

# Mellanox End-to-End InfiniBand Solutions for the Most Efficient Computational Fluids Dynamic (CFD) Applications



Increasing demand for computing power in scientific and engineering applications has spurred deployment of high-performance computing (HPC) clusters. Computational Fluid Dynamics (CFD) is a computational technology that can take advantage of HPC clusters for increasing engineering design productivity, reduce development cost and faster time to market. The end-user benefits are far more sophisticated, enhanced, safer and robust products.

## Computational Fluid Dynamics

CFD enables creation of a computational model that represents a system or device, and apply the fluid flow of physics and chemistry to this virtual prototype. The outcome of this process provides a prediction of fluid dynamics and the related physical phenomena. Architecture process increases product performance and safety on richer and more complex designs while shortening time to market and reducing development cost. CFD has been extensively used for simulations of flows of gases and liquids, heat and mass transfer, moving bodies, multiphase physics, chemical reaction, fluid-structure interaction and acoustics.

CFD simulation are typically carried on high performance compute clusters as they require an effective compute resource that can handle complex and parallel simulations. HPC Clusters consist of off-the-shelf servers, a high speed interconnect and a storage solution. The interconnect has a great influence on the total cluster performance and scalability. A slow interconnect will cause delays in data transfers between servers and between servers and storage, causing poor utilization of the compute resources and slow execution of simulations. An interconnect that requires CPU cycles as part of the networking process will decrease the compute resources available to the applications and therefore will

slow down and limit the numbers of simulations that can be executed on a given cluster. Furthermore, this will limit the cluster scalability because as the number of CPUs increases, the number of processor messages increase, increasing the burden on the CPUs to handle networking.

## Mellanox InfiniBand solutions for HPC systems

By providing low-latency and high-bandwidth with extremely low CPU overhead, InfiniBand has become the most deployed high-speed interconnect for CFD simulations, replacing proprietary solutions or low-performance networks such as Ethernet. The InfiniBand Architecture (IBA) is an industry-standard fabric designed to provide high-bandwidth, low-latency computing, scalability for ten-thousand nodes and multiple CPU cores per server platform and efficient utilization of compute processing resources. Mellanox ConnectX InfiniBand adapters and InfiniScale® IV switches are the leading-edge InfiniBand solutions that have been designed for HPC clustering technology. ConnectX and InfiniScale IV are the only InfiniBand solutions that deliver 40Gb/s of bandwidth between servers and 120Gb/s between switches, 50% higher bandwidth than any other InfiniBand solution. This high-performance bandwidth is matched with ultra-low application latency of 1µsec, and switch latencies of 100ns that enable efficient, scale-out compute systems, 30% faster than other InfiniBand solutions.

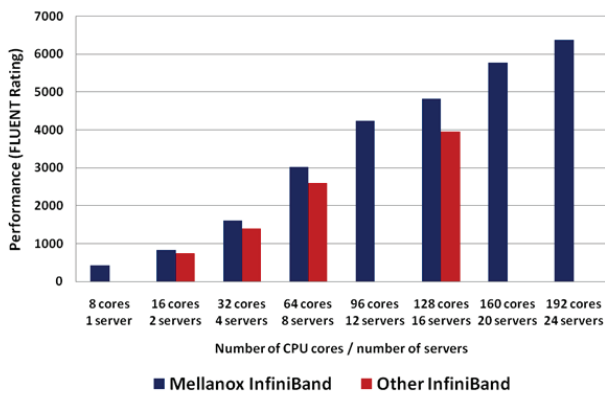
Furthermore, Mellanox ConnectX adapters are the only InfiniBand-offload solutions that manage the InfiniBand transport and, include native support for Remote Direct Memory Access (RDMA), congestion management and Message Passing Interface (MPI) offloads. These capabilities guarantee maximum performance, scalability and CPU cycles for the CFD applications. While other InfiniBand solutions require CPU involvement

in the InfiniBand transport (same as the Ethernet TCP is being handled by the CPU causing poor scalability for HPC applications), Mellanox deliver the most scalable and efficient solutions for end-to-end InfiniBand systems.

### The Performance Advantage

Mellanox is working with ANSYS and AMD to provide the best productivity experience to CFD users. The results of the collaborations enable CFD users to maximize their system efficiency and scalability resulting in highest return on investment. Mellanox InfiniBand solutions are the only solutions that provide all the necessary elements for maximizing CFD performance – lowest latency for process to process communications, full transport and MPI offloads for maximizing the CPU efficiency, and advanced hardware-based networking capabilities such as congestion avoidance and self-learning routing for overall network efficiency. ANSYS FLUENT 12 performance results shown on the following page demonstrates Mellanox InfiniBand value proposition for the CFD users.

**ANSYS FLUENT 12 Performance - Aircraft\_2M**



From concept through design to test and manufacturing, engineering relies on powerful virtual development solutions. Computational Fluid Dynamics is used in an effort to secure quality and speed up the development process. In order to achieve the desired virtual design, CFD users rely on HPC clusters to gain the needed compute ability. Mellanox InfiniBand based multi-core cluster environments provide the needed high performance compute system for the CFD simulations, and the ANSYS CFD software is ready to take full advantage of the hardware capabilities.

## KEY MELLANOX ADVANTAGES

- The only transport offload solution for highest CPU efficiency and availability
- Lowest applications latency of 1 usec
- Lowest switch latency of 100nsec at 100% switch load – 30-40% faster than other InfiniBand options
- Highest bandwidth of 40Gbs server to server and 120Gb/s switch to switch – 50% higher than other InfiniBand options
- The only solution to provide native hardware congestion avoidance and adaptive routing
- Highest dense switch solutions, up to 51.8Tb/s in a singles non-blocking switch enclosure
- Demonstrated 12% higher performance with 2-servers systems to 22% higher performance with 16-server system, performance gap increases with system size
- Mellanox InfiniBand – the only solutions that scales!



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