LS-DYNA® Performance and Scalability On Sun™ x64 Systems

Michael A. Burke, Ph.D., Youn-Seo Roh, Ph.D., Henry H. Fong
Sun Microsystems, Inc.
4150 Network Circle, Santa Clara, CA 95054

Abstract

This paper describes AMD Opteron™-based x64 systems of Sun Microsystems™, primarily the server family. Performance and scalability are shown for the refined Neon standard LS-DYNA benchmark problem – for both gigabit Ethernet and Cisco/Topspin™ InfiniBand™/SM interconnects. The Sun Fire™ X2100 server, which can be easily installed in a Sun Grid Rack System, is seen to be a very attractive solution based on price-performance considerations. A continued effort on improving LS-DYNA performance on Solaris x64 platform is described. A brief mention is made of future benchmark work planned.

x64 Systems of Sun Microsystems

Sun Microsystems develops and markets a complete line of AMD Opteron-based x64 workstations and servers [1]. This paper discusses mainly the x64 servers, and their performance/scalability on LS-DYNA. These x64 systems provide considerable benefits for LS-DYNA users because they:

1. Are 64-bit systems designed for high performance with excellent scalability and 32-bit compatibility.
2. Offer large memory capacity for complex models and data sets.
3. Feature high compute density for consolidation of 32-bit systems.
4. Offer high-speed 3D graphics for pre- and post-processing.
5. Give users a choice of three operating systems: Solaris, Linux, or Microsoft Windows.

The *x64 servers* consist of: Sun Fire V20z, V40z, X2100, X4100, and X4200. The V20z (1 rack unit high) can have either one or two AMD Opteron processors (single- or dual-core), and can have up to 16 GB of memory. The V40z (3 rack units high) can have up to 4 AMD Opteron processors (single- or dual-core), and up to 32 GB of memory. The X2100 server (1 rack unit) has only one AMD Opteron processor (single- or dual-core). The X4100 server and X4200 server (1 and 2 rack units) has up to 2 AMD Opteron processors (single- or dual-core), up to 16 GB of memory, up to 4 hot-swappable 2.5-inch SATA disk drives, and redundant, hot-swappable power and cooling.

The *x64 workstations* consist of : Sun Ultra™ 20 and Ultra 40 workstations, and Sun Java Workstations W1100z and W2100z. The Ultra 20 workstation has one AMD Opteron processor, up to 4 GB of PC3200 ECC memory (or up to 1 GB non-ECC memory), up to two SATA disk drives, and on-board ATI RageXL graphics – with optional NVIDIA™ Quadro graphics accelerators (up to 2048 x 1536 24-bit resolution). The Ultra 40 has up to two single- or dual-core AMD Opteron processors, up to 16GB of PC3200 (DDR-400) registered ECC

memory. The W1100z (1 AMD Opteron processor) and W2100z (2 AMD Opteron processors) have 8 GB (W1100z) or 16 GB (W2100z) of PC3200 registered ECC memory, ATA100 (W1100z) or Ultra320 (W2100z) disk storage, and NVIDIA Quadro graphics accelerators (up to 1920 x 1200 24-bit resolution).

These Opteron-based systems can be configured to make a cluster for high performance computing workloads, using Sun N1(TM) Grid Engine software, Sun Grid Rack System , etc [2].

Sun Fire X2100 Server

The Sun Fire X2100 server [3] uses one single- or dual-core AMD Opteron processor, and measures 1 rack unit high. The user may order up to 4 GB of memory (unregistered ECC), and up to 2 hot-pluggable SATA 3.5-inch disk drives with optional DVD-ROM. It has one PCI-Express (8-lane) expansion slot. In the benchmarks discussed in this paper, a 32-processor x2100 system is used.

Neon Benchmark Results on X2100 Cluster

The refined Neon benchmark model [4] was used to evaluate the performance and scalability of the Sun Fire x2100 systems. Both gigabit Ethernet and Cisco/Topspin InfiniBand interconnects were used to create the cluster of 32 nodes. Each node used one single-core 2.6 GHz Opteron 152 processor, and four 1GByte DIMM's of PC3200 400 MHz memory module. The Linux(TM) OS used was 64-bit SuSE(TM) SLES 9. The LS-DYNA executable used was mpp970_s_6442 (lnxamd64 build).

The scalability results for the Sun Fire x2100 server cluster system are shown below.

NCPU	*Elapsed Time – InfiniBand (sec)*	*Scaling*	*Efficiency (%)*	*Elapsed Time – GBE (sec)*	*Scaling*	*Efficiency (%)*
1	10,241	1.0	100	11,331	1.0	100
2	5,128	2.0	99.8	6,341	1.79	89.4
4	2,703	3.79	94.7	3,222	3.52	87.9
8	1,414	7.29	91.2	1,874	6.05	75.6
16	774	13.2	82.7	1,676	6.76	42.3
32	458	22.4	69.9	2,529	4.48	14.0

These Cisco/Topspin InfiniBand interconnect elapsed times were better (less) than other Opteron vendors' elapsed times on the same refined Neon benchmark problem, as shown on the Topcrunch web site [4] on February 28, 2006. The scalability and efficiency values shown clearly indicate that for LS-DYNA clustering, Gigabit Ethernet should only be used up to 8 processors. The scalability and efficiency values shown for 16 and 32 processors are obviously unacceptable.

However, for the Cisco/Topspin InfiniBand interconnect with lower latency and higher bandwidth, the scalability and efficiency values shows significant improvement exhibiting more

acceptable number up to 16 processors. Even the values at 32 processors are reasonably good. These results behave similarly to what is commonly known in the LS-DYNA literature in the past several years about these two types of interconnects. We expect that the benchmarks planned on this Sun Fire X2100 cluster using two other InfiniBand interconnects (SilverStorm, Voltaire) will behave similarly to those of Topspin/Cisco.

Status of Solaris x64 Platform

Sun has been committed to improve price/performance feature of HPC-related computing platform. The result is Solaris x64 platform, combining AMD Opteron's 64-bit capable CPU, on-chip memory controller and HyperTransport(TM) inter-processor bus, and the time-proven stability of Solaris operating system. This platform suits especially well for cluster-based multi-processor interconnect. LS-DYNA had been ported to Solaris 9 x86 [5] in 2004, but the executable was only available as 32-bit executable. With the release of Solaris 10 x64 that came with numerous performance improvement features, including support of AMD64 architecture, LS-DYNA has been updated for Solaris x64, and the executable compiled with the latest Sun Studio compiler is available at LSTC. The current executable uses LAM-MPI (7.0.3).

Recently, Sun announced the availability of Sun HPC ClusterTools(TM) 6 software suite that allows parallel program development, resource management and system/cluster administration [6]. The software system includes Sun MPI library, for both SPARC and x64 systems, and Cluster Runtime Environment that can interface with Sun N1 Grid Engine, LSF, and PBS distributed resource managers. Cluster Tools 6 will simplify the cluster administration, especially for x64 systems, since it replaces the public domain MPI such as LAM or MPICH with Sun-supported MPI library and cluster system, which will benefit the user of LS-DYNA in terms of reduced software management need.

Extensive performance tuning of the Solaris x64 executable has also been under way, aided by the latest Sun Studio compiler (version 11 and onward) [7]. This effort is targeted at achieving the performance of x64 executable up to the level equal or superior to the Linux counterpart running on the same Sun hardware as the Solaris 10 x64 operating system is running. Sun's compiler group has been involved in the process for a significant duration of time. A presentable performance result of the platform will be available by the time of the Conference in June, 2006.

LS-PREPOST has also been ported to Solaris x64, and the beta executable is currently available at LSTC. It runs with OpenGL drivers for NVIDIA graphics cards and Solaris 10, and the list of graphics boards support on the Solaris x64 are constantly growing, especially with the relase of Solaris 10 Update 1 [8]. With this executable, running LS-DYNA and LS-PREPOST on the x64 workstations mentioned above will provide the users with the latest performance benefit.

Future Work

Plans are to use the refined Neon benchmark with the same 32-processor Sun Fire X2100 cluster but using two different InfiniBand interconnects: SilverStorm Technologies, and Voltaire. Results were not obtained in time for inclusion in the paper, but it is planned that these benchmark results will be completed and presented at the 9th International LS-DYNA Users Conference, Dearborn, Michigan, June 3-4, 2006. We would also like to evaluate the LS-DYNA

performance/scalability using a cluster of 32-processor Sun Fire X4100 server. If time allows, we plan to conduct the same study using the 3-car-crash standard LS-DYNA benchmark of [3].

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References

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