

Image courtesy of ANSYS, Inc.

Microsoft Windows Compute Cluster Server 2003 Partner Solution Brief



Increasing the Value of Simulation While Shrinking the Costs

Microsoft® Windows® Compute Cluster Server 2003 Runs ANSYS® Mechanical™ and ANSYS Mechanical™ HPC

Overview

Region: Global

Industry: Manufacturing

Customer Profile

ANSYS, Inc., is a global innovator of engineering simulation software and technologies used by engineering organizations to predict how product designs will behave in manufacturing and real-world environments.

Business Situation

While simulation can greatly reduce the costs associated with physical testing, high-performance computing (HPC) is critical for shortening product development lead-times. Until recently, HPC solutions have been prohibitively expensive and difficult to realize for many small to mid-size organizations. Engineering organizations require HPC solutions that leverage their existing Windows®-based infrastructure and expertise, deliver the processing speed that detailed simulations demand, and provide a secure and scalable parallel cluster solution using cost-effective hardware.

Solution

ANSYS Mechanical and ANSYS Mechanical HPC running on the Microsoft® Windows® Compute Cluster Server 2003 operating system yields excellent parallel scaling.

Benefits

- Higher speed computing at lower costs
- More detailed and accurate simulations
- Reduced time to market
- Familiar Windows environment for HPC
- Seamless scalable parallel processing
- Better, safer, lower priced products

An easily deployed cluster solution that integrates with our customer's current Windows-based environment and skill-set allows them to increase the value they derive from simulation.

Ferit Boysan, Vice President and General Manager, ANSYS, Inc.

As market competition increases for industrial designers and manufacturers, product development lead-times are compressed. To maintain competitiveness, designers must decrease design costs, and reconcile drastic reductions in time-to-market with market demand to rapidly release highly innovative products that meet stringent regulatory standards. Finite-element analysis (FEA) is an integral part of the computer-aided engineering (CAE) environment. Engineering organizations worldwide rely on ANSYS® Mechanical™ structural simulation software to predict and improve the performance of new designs or processes, to reduce time to market, and to reduce overall engineering costs. For a simulation to yield reliable results and shorten product development lead times, detailed modeling capacity must be combined with high-performance computing (HPC). Until recently, HPC solutions have been expensive and difficult to deploy, manage and administer. ANSYS solutions running on Windows Compute Cluster Server 2003 exploit existing Windows infrastructure and resources, and deliver the processing speed necessary to run complex simulations on clusters of affordable, industry-standard 64-bit hardware.



We believe cost and complexity shouldn't be barriers to innovation and discovery. We are pleased to be working with ANSYS, Inc., to offer HPC solutions that are easier to deploy, operate and integrate with existing Windows infrastructure and tools.

Kyril Faenov, General Manager, High-performance Computing, Microsoft Corporation.

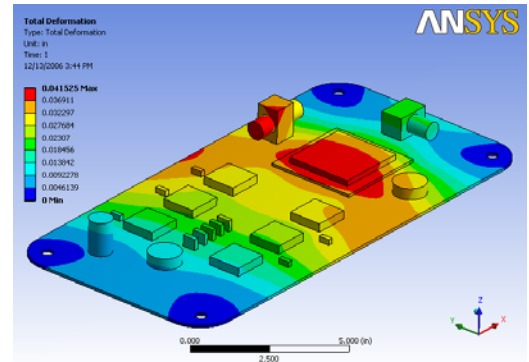
Situation

For engineering organizations to maintain competitiveness, designers and engineers must decrease design costs, reduce time-to-market and deliver highly innovative products that meet stringent regulatory standards. Across a wide spectrum of industries—including aerospace, automotive, consumer products, medical, and power generation—engineers use computer-aided engineering (CAE) simulation to lead their product development. By studying product configurations in the early phases of development, engineers can make changes and refine designs easily and inexpensively. This approach enables designers to deliver superior products, improve time to market, and lower product development costs.

However, for a simulation to be as reliable as physical testing, it must be sufficiently detailed and accurate. An increase in detail creates a corresponding increase in the turnaround time for computations and in the computer memory requirements. High-performance computing (HPC) is critical for shortening product development lead-times by enabling engineers to improve simulation speed and accuracy.

Finite-element analysis (FEA) simulation is used to predict the integrity of a structure, for example the structure of aircraft landing gear. FEA simulation is used to conduct rigorous analyses on every component of the structure to determine how the structure will react to every conceivable loading once deployed.

Engineering organizations worldwide rely on ANSYS simulation software for FEA analyses. The ANSYS Mechanical family of products offers full depth of analysis, from concept simulation to advanced analysis, and a breadth of simulation capabilities from linear to nonlinear coupled physics analysis.



Deflection results of a Thermal Stress analysis of a PCB. Image courtesy of ANSYS, Inc.

On a single CPU a typical FEA simulation might run for several hours or even days, and this turnaround time can be reduced almost linearly by running on additional processors. Parallel processing dramatically reduces turnaround time by splitting analysis workload over multiple CPUs. Cluster computing reduces turnaround time, and enables bigger, more detailed and accurate simulations.

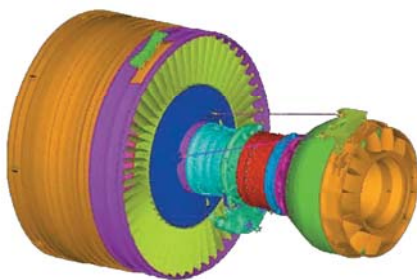
Until recently, HPC solutions have been prohibitively expensive and technically problematic to realize for many small to mid-size organizations. "Many customers," says Ferit Boysan, Vice President and General Manager, ANSYS, Inc., "are already using Microsoft Windows, and an easily deployed cluster solution that integrates with their current environment and skill-set allows them to increase the value they derive from simulation."

Consequently, engineering organizations require HPC solutions that leverage their existing Windows®-based infrastructure and expertise, deliver the processing speed that detailed simulations demand, and provide a secure and scalable parallel cluster solution using cost-effective hardware.

The combination of support for clustering and 64-bit memory addressing has made Windows a very viable option for our customers who need high-performance computing.

We see great scaling on clusters using Windows Compute Cluster Server 2003, so customers can dramatically reduce the time spent waiting for engineering insight

Ferit Boysan, Vice President and General Manager, ANSYS Inc.



Using Windows Compute Cluster Server 2003, ANSYS, Inc. recently solved a 100 million-degree-of-freedom (DOF) structural analysis problem. The 100 million DOF problem mimics the size of problem typically encountered when solving an entire jet engine to validate its commercial robustness.

Solution

Microsoft Windows Compute Cluster Server 2003 is a high-performance computing platform for processing large-scale, complex computing problems. Windows CCS runs on industry-standard 64-bit computers, and provides an inexpensive and highly scalable platform for HPC. Windows CCS is based on Windows Server 2003 Standard x64 Edition.

ANSYS Mechanical contains the most comprehensive set of solvers available, including parallel solvers when combined with ANSYS Mechanical HPC. ANSYS® Workbench™ is an integrated environment, user interface (UI), that designers can use to access CAD, meshing tools, model parameters, and ANSYS Mechanical.

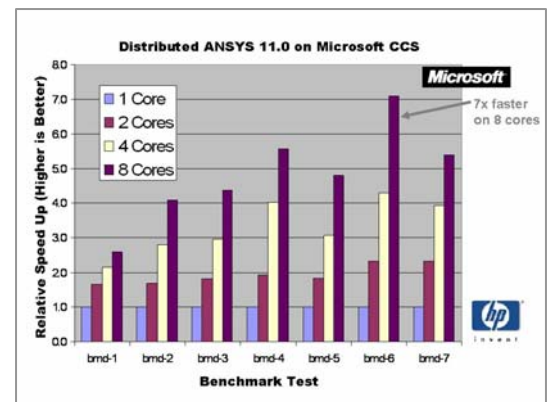
ANSYS Mechanical combined with ANSYS Mechanical HPC and Windows Compute Cluster Server 2003 enable engineers to perform highly realistic structural simulations quickly and easily with minimal administrative overhead, and the added security and manageability benefits that integration with Microsoft Active Directory® directory services brings.

“Before 64-bit-enabled Windows Compute Cluster Server 2003,” says Mike Wheeler, Vice President and General Manager, ANSYS, Inc., “our customers would need a shared memory machine or Linux cluster to solve 100-million DOF models and beyond. It’s very exciting to deliver this type of performance

with Microsoft Job Scheduler integrated with ANSYS Workbench to our customers.”

Performance

When using ANSYS Mechanical and ANSYS Mechanical HPC licenses with the distributed version of ANSYS, customers achieve excellent performance on Windows CCS, see the Distributed ANSYS benchmark test results below.



Performance results courtesy of Hewlett-Packard.

The Distributed ANSYS executable, which uses ANSYS Mechanical HPC licenses, was designed to operate on clusters and to work with a higher number of cores than Shared Memory ANSYS, which is typically in use by customers today. The Distributed ANSYS support of Windows CCS extends this performance to the Windows platform.

“The combination of support for clustering and 64-bit memory addressing has made Windows a very viable option for our customers who need high-performance computing,” says Boysan. “We see great scaling on clusters using Windows Compute Cluster Server 2003, so customers can dramatically reduce the time spent waiting for engineering insight.”

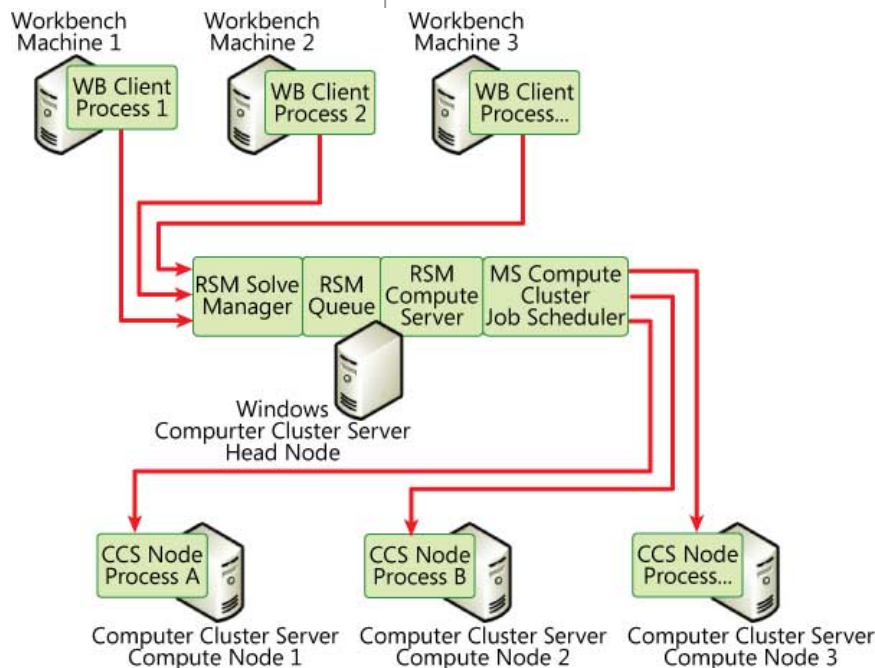
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Mike Wheeler, Vice President and General Manager, ANSYS, Inc

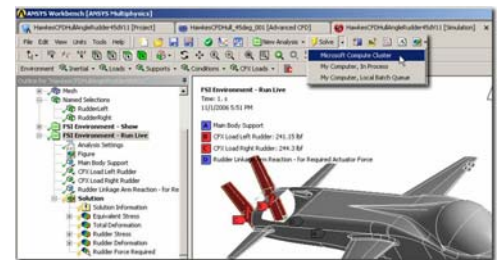
Solution Architecture

ANSYS Workbench is integrated with the Microsoft Compute Cluster. The diagram below represents a typical ANSYS Workbench and Windows CCS architecture—the architecture can vary from a single machine running all of the components to a distributed architecture. The architecture below depicts three tiers: ANSYS Workbench Client tier, Windows CCS Head Node and Remote Solve Manager (RSM) tier, and Windows CCS Processing Nodes tier.

In the architecture below, ANSYS Workbench clients submit remote solve requests to the Remote Solve Manager (RSM). The RSM places the request in the RSM queue. The RSM Compute Server checks the queue and feeds the solve request to the Microsoft Compute Cluster Job Scheduler. The Job Scheduler allocates the necessary resources to the solve request, tracks the processors (compute nodes) associated with the request, and deallocates the resources after producing the result.



The solved request flows back through the architecture by using the same process. The Microsoft Message Passing Interface (MS MPI) is used as the communication software layer between compute nodes on the cluster.



Example of ANSYS Workbench running Windows Compute Cluster Server

Windows CCS Architecture

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.

A Windows CCS cluster of servers includes a single head node and one or more compute nodes. 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. The Microsoft Compute Cluster Server Job Scheduler resides on the Head Node server.

Microsoft Message Passing Interface (MS MPI)

The Microsoft Message Passing Interface (MS MPI) is used as the communication software layer between compute nodes 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 runs over Gigabit Ethernet, InfiniBand, or any

Windows CCS System Requirements

<p>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).</p>
<p>Minimum RAM: 512 MB</p>
<p>Maximum RAM: 32 GB</p>
<p>Multiprocessor Support: Up to 4 processors per node.</p>
<p>Disk Space for Setup: 4 GB</p>
<p>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.</p>
<p>Network Interface Cards: All nodes require at least one network interface card. 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.</p>

network that provides a WinSock Direct-enabled driver. MS MPI is based on and compatible with the Argonne National Labs MPICH2 implementation of MPI2.

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.

ANSYS Mechanical System Requirements

Typical cluster sizes for ANSYS Mechanical vary widely, from 4-16 cores or more. The ideal number of CPUs (or cores) in the cluster depends on the size of the analysis model (measured in terms of number of degrees of freedom) and on the number of simultaneous analysis jobs to be run on the cluster. The recommended memory requirement for ANSYS Mechanical is 4 to 8 GB per core. The total memory requirement for one ANSYS Mechanical simulation on the cluster will scale nearly linearly with the model size. The following specifications are guidelines only and are NOT hard requirements or limits.

Cluster Size (number of CPUs or cores)	Structural Model Size (number of DOF)	RAM
4	Up to 16M	16-32 GB
8	16M up to 100M	32-64 GB
16	32M up to 200M	64-128 GB
32	64M up to 400M	128 GB and up

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>

To join the HPC Community, please visit <http://www.windowshpc.net>

For more information about ANSYS, Inc., and its simulation software and technologies please visit <http://www.ansys.com>

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

Benefits

Microsoft Windows Compute Cluster Server 2003 combined with ANSYS Mechanical and ANSYS Mechanical HPC simulation software provides a powerful, scalable, parallel processing solution that is easy to deploy and use, and provides the processing speed necessary to run complex simulations on clusters of affordable, industry-standard 64-bit hardware. Moreover, running ANSYS Mechanical and ANSYS Mechanical HPC on Windows CCS allows customers to exploit their existing Windows infrastructure, tools and expertise. This combination translates into better, safer, lower-priced products that are designed faster and at lower cost than before.

Increase Computing Power While Reducing Costs

By running ANSYS Mechanical on Windows CCS, ANSYS, Inc. enables its 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 that achieves faster solutions. The ability to leverage existing Windows infrastructure and IT resources yields substantial time and cost savings for Windows CCS customers.

More Detailed and Accurate Simulations Reduce Design Time and Costs

With the increased computing power of Windows Compute Cluster Server 2003, ANSYS, Inc.'s customers will be able to 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. More detailed simulations and increased computing power translates into better, safer,

lower-priced products that are designed faster and at lower cost than before.

Simple Cluster Setup and Management Increases Productivity

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.

Secure, Scalable Parallel Clustering

ANSYS Mechanical and ANSYS Mechanical HPC running Windows CCS yields excellent parallel scaling. Windows CCS provides the additional benefit of enhancing security. By leveraging the existing Windows infrastructure, Windows CCS can integrate with Active Directory for user authorization and authentication services.

Windows Compute Cluster Server 2003 represents a breakthrough in bringing high-performance computing into the mainstream of computer-aided engineering.

Dr. Ferit Boysan, Vice President and General Manager, ANSYS, Inc.