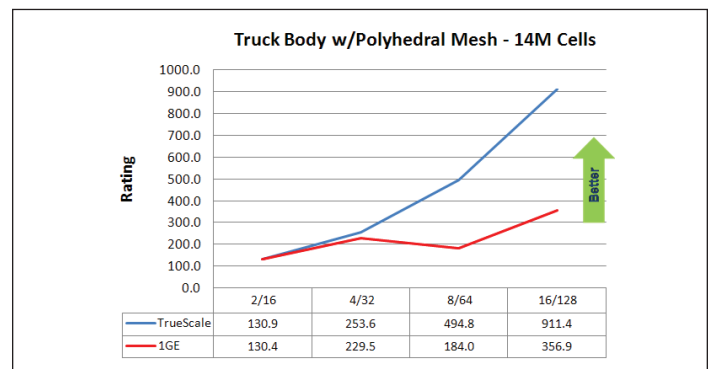
### External Flow Over a Truck Body with a Polyhedral Mesh



External flow over a truck body using a polyhedral mesh is a test case that has approximately 14 million polyhedral cells and uses the DES model with the segregated implicit solver.

|                 |                     |
|-----------------|---------------------|
| Number of cells | 14,000,000          |
| Cell type       | Polyhedral          |
| Models          | DES turbulence      |
| Solver          | Segregated implicit |

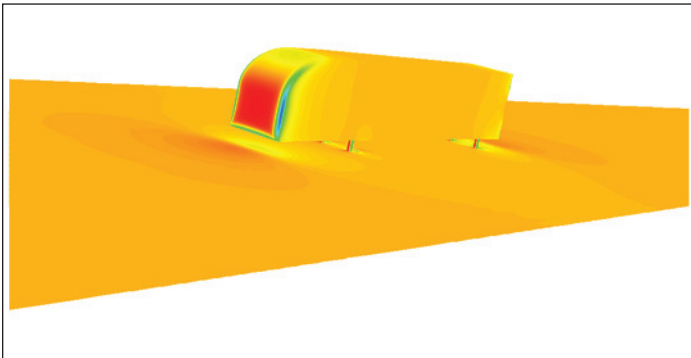
### Rating Results



### Test Findings

- The iDataplex cluster with TrueScale InfiniBand achieved a scaling efficiency of 87% when going from 16 cores to 128 cores. For the same range of cores, gigabit Ethernet scaling efficiency was only 34%.
- The TrueScale-based iDataplex cluster showed 208% better performance than gigabit Ethernet at 16 nodes/128 cores.

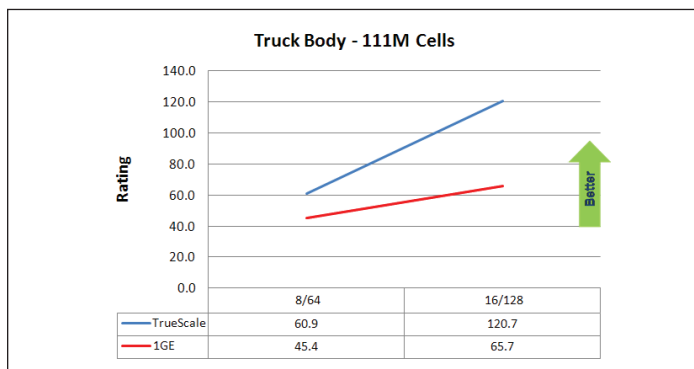
## External Flow Over a Truck Body



This is the largest and most complex of the test cases. It shows an external flow over a truck body. The case has approximately 111 million cells of mixed type and uses the DES model with the segregated implicit solver.

|                 |                     |
|-----------------|---------------------|
| Number of cells | 111,000,000         |
| Cell type       | Mixed               |
| Models          | DES turbulence      |
| Solver          | Segregated implicit |

### Rating Results



### Test Findings

- The iDataPlex/QLogic TrueScale cluster scaled well, achieving near-linear scaling efficiency when scaling from 64 cores to 128 cores.
- iDataPlex with TrueScale performed 84% better than gigabit Ethernet at 128 cores.

## ANSYS Corporation

ANSYS, Inc. develops and globally markets engineering simulation software and technologies used by engineers and designers across a broad spectrum of industries. The company develops open and flexible solutions that enable users to analyze designs directly on the desktop, providing a common platform for fast, efficient, and cost-conscious product development, from design concept to final-stage testing and validation. The company and its global network of channel partners provide sales, support, and training for customers.

## IBM—High Performance Cluster Technology

IBM is the world's leading provider of high performance computing (HPC) systems. IBM delivers innovative and powerful breakthrough solutions and technologies, like the System x® iDataPlex and the System Cluster 1350. These systems support Linux® and Windows® HPC Server 2008, cloud computing, and IBM research-led HPC initiatives that enable customers to address demands of intense computation and data manipulation.

IBM System x iDataPlex, a large-scale solution, solves customer problems such as constraints in power, cooling, or physical space. The innovative design of the iDataPlex solution integrates Intel Xeon processor-based processing into the node, has a rack and data center for efficient power and cooling, and has the compute performance and density customers need. Highlights of this solution include:

- The iDataPlex dx360 M2 is the top-rated server for both performance and energy efficiency in the x86 marketplace (see IBM System x iDataPlex).
- Provides a flexible design for large-scale data centers.
- iDataPlex dramatically reduces cooling costs. Air conditioning expenses are minimized or even eliminated (see IBM System x iDataPlex).
- Provides up to five times the compute density for efficient space utilization.

The IBM System Cluster 1350—built on the innovative IBM System x rack, BladeCenter®, and iDataPlex servers—integrates servers, storage, interconnects, and software with a single point-of-contact for support. The Cluster 1350 is an ideal solution for a broad range of application environments, including industrial design and manufacturing, financial services, life sciences, government, and education. These environments typically require excellent price/performance for handling HPC and business-performance computing workloads. Highlights of this solution include:

- Leading-edge technology with flexibility of choice
- High performance
- Energy and space efficient

- Easily deployed, operated, and maintained
- Custom integration with a single point-of-contact for support

The IBM system cluster with QLogic TrueScale InfiniBand interconnects processors between servers and storage; it is a mature HPC solution with demonstrable gains over competing configurations. These low-latency, high-bandwidth, energy-efficient solutions deliver significantly faster time-to-solution and enhanced productivity. For customers, this means superior support and faster return on investment (ROI) on HPC investments.

## Intel Xeon 5500 Processor Series

The Intel Xeon processor 5500 series automatically and intelligently adjusts server performance (based on application needs) for a performance gain that is 9 times greater than single-core servers running at 18 percent less operating power. This performance equates to a 9:1 server consolidation ratio, reducing operating costs by up to 90 percent, which results in an estimated 8-month return on a new server investment. Two-processor servers based on the Intel Xeon processor 5500 series have up to 8 computation engines, 16 threads per 2-socket platform (with Intel hyper-threading technology), and up to 3.5 times 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 four times more performance for HPC applications compared to Intel dual-core processors. Intel recognizes that the need for performance is always increasing. 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. Seventy-five percent of the Supercomputing Top 500 results are on Intel processor-based platforms.

Intel micro-architecture (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 benefit from parallel, multi-threaded 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-bit and 64-bit processing capabilities; up to 144GB of memory; and a new, inclusive, shared L3 cache that boosts performance while reducing traffic to the processor cores. These multi-core servers 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 a high-performance interconnect fabric.

QLogic InfiniBand adapters offer the industry's highest message rate, combined with the lowest MPI latency and the highest effective bandwidth, to enable MPI and TCP 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 built to meet the most demanding compute cluster requirements. This offering, combined with the industry's only fabric management tools, satisfies the growing demand for high-performance computational clusters and grids.

## Value of iDataplex with TrueScale InfiniBand

Recent improvements in ANSYS FLUENT 12 enhance its ability to leverage the latest in today's HPC computing technologies. Choosing an HPC cluster interconnect is an important consideration for maximizing the new features and benefits of ANSYS FLUENT 12. InfiniBand provides the following advantages over gigabit Ethernet:

- Leading-edge technology with flexibility of choice
- High performance
- Energy and space efficient
- Easily deployed, operated, and maintained
- Custom integration with a single point-of-contact for support

### Performance

When time-to-solution is critical, the value of an InfiniBand-based cluster becomes evident. iDataplex, with QLogic TrueScale InfiniBand, delivers time-to-solution improvements from 84 percent to over 3000 percent at 16 nodes compared to gigabit Ethernet (depending on the ANSYS FLUENT test). TrueScale InfiniBand reveals its performance advantage with as few as 4 nodes/32 cores, and performance continues to improve as the cluster size expands.

### Price Versus Performance

An iDataplex-TrueScale InfiniBand cluster requires significantly less server resources to complete an equivalent simulation compared to a gigabit Ethernet-based cluster. On average, it takes an iDataplex with 4 servers/32 cores utilizing TrueScale to produce equivalent results of a 16-server/128-core cluster inter-connected with gigabit Ethernet. Achieving real savings in computational resources and ongoing operational expenses, such as power and cooling, improves the bottom line.

### Scalability

The value of TrueScale InfiniBand is evident with larger simulations. The Truck\_111M test is a simulation that involved 111 million cells. This test scaled linearly across the servers with the TrueScale InfiniBand interconnect, cutting the time-to-solution nearly in half (sequentially) from 64 cores to 128 cores. The same tests using gigabit Ethernet showed only marginal performance improvement from 64 cores to 128 cores.

### Bandwidth

The bandwidth capabilities of InfiniBand—up to 40Gbps—can build a solution that consolidates data networking, clustering communications, and storage access over a single fabric. This solution significantly lowers overall power, real estate, and management overhead in data centers. InfiniBand's enhanced quality of service (QoS) capabilities support running and managing multiple applications, workloads, and traffic classes. For example, the TrueScale InfiniBand fabric can concurrently run both MPI inter-processor communication and NFS traffic.

#### Disclaimer

Reasonable efforts have been made to ensure the validity and accuracy of these performance tests. QLogic Corporation is not liable for any error in this published white paper or the results thereof. Variation in results may be a result of change in configuration or in the environment. QLogic specifically disclaims any warranty, expressed or implied, relating to the test results and their accuracy, analysis, completeness or quality.



**Corporate Headquarters** QLogic Corporation 26650 Aliso Viejo Parkway Aliso Viejo, CA 92656 949-389-6000

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

**International Offices** UK | Ireland | Germany | France | India | Japan | China | Hong Kong | Singapore | Taiwan

© 2011 QLogic Corporation. Specifications are subject to change without notice. All rights reserved worldwide. QLogic, the QLogic logo and TrueScale are registered trademarks of QLogic Corporation. ANSYS and ANSYS FLUENT are trademarks or registered trademarks of ANSYS, Inc. Intel and Xeon are trademarks of Intel, Inc. IBM, iDataPlex, BladeCenter and System x are trademarks or registered trademarks of International Business Machines, Inc. Linux is a registered trademark of Linus Torvalds. Windows Server is a registered trademark of Microsoft Corporation. InfiniBand is a trademark and service mark of the InfiniBand Trade Association. All other brand and product names are trademarks or registered trademarks of their respective owners. Information supplied by QLogic Corporation is believed to be accurate and reliable. QLogic Corporation assumes no responsibility for any errors in this brochure. QLogic Corporation reserves the right, without notice, to make changes in product design or specifications.