Case Study

Princeton Plasma Physics Laboratory (PPPL)

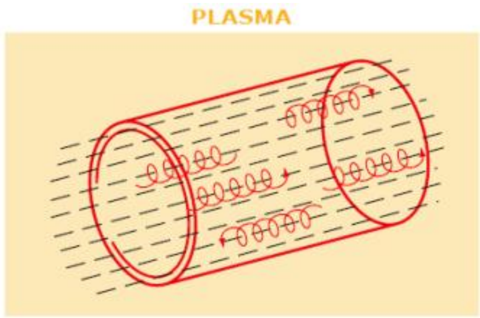
Princeton Plasma Physics Laboratory (PPPL) Finds 10GbE Improves Cluster Performance by 36% over DDR InfiniBand

FUSION 101

The fusion of the deuterium and tritium isotopes of hydrogen produces helium and a tremendous amount of energy – as much as 450 times the input energy required for the fusion reaction to occur. Fusion provides significant advantages over other forms of energy conversion, including an inexhaustible low-cost fuel supply, no contribution to global warming or acid rain, and no risk of a reactor meltdown or weapons production. Today fusion reactions stop operating after a short period, but the goal is to create a fully sustainable fusion reactor that would be able to operate for long periods of time, sustained only by the addition of more hydrogen to the reaction.

SIMULATION ACCELERATES RESEARCH

Experimental fusion reactors can cost $100M or more and take years to build. Researchers base their designs on both physical experimental data and the results of computer simulations of the physical processes. Physical experiments provide data that is used to create the simulation models, and are also used by researchers to validate theoretical simulation outputs with observed experimental results. The simulations themselves enable both dramatic reduction in experimentation costs and time, accelerating research and allowing researchers to model the expected behavior of the reactor long before it is actually built and operational. This can all lead to the successful design of the first fusion reactor within a reasonable time frame and budget.



Motion of charged particles with magnetic field.

Princeton Plasma Physics Laboratory (PPPL), joined by the world-wide fusion energy research community, is working to develop the first self-sustaining fusion reactor, slated to go on line by 2016. To reach this goal, researchers model the properties of deuterium and tritium movement in a plasma field, which is required for sustained fusion reaction.

To simulate the fusion processes, PPPL hosts a shared compute cluster which runs over 230,000 simulation jobs every year. Simulation models are developed by research universities in a community environment, and dedicated compute facilities tuned for each specific model are shared with members of the fusion energy research community. Most models are highly parallelized requiring several thousand CPU cores per job. Simulations model fusion reactor processes. In general, each simulation may run for hours, days, or even weeks, so saving even 2% or 3% on run times moves research significantly closer to the goal in real time.

10GBE DELIVERS 36% BETTER RESULTS THAN INFINIBAND

PPPL is one of many shared high-performance computing (HPC) clusters in the fusion energy community that operates both Gigabit Ethernet (GbE) and InfiniBand (IB) clusters. Attracted by the competitive price per port and ease of use of 10GbE, PPPL decided to measure application performance on 10 Gigabit Ethernet (10GbE) interconnect, PPPL found that the 18 node cluster utilizing 10GbE significantly outperformed the cluster configured with DDR IB, reducing GYRO code compute time by over 36%. This result was startling and implies that 10GbE can be a useful interconnect not only for GYRO, but also for any stepwise iterative code in other physical modeling fields, such as Genomics, Computational Fluid Dynamics (CFD), and Finite Element Analysis.

GYRO Code Performance	10GbE	InfiniBand
Test tun time (sec)	2,169	3,403

TEST CONFIGURATION

For this head-to-head test of 10GbE and IB, PPPL used an 18-node cluster of Sun X2200 M2 servers with dual-AMD 2.3GHz Opteron quad-core CPUs. For the 10GbE network, each of the servers were equipped with Solarflare SFN5122F dual-port server adapters and connected using a Blade Network Technologies G8124 10GbE rack switch.