Microsoft Windows Compute Cluster Server 2003
Customer Solution Brief

Accelerating Crash Test Simulation—Microsoft Compute Cluster Server 2003

Microsoft® Windows® Compute Cluster Server 2003 Runs PAM-CRASH™ 2G Simulation Software

Overview

Region: Global
Industry: Manufacturing: Automotive and Industrial Equipment

Customer Profiles

ESI Group is a leading world-wide provider of digital simulation software for professionals in the field of applied mechanics and the developer of PAM-CRASH 2G simulation software. PAM-CRASH 2G offers a fully integrated solution for crash test simulations for the transportation industry.

Business Situation

Simulation is widely used in the development of automotive products. Rigorous safety regulations mandate an increase in the number of physical crashworthiness tests that must be performed on new product innovations. High-performance computing is critical to increase the detail and accuracy of simulations and to decrease development lead times. Customers require affordable HPC solutions that are easy to deploy and manage, decrease turnaround time for simulations, and leverage their existing Windows infrastructure and resources.

Solution

ESI Group ported its PAM-CRASH™ 2G software to Microsoft® Windows® Compute Cluster Server 2003.

Benefits

- Higher speed computing at lower cost
- More detailed and accurate simulations
- Simpler cluster setup and maintenance
- End-to-end security and integration with existing Windows infrastructure
- Reduced time-to-market

The release of PAM-CRASH 2G enables our customers to benefit from the increased headroom provided by Microsoft Windows Compute Cluster Server 2003 and allows them to work interactively with very large models.

Peter Ullrich, PAM-CRASH 2G Product Manager, ESI Group.

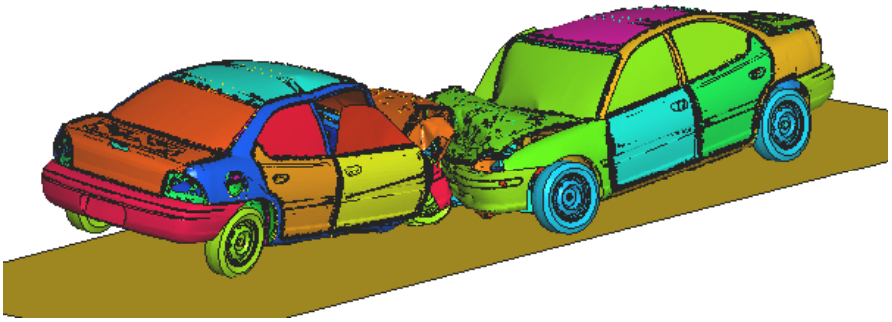
Physics-based simulation is one of the most demanding of all computing tasks. Crash simulation software is widely used by the automotive industry and must be able to handle large deformations, sophisticated material models, complex contact conditions among multiple components, and short-duration impact dynamics. New safety regulations governing crashworthiness—the structural integrity of a vehicle during impact—mandate a significant increase in the number of physical tests that must be performed on new product innovations. While simulation software has greatly reduced the costs associated with physical testing, computation speed has now become critical for shortening product development lead-times. In order to meet this need, ESI Group ported its PAM-CRASH™ 2G simulation software to Microsoft® Windows® Compute Cluster Server (CCS) 2003, 64-bit, high-performance computing (HPC) platform. This solution will enable ESI Group's customers to dramatically shorten their product development time and deliver cars to market faster than before.

Carmakers require CAE, high- performance computing (HPC) solutions that enable them to run the large number of virtual crashes that every project requires while shortening the vehicle development cycle. Carmakers have to leverage the best price and performance servers in a compute-intensive environment.

Situation

Computation speed has become a key area for shortening product development lead-times in the highly competitive automotive industry. Computer Aided Engineering (CAE) software enables automotive companies to evaluate their vehicle design early in the design process, analyze their designs to understand the interactions between component parts, and simulate realistic product performance to reduce the need for physical prototypes. This approach is cost efficient and accelerates time to innovation.

Automotive crashworthiness refers to a car's behavior in a collision and the effects of the collision upon the car's occupants. Crash simulation software must be able to handle large deformations, sophisticated material models, complex contact conditions among multiple components, and short-duration impact dynamics.



Frontal offset car to car crash simulation.

Image courtesy of ESI-Group

For a simulation to be as reliable as physical testing, it must be detailed and accurate in its modeling. An increase in detail can have a corresponding increase on the turnaround time for computations. Complex simulations require extremely high computer memory capacity, ranging from a few gigabytes to hundred of gigabytes of RAM. A large simulation on a single CPU could take days or even weeks to complete. For customers to solve complex computations without increasing their time to market, or exceeding budget expectations, they need high-performance computing (HPC) applications that are reliable, simple to deploy, operate, and integrate with existing infrastructure, IT resources and tools.

ESI Group's crashworthiness simulation software, PAM-CRASH 2G is an essential element of the crash and safety value chain in the automotive industry. PAM-CRASH 2G provides a collaborative environment for virtual prototype development. It offers a fully integrated solution for crash test simulation and the design of occupant safety systems.

ESI Group's automotive customers require CAE simulation solutions that enable them to run the large number of virtual crashes that every project requires while shortening the vehicle development cycle. Carmakers have to leverage the best price and performance servers in a compute-intensive environment.

"We understand the availability of 64-bit applications from software vendors such as ESI Group is critical in helping our mainstream customers to easily deploy, manage and use Windows Compute Cluster Server 2003," says Kyril Faenov, General Manager, High Performance Computing, Microsoft Corporation.

This combination [PAM-CRASH 2G and Windows CCS] delivers a cost effective industrial solution which takes advantage of the Distributed Memory Processing version of PAM-CRASH on high performance clusters of industry standard 64-bit hardware, and helps to converge towards a uniform Windows based simulation environment.

Vincent Chaillou, President and Chief Operating Officer, Product Operations, ESI Group

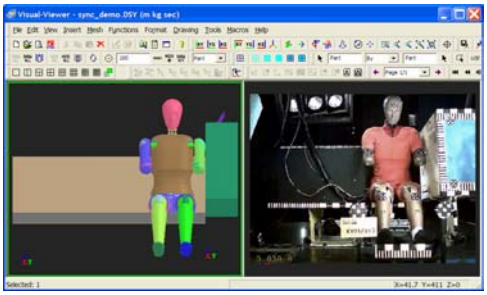
Solution

Microsoft Windows Compute Cluster Server 2003 is a high-performance computing platform for processing large-scale, complex computing problems. Windows CCS runs on commodity x64-based computers, and provides an inexpensive and highly scalable platform for HPC. Windows CCS is based on Windows Server 2003 Standard x64 Edition.

In response to market requirements, ESI Group ported its PAM-CRASH 2G to Microsoft Windows Compute Cluster 2003. "ESI Group's PAM CRASH Solver leverages key Windows CCS technologies, such as MS MPI and the CCS Job Scheduler, which in turn simplifies integration for our customers," says Kyril Faenov, General Manager, High Performance Computing, Microsoft Corporation.

The combination of PAM-CRASH 2G and Windows CCS accelerates calculation speed and provides a powerful and cost-effective parallel processing solution for running crash analysis simulation. Windows CCS allows customers to benefit from the performance of the Distributed Memory Processing version of PAM-CRASH 2G on clusters of industry standard 64-bit hardware.

PAM-CRASH 2G and Windows CCS enables engineers to handle very large models—more than 4.5 millions finite elements—that require more than 3 to 4 Gigabits of memory. "This combination delivers a cost effective industrial solution which takes advantage of the Distributed Memory Processing version of PAM-CRASH on high performance clusters of industry-standard 64-bit hardware, and helps to converge towards a uniform Windows-based simulation environment," says Vincent Chaillou, President and Chief Operating Officer, Product Operations, ESI Group.



Synchronization of simulation and video reading with Visual-Viewer. Image courtesy of ESI Group.

Performance

The performance of PAM-CRASH 2G on Windows CCS is excellent. PAM-CRASH 2G scales extremely well, and speed-up is nearly linear with the number of processors on a correctly sized cluster.

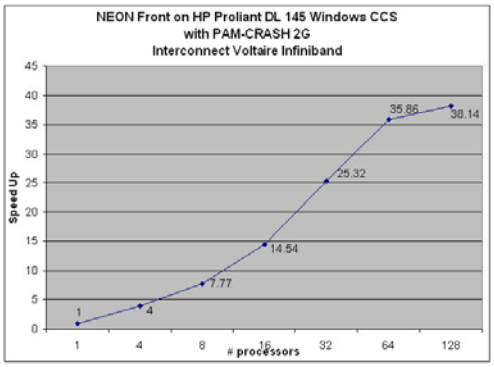


Figure 1- Performance of PAM-CRASH 2G running Windows CCS. As CPUs are added to the cluster, the simulation speed increases linearly. Results courtesy of ESI Group.

ESI Group's PAM CRASH Solver leverages key Windows Compute Cluster Server 2003 technologies, such as Microsoft MPI and Job Scheduler, which in turn simplifies integration for our customers.

Kyril Faenov, General Manager, High Performance Computing, Microsoft Corporation

Windows CCS Architecture

A Windows Compute Cluster Server cluster of servers includes a single head node and one or more compute nodes, see Figure 2. The head node controls and mediates all access to the cluster resources and is the single point of management, deployment, and job scheduling for the compute cluster. Windows CCS leverages the functionality of several components to provide authentication and authorization mechanisms, simple and familiar interfaces for managing and administering the cluster, and tools for cluster setup, deployment, job management, CPU efficiency and more.

Microsoft Active Directory

Windows CCS uses the existing corporate infrastructure and Microsoft Active Directory® to provide authorization and authentication services. Each node of the cluster must be a member of an Active Directory domain. The Active Directory domain can be independent of the cluster, or run within the cluster.

Head node

The head node provides deployment and administration user interfaces (UIs) as well as management services for the compute cluster. The UIs provided by the head node include the Compute Cluster Administrator, the Compute Cluster Manager, and the Command Line Interface (CLI). The management services provided by the head node include job scheduling as well as job and resource management.

Compute node

Any computer configured to provide computational resources as part of the compute cluster is a compute node. Compute nodes allow users to run computational jobs. These nodes must run a supported operating system, but they do not require the same operating system or even the same hardware configuration. Optimally, compute nodes include a similar configuration to simplify deployment, administration, and resource management.

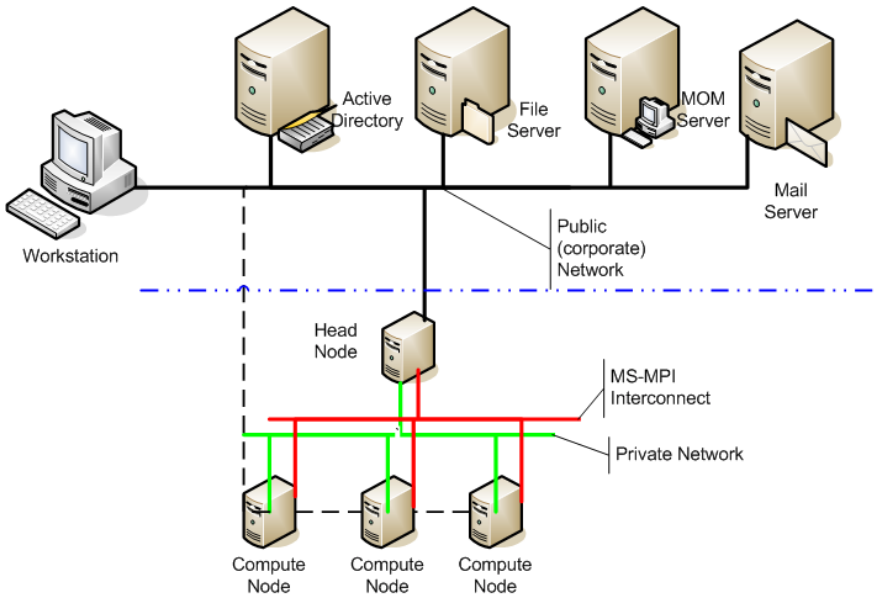


Figure 2: Typical Windows Compute Cluster Server 2003 network

Compute Cluster Job Scheduler

The Compute Cluster Job Scheduler runs on the head node and manages the job queue, all resource allocations, and all job executions by communicating with the Node Manager Service that runs on each compute node. Job scheduling ensures that the operating system allocates the necessary resources to the simulations, tracks the processors associated with the job, partitions the large scaled-out system to the size required by the simulation job, and deallocates the resources after producing the result. With this setup in place, customers can manage and monitor the progress of their simulations on the cluster effectively.

Microsoft ® Message Passing Interface (MPI)

Microsoft MPI (MS MPI) is a key networking component of the compute cluster. Effectively, MS MPI is the communication software layer between CPUs on the cluster. Windows CCS provides end-to-end security over secure and encrypted channels throughout the job process when using MS MPI. As the node manager schedules and assigns the job, the job always runs in the context of the scheduling users.

MS MPI can utilize any Ethernet connection that Microsoft Windows Server™ 2003 supports as well as low-latency and high-bandwidth connections, such as InfiniBand or Myrinet, through Winsock Direct drivers provided by the hardware manufacturers. Gigabit Ethernet provides a high-speed and cost-effective connection fabric, while InfiniBand is ideal for latency sensitive and high-bandwidth applications.

Windows CCS System Requirements

CPU Requirement: 64-bit architecture computer Intel Pentium, or Xeon family with Intel Extended Memory 64 Technology (EM64T) processor architecture, or AMD Opteron family, AMD Athlon family, or compatible processor(s).
Minimum RAM: 512 MB
Maximum RAM: 32 GB
Multiprocessor Support: Up to 4 processors
Disk Space for Setup: 4 GB
Disk Volumes: Head node requires a minimum of two volumes (C:\ and D :\). For additional roles, additional partitions are recommended. Compute node requires a single volume. RAID 0/1/5 may be used, but is not required.
Network Interface Cards: All nodes require at least one. Each node may require additional network interface cards as appropriate for the network topology, for public network access or in support of an MPI network.

For More Information

For more information about Microsoft products and services, call the Microsoft Sales Information Center at (800) 426-9400. In Canada, call the Microsoft Canada Information Centre at (877) 568-2495. Customers who are deaf or hard-of-hearing can reach Microsoft text telephone (TTY/TDD) services at (800) 892-5234 in the United States or (905) 568-9641 in Canada. Outside the 50 United States and Canada, please contact your local Microsoft subsidiary. To access information using the World Wide Web, go to: www.microsoft.com.

For more information about Windows Compute Cluster Server 2003, please visit: http://www.microsoft.com/hpc

For more information about ESI Group and PAM-CRASH 2G, please visit http://www.esi-group.com

For information about purchasing PAM-CRASH 2G, please email crash2G@esi-group.com

For information about purchasing Microsoft Windows Compute Cluster Server 2003, please email hpcinfo@microsoft.com

To join the HPC Community, please visit http://www.windowsphc.net

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Benefits

By porting PAM-CRASH 2G software to the Microsoft Windows Compute Cluster Server 2003 operating system, ESI Group is providing its customers with increased computing power on industry standard processors. The increased computing powers allows its customers to quickly resolve more complicated physical simulations, easily set up and maintain compute clusters, improve productivity, reduce costs, reduce administration and technical support time, and most importantly—shorten development time. These benefits yield more innovative and safer cars delivered to market faster than before.

Increased Computing Power Speeds Up Computations

PAM-CRASH 2G software running on Windows Compute Cluster Server 2003 operating system enables ESI Group's customers to increase the computing power available to them while remaining within the Windows environment. With 64-bit cluster technology on industry standard processors and Windows CCS, customers will obtain more realistic simulation capabilities on Windows and receive a performance boost and achieve faster computations. The wider data pipe of 64-bit architecture enables faster data flow between the CPU and memory.

More Capable Visualization Reduces Time and Expense

With the increased computing power of Windows Compute Cluster Server 2003, ESI Group's customers can run more detailed simulations and analyze more design options than before. With more detailed simulations, engineers can reduce design time and expense by reducing the amount of physical testing of prototypes. By analyzing more design options in the given time, engineers can identify how to improve and optimize their products. In the competitive automotive industry, increased computing power translates into better, safer, lower priced products, that are designed faster and at lower cost than before.

Simple Cluster Setup and Maintenance Increases Productivity

With Windows Compute Cluster Server 2003, Microsoft is delivering a highly tuned operating system for clustering. The tight integration between the Windows Compute Cluster Server 2003 operating system, the Job Scheduler, and the Message Passing Interface results in an off-the-shelf process for customers setting up clusters. Because Windows CCS works with the Active Directory service, any Windows administrator can set up a cluster as easily as adding any other network resource. With Microsoft, customers will have a single source for a certified, stable operating system.

The Combination

Together, Windows CCS and ESI Group have succeeded in delivering a cost-effective solution that is highly scaleable, easily integrated with existing infrastructure, provides for more complex visualization and overnight calculations, and most critically—reduce costs and time to innovation.

Microsoft