Speeding Up Structural Analysis with MSC Nastran™ and the Cray® DataWarp™ I/O Accelerator

![MSC Software logo]

Scientific Field
Automotive manufacturing

Application: MSC Nastran
MSC Nastran is a multidisciplinary structural analysis application used to perform static, dynamic and thermal analysis.

Cray Technology: DataWarp Applications I/O Accelerator for the Cray XC Supercomputer
The Cray DataWarp accelerator delivers application-ready storage I/O to high-velocity data-driven workflows. Leveraging features of the Cray Linux environment, solid-state disk (SSD) storage and the Cray high-speed network, DataWarp technology enables high-performance I/O without the need for SSDs on every node. It scales from 70,000 to 40 millions IOPS in a single XC system, delivering up to five times the performance of disk storage at the same cost.

Results at a Glance

- 50 percent reduction in processing time
- 5x improvement in disk storage
- Minimal SSD requirements

Elapsed Time: Lustre vs. DataWarp
Performance of MSC Nastran NVH simulation with over 19 million degrees of freedom.

Lustre only	17,000 seconds
DataWarp	8,500 seconds

About Cray
Cray provides systems and solutions that help you solve your most difficult computing, storage and data analytics challenges. The company's comprehensive portfolio includes optimized cluster systems, powerful supercomputers, advanced storage systems and high performance data analytics and discovery platforms. Founded in 1972, Cray has developed, built and supported supercomputing technologies for over 40 years.

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Challenge: Getting Sufficient I/O Performance on Cluster Architectures
MSC Nastran™ is a widely used structural analysis application requiring a high-capability I/O system for good throughput performance. Producing sufficient I/O performance is a challenge because clusters are often configured to maximize compute scalability, and have weak I/O capability per node as a result.

Solution: DataWarp Applications I/O Accelerator
To address this challenge Cray introduced the DataWarp™ feature for the Cray® XC™ supercomputer. The DataWarp applications I/O accelerator leverages features of the Cray Linux® environment, solid-state disk (SSD) storage and the Cray high-speed network to enable high-performance I/O at every node in the system without the need for SSDs on every node. Unlike computational fluid dynamics and explicit structural applications, most implicit structural simulations do not scale to hundreds of cores, and I/O performance is critical.
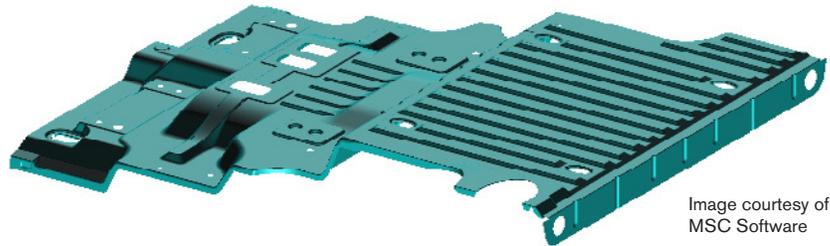

Image courtesy of MSC Software

Proof: Improved I/O Performance for NVH
To test the DataWarp capability, a team from MSC Software and Cray conducted a large MSC Nastran noise, vibration and harshness (NVH) simulation of an automotive floor pan on a Cray XC supercomputer. They ran the simulation twice, first using only the spinning disk in a high-performance Lustre® file system for I/O and then using the DataWarp feature on the XC system. The use of DataWarp significantly reduced I/O time, finishing the simulation in half the elapsed time.

With over 19 million degrees of freedom, the MSC Nastran NVH simulation is typical of the size of models now common in the automotive industry. The Lanczos algorithm was used to extract the first 10 modes. While a relatively small number of modes for this size model, when using Lustre alone the I/O requirements still account for over half the execution time. For this example the simulation's elapsed time went from 17,000 seconds with Lustre alone to 8,500 seconds with DataWarp technology.

Analysis of the simulation showed that the files being read forward and backward multiple times in the Lanczos eigenvalue algorithm dominated the I/O time. While Lustre is optimized for performance while streaming data sequentially forward through the file, the backward read pushes the load into more of a transactional form. The DataWarp accelerator's solid-state storage and specialized file system work well in this domain and allow the backward reads to go dramatically faster.

Find a full report on this simulation on the Cray blog.

Visit www.cray.com for more information about Cray DataWarp technology.