



PTC[®] Windchill[®] 10 on VMware[®] vSphere 5.0 using HP Hardware

Dec 2012

DEPLOYMENT AND TECHNICAL CONSIDERATIONS GUIDE



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Executive Summary

The purpose of this assessment was to determine if there were any performance or scalability concerns in using PTC Windchill application in a virtualized environment.

Highlights of the assessment include:

- No functional issues or errors encountered
- 'Vertical' scaling tests always had one Windchill server, but the CPU and Memory available to the server would increase. Windchill server sizes were either 8 vCPU and 32 GB RAM, or 16 vCPU and 64 GB RAM.
- 'Horizontal' scaling involved a Windchill cluster. The application servers always used a total of 16 vCPU and 64 GB RAM, but it was divided to be either two 8 vCPU servers or four 4 vCPU servers,
- Advanced features such as VMotion was tested and worked as advertised
- The overall results indicate that PTC Windchill performs well under load and scales well on the VMware virtualized infrastructure. The flexibility of VMware's infrastructure greatly enhances the service levels and manageability of Windchill.

Introduction

This document provides direction to those interested in running PTC Windchill 10 on VMware vSphere 5.0. It provides basic guidance on the architecture of PTC Windchill 10, as well as the value of utilizing the VMware platform. The results of recent testing done jointly by VMware and PTC are covered, where the performance and functionality of PTC Windchill 10 on VMware virtual infrastructure are characterized. Finally, the document outlines some best practices for utilizing the two product sets together in your datacenter.

VMware and PTC

About VMware (<http://www.vmware.com>)

VMware (NYSE: VMW), the global leader in virtualization and cloud infrastructure, delivers customer-proven solutions that significantly reduce IT complexity and enable more flexible, agile service delivery. VMware accelerates an organization's transition to cloud computing, while preserving existing IT investments and enabling more efficient, agile service delivery without compromising control. With more than 3,50,000 customers and 50,000 partners, VMware helps organizations of all sizes lower costs, preserve freedom of choice and energize business through IT while saving energy—financial, human and the Earth's.

About PTC (<http://www.ptc.com>)

PTC (Nasdaq: PMTC) enables manufacturers to achieve sustained product and service advantage. The company's technology solutions help customers transform the way they create and service products across the entire product lifecycle - from conception and design to sourcing and service. Founded in 1985, PTC employs over 6,000 professionals serving more than 27,000 businesses in rapidly-evolving, globally distributed manufacturing industries worldwide. Get more information at www.ptc.com.

PTC Windchill 10 Solution Overview

Windchill 10 offers powerful capabilities for configuring, managing, validating, and controlling product structures and service information. Windchill 10 manages the complete product lifecycle - from initial project planning to critical aftermarket business.

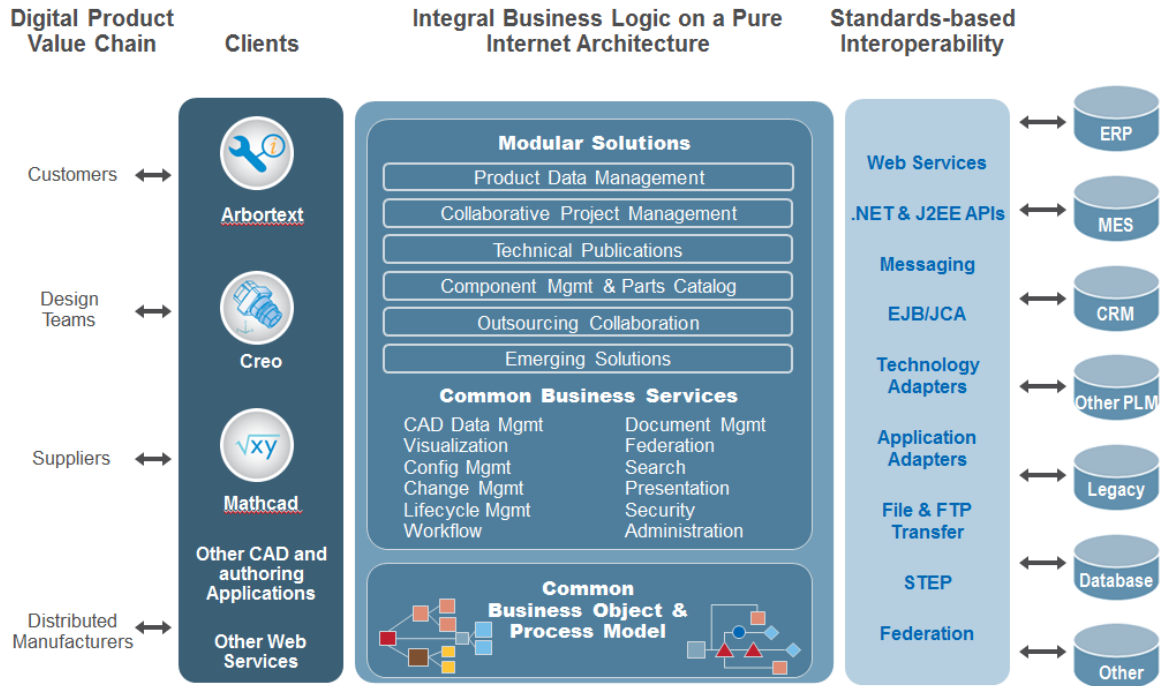


Figure 1. PTC Windchill overview

VMware vSphere Virtual Infrastructure

VMware's leading virtualization solutions provide multiple benefits to IT administrators and users. VMware virtualization creates a layer of abstraction between the resources required by an application and operating system, and the underlying hardware that provides those resources. A summary of the value of this abstraction layer includes the following:

- **Consolidation:** VMware technology allows multiple application servers to be consolidated onto one physical server, with little or no decrease in overall performance.
- **Ease of Provisioning:** VMware virtualization encapsulates an application into an image that can be duplicated or moved, greatly reducing the cost of application provisioning and deployment.
- **Manageability:** Virtual machines may be moved from server to server with no downtime using VMware® VMotion™, which simplifies common operations like hardware maintenance and reduces planned downtime.
- **Availability:** Unplanned downtime can be reduced and higher service levels can be provided to an application. VMware® High Availability (HA) ensures that in the case of an unplanned hardware failure, any affected virtual machines are restarted on another host in a VMware cluster.

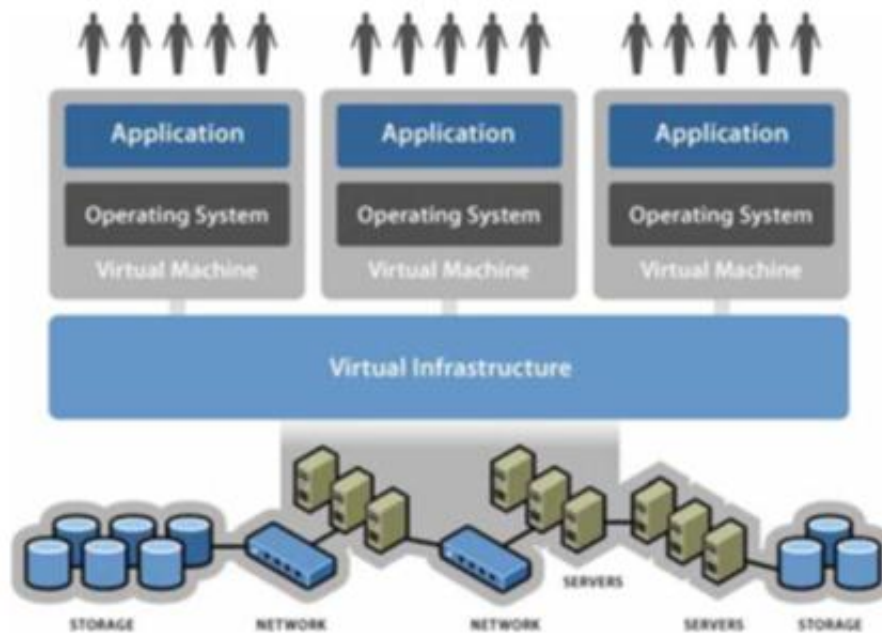


Figure 2. VMware vSphere Virtual Infrastructure

PTC Windchill 10 Architecture and Deployment Strategy

PTC Windchill has a multi-tier architecture that can be deployed in a configuration small enough to run on a single server (for small workgroup teams), as well as in a configuration as large and complex as a highly redundant clustered system serving thousands of end users on a global scale.

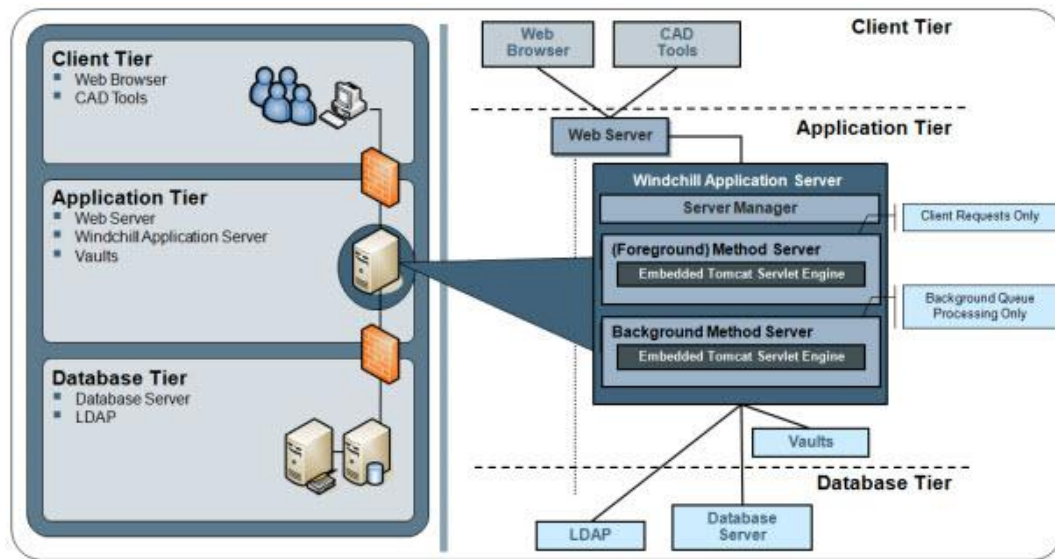


Figure 3 : PTC architecture Diagram.

The architecture is commonly represented as three tiers:

Client Tier – Contains the products that people use to access PTC Windchill.

Application Tier – Contains the web server and application servers. The application servers contain the business logic, provide the interfaces to integrations to other systems (such as ERP), and are responsible for content storage. The application tier is typically placed in a protected zone for applications (often within a corporate data center) and, in highly secured deployments, the web server is often placed within a demilitarized zone (DMZ).

Database Tier –The database or data tier is typically where the metadata is stored in a Relational Database Management System (RDBMS) such as Oracle or SQL Server.

The PTC Windchill multi-tier architecture offers the flexibility and options deployed with an infrastructure that can support the most demanding distributed, collaborative, and product-development processes. This architecture can support users from various departments within the company, as well as users from supplier, manufacturing partner, and customer communities.

The core components of the Windchill runtime architecture are the following:

- Web Server
- Windchill Application Server
- Database Server
- LDAP Directory

A detailed discussion of the PTC Windchill Architecture can be found here (subscription required): http://www.ptc.com/view?im_dbkey=123332

Hardware and Software Configuration

The following diagram shows the details of the hardware and software used in the testing.

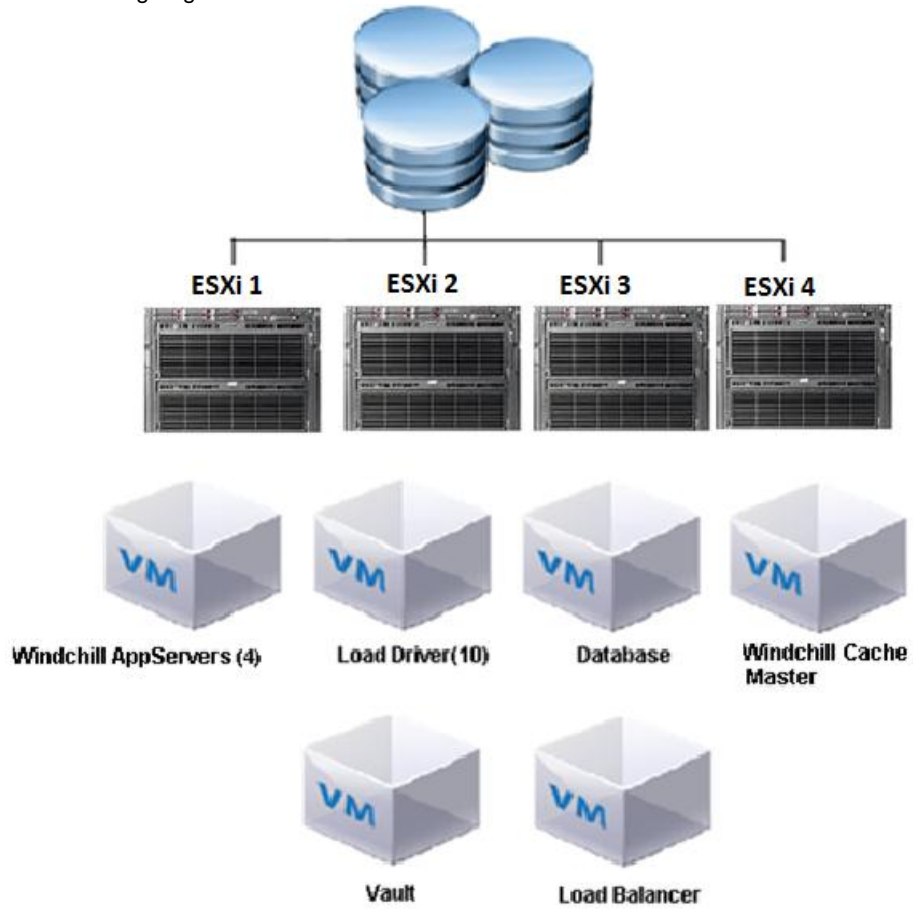


Figure 4: Hardware Configuration Diagram

The following table describes the configuration of ESXi host servers and storage in the PTC Windchill test configurations.

HARDWARE	CONFIGURATION
HP ProLiant DL980 G7	Server is equipped with: <ul style="list-style-type: none"> • Intel(R) Xeon(R) X7560 @2.27 Ghz • Sockets: 8 • Number of Cores per Socket: 8 • Hyperthreading: Enabled • 512 GB RAM • 4 X 1 GbE NIC – NetXen HP NC375i • 2 x 10 GbE NIC – Emulex NC550SFP
HP ProLiant DL380 G7	Three HP ProLiant DL380 G7 with <ul style="list-style-type: none"> • Intel(R) Xeon(R) CPU X5680 @3.33 GHz • Sockets: 2 • Number of Cores per Socket: 6 • 98 GB RAM • 4 X 1 Gb NIC per ESXi – Broadcom Corporation NetXtreme II BCM5709 • 4 X 1 Gb NIC per ESXi – Intel Corporation 82580
Storage	HP P4500 G236 disks/capacitySAS, 15KRPM <ul style="list-style-type: none"> • RAID 5Hardware iSCSI Broadcom Adapter

Table 1: Hardware Configuration

Installed Software

Table 2 lists the software used in the PTC solution.

Installed Software	
VMware	VMware vSphere ESXi 5.0.0 Build 469512
Microsoft	a) Windows 2008 Enterprise R2 64 Bit b) Oracle 11 g R2
PTC	PTC Windchill PDMLink 10.0 F000

Table 2: Software Installed

Virtual Machine Configuration

The following table describes the configuration of virtual machines running on ESXi host servers in the PTC test configurations.

VIRTUAL MACHINE	HARDWARE CONFIGURATION
Two or Four Windchill Application Servers for clustered (or horizontal scale testing).	<ul style="list-style-type: none"> • 8 vCPU 32 GB • 4 vCPU 16 GB • Ethernet card(1 GbpsNetwork) • (1 x 40 GB) storage • vmdk only
1 Database virtual machine	<ul style="list-style-type: none"> • 8 vCPU • 32 GB memory • Ethernet card • (1 X 126 GB), (1 X 12 GB), (1 x 199 GB), (1 x 3 GB), (1 x 5 GB) storage • vmdk only
1 Windchill Server for Standalone (or vertical scale) testing.	<ul style="list-style-type: none"> • 8 vCPU 32 GB • 16 vCPU, 64 GB • 1 Ethernet card • (1 X 40 GB) storage • vmdk only
1 Master Windchill Server for clustered testing	<ul style="list-style-type: none"> • 2 vCPU • 8 GB memory • 1 Ethernet card • (1 X 40 GB) storage • vmdk only
10 Load Driver VM's	<ul style="list-style-type: none"> • 4 vCPU • 8 GB memory • 1 Ethernet card • (1 X 50 GB), storage • vmdk only
1 Load Balancer VM	<ul style="list-style-type: none"> • 2 vCPU • 4 GB memory • 1 Ethernet card • (1 X 40 GB), storage • vmdk only

Table 3: Virtual Machine Configuration

Workload Used

For this test, a multi-user load simulator based on Silk Performer was used to simulate PDMLink users, ProjectLink users, and Creo data management user loads to the Windchill 10 systems. This is the same load engine used by PTC for performance investigations and server hardware sizing.

Simulated PDMLink users create and modify product related business information stored within Windchill products. They may be engineers or office personnel who use a variety of systems to create and modify business objects. The business objects will most often represent documents, parts, and changes. They will typically search the database or scan folders for business objects. They may checkout an object for modification or retrieve it to perform an analysis. Others will create, analyze, and approve change objects. They will often perform enterprise and local searches for business objects they are looking for in products.

Simulated ProjectLink users create and modify business information in Windchill projects. They will typically create projects, deliverables, milestones, documents, review and modify project plans, and review project assignments. They will often perform enterprise and local searches for business objects they are looking for in projects.

The users from this load engine simulate Creo load on the server. These users create, add to workspace and delete workspace using SOAP calls. These users also simulate Creo-related operations using both RMI and SOAP calls. The operations are create new workspace, download assembly, checkout assembly, check in assembly, and undo checkout. These transactions are completed on three different assembly sizes (40, 200, and 500 components).

Test Methodology and Overview

The primary objectives of testing were to determine PTC Windchill application performance characteristics and show that Windchill can scale and be run resiliently on VMware virtual infrastructure. For vertical scaling, a single VM with 16 vcpu's was used and for horizontal scaling, 2 VMs with 8 vcpu's each and 4 VMs with 4 vcpu's each were used.

The virtual machines are created using only .vmdk files and are stored on a vmfs file system, which is a high performance cluster file system that allows virtualization to scale beyond the boundaries and is designed, constructed, and optimized for the virtual server environment.

Vertical scaling tests always had one Windchill server, but the CPU and memory available to the server would increase. Windchill server sizes were either 8 vCPU and 32 GB RAM, or 16 vCPU and 64 GB RAM.

Horizontal scaling involved a Windchill cluster. The application servers always used a total of 16 vCPU and 64 GB RAM, but the cluster was either two 8 vCPU servers or four 4 vCPU servers,

ESXTOP was used to collect the resource metrics and monitor the health of the system while the test was running. ESXTOP allows monitoring and collection of data for all system resources: CPU, memory, disk, and network. When used interactively, this data can be viewed on different types of screens; one each for CPU statistics, memory statistics, network statistics, and disk statistics. In batch mode, data can be redirected to a file for offline uses.

Windchill 10 on VMware vSphere Test Results:

With PTC supporting the use of VMware vSphere, many customers are very interested in deploying their Windchill solution on the VMware platform. Given the mission-critical nature of the application suite, customers need to ensure that the combined solution delivers the required scalability and performance.

The purpose of joint tests was to provide answers to a common set of questions, and to derive and document a set of best practices that can be used by customers.

Specifically, key areas under investigation were:

- Horizontal and vertical scalability of PTC Windchill 10 solution on VMware vSphere platform
- Impact on users during a VMware vMotion event
- Effectiveness of load-balancing scenarios.

The results were very positive. In summary, the following was confirmed:

- Scalability:
 - Application servers scale well vertically and horizontally
 - Excellent scalability from 200 to 1000 concurrent users with increased number of Application Servers as well as increased number of vcpu on a single Application Server
- Load balancing:
 - As expected, load is distributed across virtual machines.
- vMotion
 - vMotion process was smooth without any issues
 - There was no negative response time impact through vMotion

In the following sections, the process and the results are described in detail.

Tests Performed

Loads were generated by the Silk load generators in terms of weighted active users, typically either 400, 600, or 1000 user loads.

These loads were then applied to Windchill systems under different scaling configurations; vertical scaling, and horizontal scaling.

Vertical scaling tests always had one Windchill server, but the CPU and memory available to the server would increase. Windchill server sizes were either 8 vCPU and 32 GB RAM, or 16 vCPU and 64 GB RAM.

Horizontal scaling involved a Windchill cluster. The application servers always used a total of 16 vCPU and 64 GB RAM, but the cluster was divided to be either two 8 vCPU servers or four 4 vCPU servers,

Vertical Performance - Results and Analysis

For review of the vertical testing, we compared results from this testing to the PTC baseline dataset (which was collected from previous Windchill 10 server sizing tests).

Non CAD Users

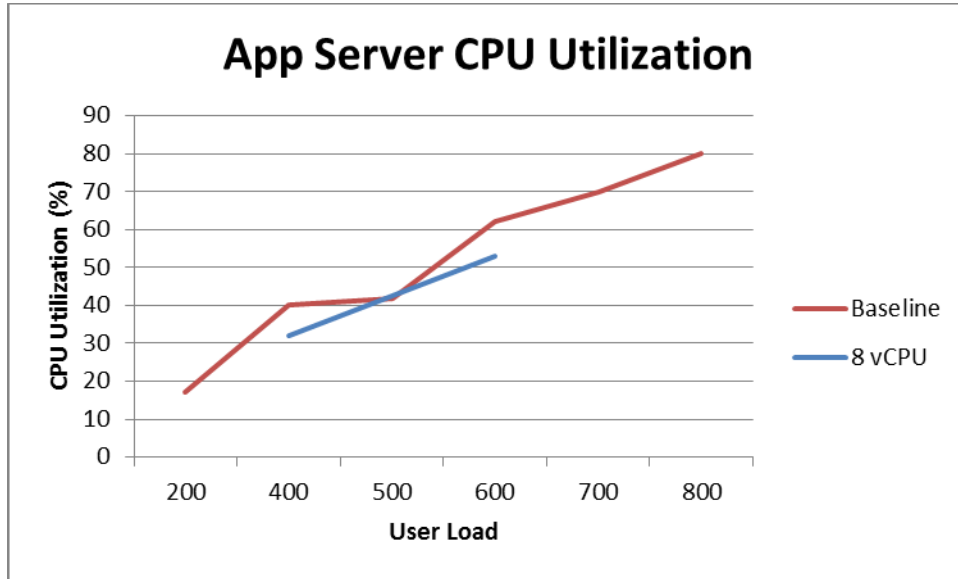


Figure 5: AppServer CPU Utilization

This chart shows that this 8 core testing trended just below established baseline data from PTC. The trend is adjusted to the right, indicating that Windchill operation on vSphere 5 can support more users.

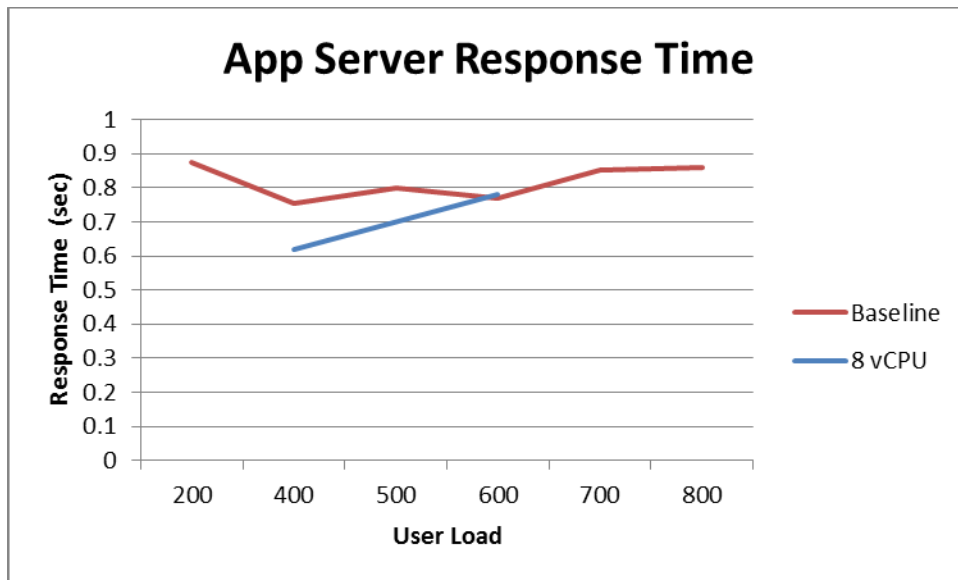


Figure 6: AppServer Response Time

This chart shows that server response times on this system maintained the baseline times that were established at PTC. Actually it suggests that response times were mildly better, although this minor improvement would not be detected by individual users.

CAD Users

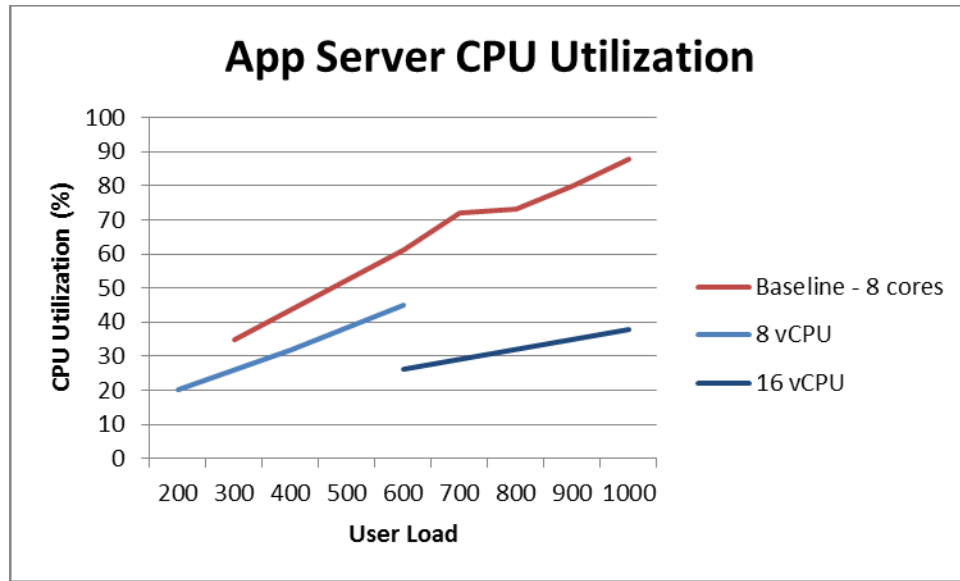


Figure 7: AppServer CPU Utilization

This chart shows both the 8 core and 16 core test performing below the established baseline at PTC.

The baseline 8 core testing can be directly compared to the 8 core testing for this project. It shows that the vSphere platform required slightly less CPU utilization to complete the same task.

And for the higher user loads, where the baseline CPU trend goes beyond 70%, this chart shows the CPU utilization is decreased by 50% (as would be expected when the number of cores is doubled.)

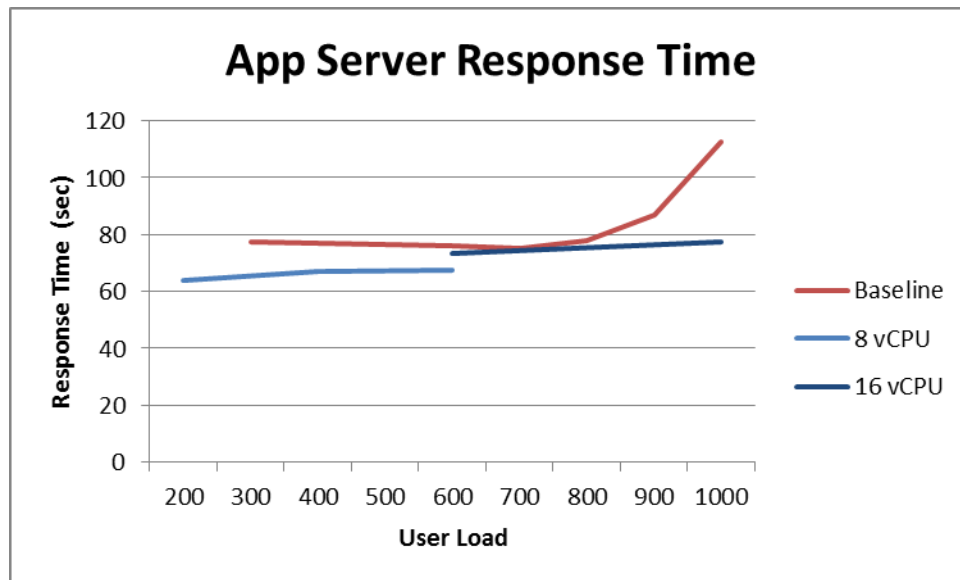


Figure 8: AppServer Response Time

This chart shows that this testing maintained the server response trends established in the PTC baseline.

It also shows that, the PTC baseline curve (for an 8 core server) begins an exponential increase around 700 users. However, the 16 core trend line maintains the 70-80 sec response time norm as the user base increases.

Horizontal Performance Results

For the horizontal testing, we analyzed and compared the performance of many small servers compared to a few large servers. Specifically we compared performance results from a Windchill cluster using four server with 4 vCPU each,

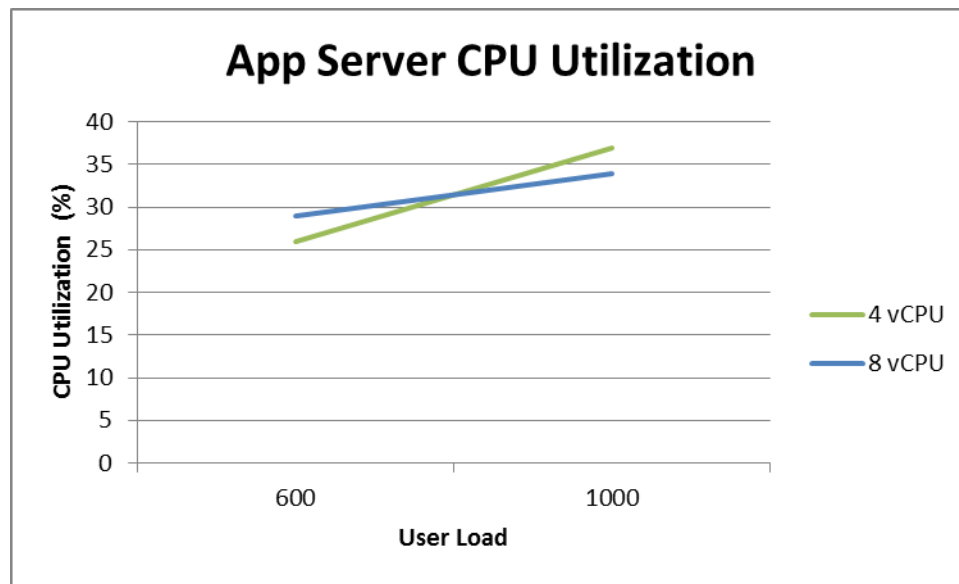


Figure 9: CPU Utilization of AppServer

This chart shows the roughly equivalent use of 16 cores in this horizontal scale testing, whether using four VMs provisioned with 4 vCPU, or two VMs provisioned with 8 vCPU.

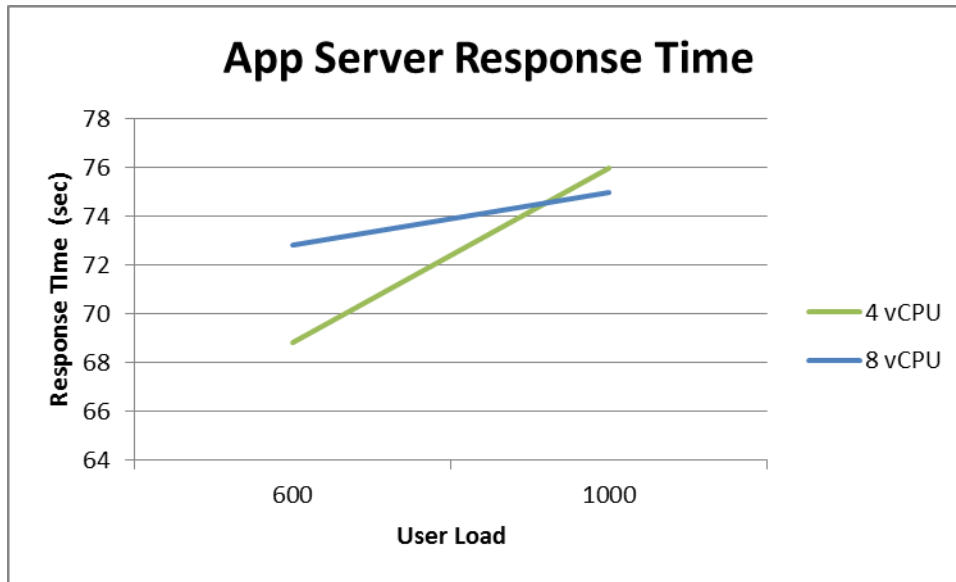


Figure 10: Response Time of AppServer

This chart probably provides the most interesting results to consider. For the lower user loads, the 4 vCPU servers provided faster responses compared to the 8 vCPU servers. But as the user load grew to over 900 users, the 8 vCPU system starts to have the better response times.

Additional VMware Features Testing

VMotion

VMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. This capability makes hardware maintenance possible at any time of the day and does not require clustering or redundant servers. VMotion makes it possible to move online workloads as required from one ESXi Server host machine to another in order to maintain service levels and performance goals. The scope of this test is to check the migration of AppServer virtual machine

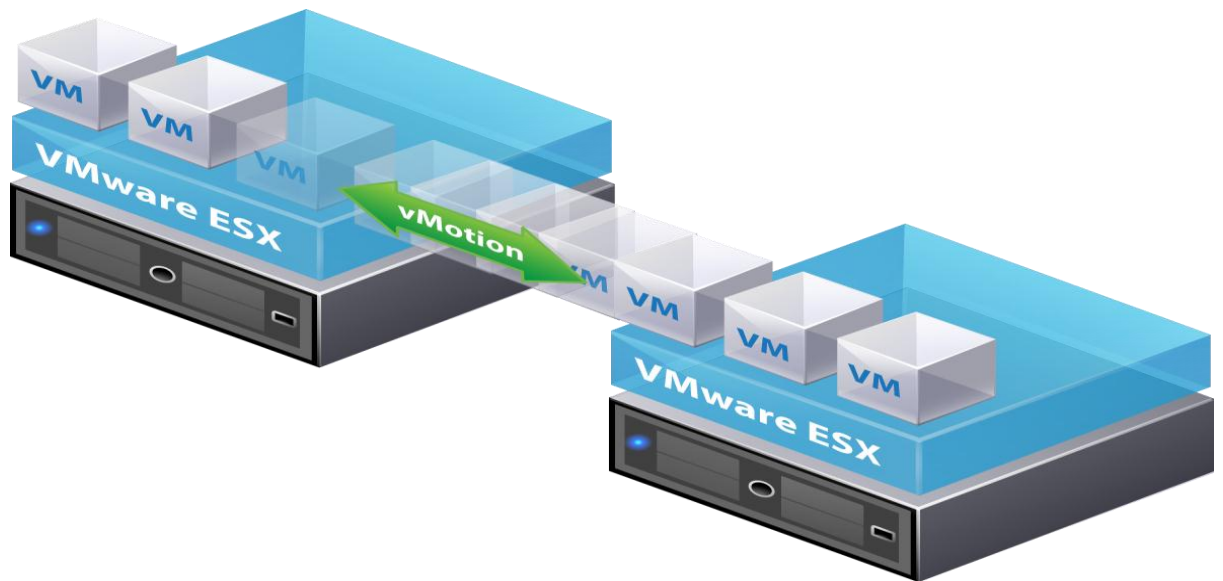


Figure 11.:vMotion Architecture

The VMotion test was done with 10 Users and the goal was to check if all the components of the PTC Application work fine when VMotion was in process. The VMotion was completed in 115 seconds with no failures, indicating that user activity could continue successfully during any VMotion events. No negative impact on transaction execution time was observed during VMotion events.

Deployment Best Practices

Here are some of the best practices derived from configuration and testing of the PTC application in a VMware virtual infrastructure environment

- VMware recommends using Intel based Nehalem or AMD based Shanghai processors that have the Hardware-Assist capabilities which help in memory management operations.
- While using Intel based systems, ensure that the BIOS settings enable Hyperthreading, VT, and EPT options on all ESXi hosts.
- Use Eager zeroed disks for better IO performance. This can be done using the VMware vmkfstools command:


```
vmkfstools -w abc.vmdk
```
- For large load applications, disk I/O latency can become a factor for database datafiles. PTC suggests using Fibre Channel Adapters and configure proper RAID configuration with sufficient spindles for large loads.
- Install VMware tools on the VMs. The VMware Tools package provides support required for shared folders and for drag and drop operations. Other tools in the package support:
 - synchronization of time in the guest operating system with time on the host
 - automatic grabbing and releasing of the mouse cursor, copying and pasting between guest and host
 - improved mouse performance in some guest operating systems
- Consider using server-class network interface cards (NICs) for the best performance and configure paravirtualized vmxnet3 adapters for better network throughput.
- Performance gains can be achieved when dependent VMs are located on the same ESXi host and communicate through the same vSwitch.
- Disconnect or disable unused or unnecessary physical hardware devices, such as:
 - COM ports
 - LPT ports
 - USB controllers
 - Floppy drives
 - Optical drives (that is, CD or DVD drives)
- Disconnecting devices helps free up interrupt resources. Traditionally, some devices, such as USB controllers, operate on a polling scheme that consumes extra CPU resources.

Technical Support

For Windchill technical support, please contact PTC Technical Support through the PTC website, or by phone, email, or fax if you encounter problems using this product or the product documentation.

For complete details, see the PTC Customer Service Guide. You can find this guide under Contacting Technical Support on the PTC Technical Support page:

<http://www.ptc.com/support/index.htm>

Conclusion

Overall, testing results show that running PTC Windchill 10 on VMware vSphere 5.0 completely on HP's certified Intel-based servers, iSCSI-based SAN and other networking equipments performs well. Furthermore, it has potential to reduce cost, increase service levels and simplify the manageability of the application.

This study demonstrates how new virtualization server capabilities can be used to significantly increase performance of PTC Windchill. It's equally important that the CPU and memory recommendations specified in PTC's Windchill server sizing guides are followed to get expected performance.

When customers use Windchill clustering to scale their system horizontally, there are both performance and administration factors to consider:

- From a performance perspective, customers can gain a slight performance edge when using many smaller virtual machines. This testing demonstrated that four virtual machines each with 4 vCPU (16 vCPU total) performed slightly faster than two virtual machines each with 8 vCPU.
- Routine maintenance, system administration, management and monitoring can become a bigger task as more virtual machines are added to a Windchill cluster. Such tasks would be reduced when fewer and larger virtual machines are used instead.

Resources

Customers can find more information about VMware and PTC products using the following links.

VMware Resources

- VMware official website:
<http://www.vmware.com/>
- VMware Infrastructure 3 and vSphere 4 product Web site:
http://www.vmware.com/products/data_center.html
- VMware download Web site:
<https://www.vmware.com/download/>
- VMware support Web site:
<http://www.vmware.com/vmtn/>
- VMware Performance Tuning Paper:
- http://www.vmware.com/pdf/Perf_Best_Practices_vSphere5.0.pdf
- System Compatibility Guide for a complete list of compatible hardware:
http://www.vmware.com/pdf/vi41_systems_guide.pdf
- Storage/SAN Compatibility Guide for a complete list of compatible storage devices:
http://www.vmware.com/pdf/vi41_san_guide.pdf
- I/O Compatibility Guide for a complete list of compatible networking devices:
http://www.vmware.com/pdf/vi41_io_guide.pdf
- [VMware Java Performance Tuning Best Practice](#)

PTC Resources

- PTC official website
<http://www.ptc.com>
- Windchill Installation and Configuration Resource Page
<http://www.ptc.com/go/install-windchill>
- Windchill support website
<http://www.ptc.com/support/windchill.htm>
- Windchill Architecture Overview
http://www.ptc.com/view?im_dbkey=123332
- Windchill Server Sizing Calculator
http://www.ptc.com/view?im_dbkey=136972
- Windchill 10 Server Hardware Sizing Guide for Microsoft Windows with Oracle
http://www.ptc.com/view?im_dbkey=139004

HP Resources

- [HP Official Web-Site](#)



<http://www.hp.com/>

- HP Server Information

<http://www.hp.com/go/servers>

- HP ProLiant DL980 Servers

<http://www.hp.com/servers/dl980-g7>

- HP Converged Infrastructure

<http://www.hp.com/go/CI>

- HP and PTC Partner Pages

<http://www.hp.com/go/ptc>

<http://www.hp.com/solutions/ptc>

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- David Bernbeck, Senior Technical Consultant, PTC
- Gilbert Lau, Sr. Technical Alliance Manager, VMware

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