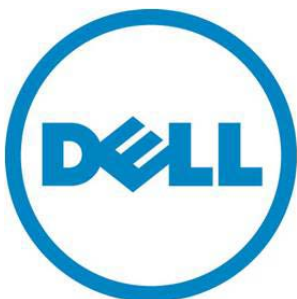


Microsoft Dynamics CRM 4.0

# Microsoft Dynamics CRM Performance and Scalability in a Virtual Environment with Hyper-V and Intel<sup>®</sup> Xeon<sup>®</sup> Processor 7500 Series-based Dell PowerEdge R910 Servers

A Dell Technical White Paper

Dell | Microsoft | Intel



**Microsoft<sup>®</sup>**



## Acknowledgements

This document was developed in part with support from across the Microsoft organization and in direct collaboration with the following:

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May 2010

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## Overview

Microsoft® Dynamics CRM 4.0 is designed to help enterprise organizations attain a 360-degree view of customers, achieve reliable user adoption, adapt quickly to business change, and accelerate project delivery and returns—all on a platform that provides enterprise levels of scalability and performance. This white paper focuses on system configuration for the support of high-scale systems in virtual environments.

Microsoft, working with Intel® Corporation and Dell Inc., completed workload test of virtualized Microsoft Dynamics CRM 4.0 on Dell™ PowerEdge™ R910 servers equipped with Intel® Xeon® Processor 7500 Series and solid state drives (SSDs). With 20 virtual machines (VMs) on two Dell PowerEdge R910 servers, Microsoft Dynamics CRM 4.0 was able to sustain 100,000 users showing its ability to scale on a hardware platform ideal for large-scale application consolidation projects.

## Results Summary

Benchmark testing was performed on a Microsoft Dynamics CRM 4.0 implementation that included Microsoft® Windows Server® 2008 R2 Hyper-V and Microsoft SQL Server® 2008 R2, two Dell PowerEdge R910 servers running Intel® Xeon® Processors 7500 Series-based with storage managed by a Dell PowerVault™ MD1220 with solid state drives.

Large enterprises often deploy multiple parallel CRM instances to meet the diverse needs of different business units or geographies. Microsoft Dynamics CRM meets this need through a multi-tenant architecture which can add independent tenants to a shared hardware and management environment. Microsoft Dynamics CRM's multi-tenant capabilities were employed to create five organizations running under a single deployment with workload distributed across 20 virtual machines. In this test environment, Microsoft Dynamics CRM 4.0 demonstrated the following performance characteristics:

Concurrent Users	Average Response Time	Web Requests	Business Transactions
100,000	.29 seconds	5.1 M/hr.	778,000/hr.

## Microsoft Dynamics CRM Performance and Scalability in a Virtual Environment

According to the *Microsoft Dynamics CRM Scalability Benchmark May 2009* study<sup>1</sup>, performance results with half as many concurrent users were as follows:

Concurrent Users	Average Response Time	Web Requests	Business Transactions
50,000	.12 seconds	2.4 M/hr.	374,000/hr.

This workload demonstrates that five Microsoft Dynamics CRM 4.0 instances can achieve sub-second response times with 100,000 concurrent users executing a heavy workload in a virtual environment.

This white paper details the results of workload testing conducted on Microsoft Dynamics CRM 4.0 running on a Dell PowerEdge R910 server with Intel® X7560 (Nehalem-EX) processors and solid state drives. Included are:

- A description of the CRM implementation and the methods used to obtain the benchmark.
- Details of the hardware configuration and optimization settings used in testing.
- A summary of the key test parameters and results achieved.

These results reflect the scalability and performance of a specific Microsoft Dynamics CRM 4.0 implementation running in a particular test environment powered by Intel® Xeon® Processors 7500 Series-based servers. Each organization is different; factors ranging from industry vertical to geographic span can affect how an enterprise organization uses its CRM system, so results will vary for each implementation. Customers may be able to achieve higher levels of performance and scalability through customization and a finer level of optimization.

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<sup>1</sup> For more detailed information, you can download the entire paper at <http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=642899d1-0fb9-4f17-ad24-c30cecdb92c8>. A graphical illustration of the hardware environment used in the benchmark testing is shown in Appendix E of this paper.

## Testing Methodology

Testing was conducted by Microsoft, working with Intel Corporation and Dell Inc. to demonstrate the performance and scalability characteristics of a multi-tenant Microsoft Dynamics CRM 4.0 implementation that included:

- Microsoft® Windows Server® 2008 R2 Hyper-V
- Microsoft SQL Server® 2008 R2
- Intel® Xeon® Processor X7560 Series-based servers
- Dell™ PowerEdge™ R910 Servers
- Dell™ PowerVault™ MD1220 storage array
- Dell™ PERC (PowerEdge™ RAID Controller) H800
- Solid state drives

### Test Scenarios

Based on customer research, test scenarios were created by using the Microsoft Dynamics CRM 4.0 Performance and Stress Testing Toolkit (the “Toolkit”). Available as a free download, the Toolkit is designed to help formalize performance testing of Microsoft Dynamics CRM by facilitating load testing in customer environments. The Toolkit provides enterprise organizations with a means of evaluating Microsoft Dynamics CRM for their own environments.

The Toolkit includes all of the test cases used in this benchmark and can be used as-is or expanded for customer benchmarking efforts. For additional information or to download the Toolkit, see the Microsoft Dynamics CRM Performance and Scalability Toolkit at:

<http://www.codeplex.com/crmperftoolkit>

### Business Transactions

To accurately model heavy usage of a real-world Microsoft Dynamics CRM implementation, simulated clients in this benchmark executed business transactions across several functional areas of Microsoft Dynamics CRM. Each business transaction in the testing consists of several discrete interactions between the user and the system.

For example, the Create e-mail business transaction consists of the following Microsoft Dynamics CRM atomic interactions:

1. Open the **Workplace** homepage.
2. Under **Activities**, select **New** to create a new e-mail message.
3. Use the Find feature to select the recipient from the user list.
4. Enter a subject and description.
5. In the **Regarding** field, select an account from the list.
6. Click **Save**.
7. Close the form.

In this test, each business transaction represents between 5 and 10 commands, these commands executed at a rate of over 5 million per hour.

## **Transaction Workload**

Forty-nine unique business scenarios were tested to simulate a variety of enterprise roles and activities. The workload was created to simulate a high-transaction CRM deployment exercising a broad range of CRM functionality.

Several test runs were executed. This paper highlights results from three runs: one with a single CRM organization of 25,000 users, another with results from two organizations with a total of 50,000 users and finally with 100,000 users across five organizations running within a single multi-tenant deployment.

For a list of the business scenarios selected for testing, in Appendix C: Benchmark Testing Detail, see Table 11.

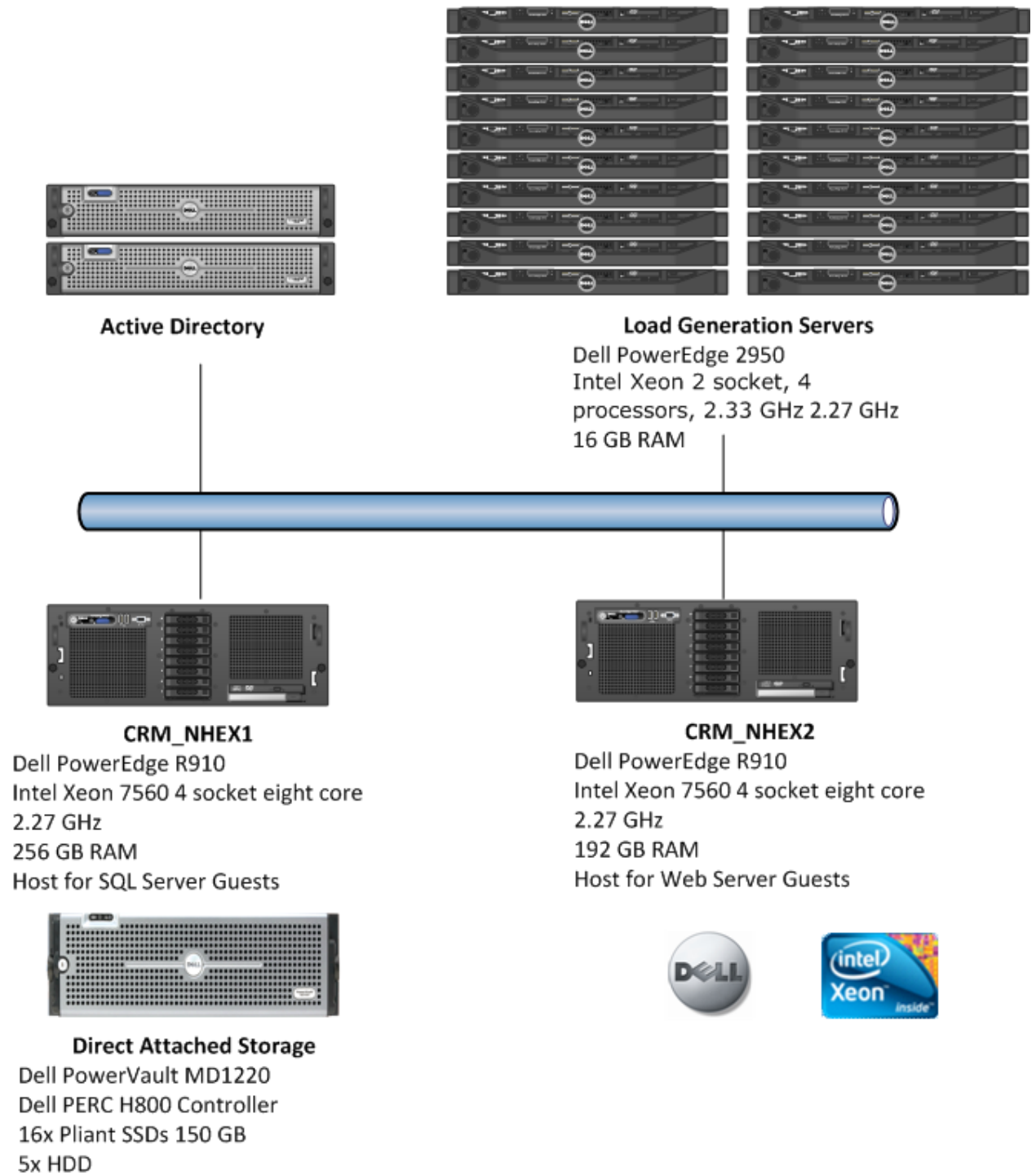
## **Database Server**

The benchmark transactions were performed against a database with size and complexity comparable to a real-world implementation of Microsoft Dynamics CRM 4.0. The test databases included over 140 million business records with a finished size of 157 GB.

## **Hardware Environment**

Physical hardware deployed for the workload included two Dell PowerEdge R910 servers running Intel® Xeon® X7560 processors with eight cores, a Dell PowerVault™ MD1220 storage array with solid state drives and an F5 Networks Big-IP® Local Traffic Manager™. Twenty load generation servers running Visual Studio® Team Test were used to simulate the 100,000 users and their workload. Two domain controllers managed client authentication.

Figure 1 shows the simplified hardware layout deployed for this workload.



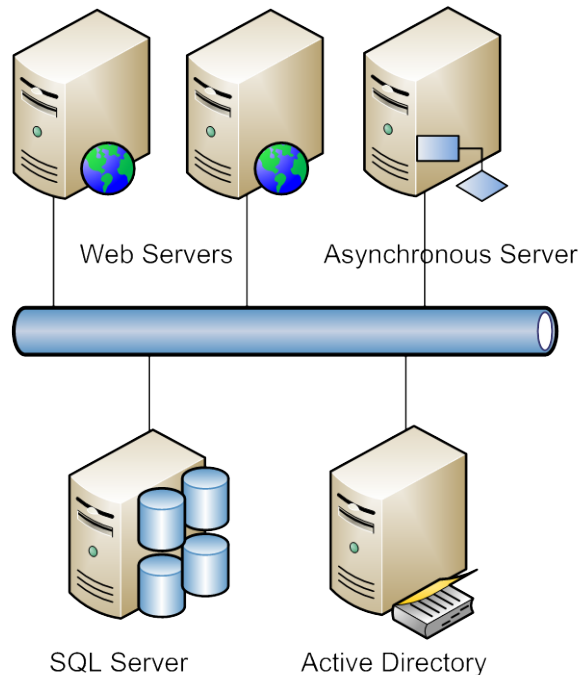
**Figure 1.** Hardware Configuration

For additional information about the hardware used in this test, see Appendix B: Detailed Hardware Environment and Appendix C: Benchmark Testing Detail.



## Microsoft Dynamics CRM Environments

Microsoft Dynamics CRM deployments require several logical server roles: a database server which stores transactional and configuration information, one or more shared Web servers dedicated to serving the application user interface and an Asynchronous Server (an Internet Information Server (IIS) running the Microsoft Dynamics CRM 4 Asynchronous Service) for managing workflow, bulk e-mail, duplicate detection and other application services.



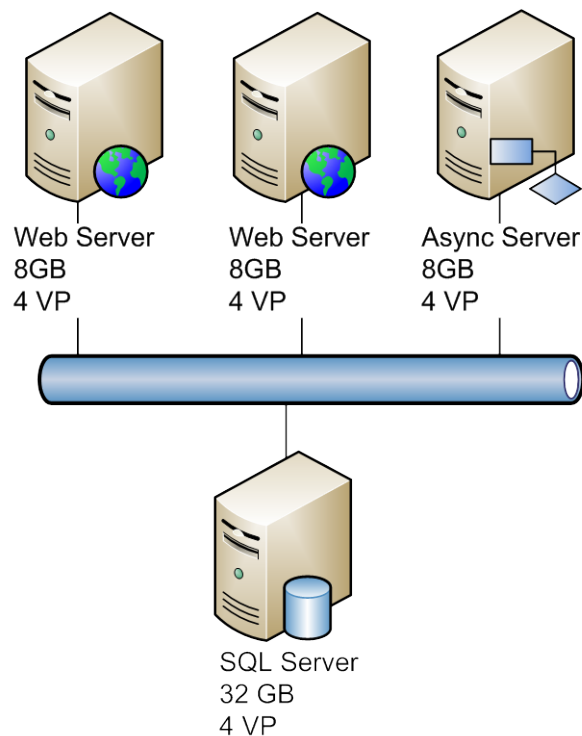
**Figure 2.** A Typical Multi-Tenant Deployment of Microsoft Dynamics CRM

In practice, this logical separation of servers can be scaled down to a single physical server or scaled up to many physical servers: Web servers can be added to handle a greater volume of end user traffic and each CRM tenant, using its own SQL database, can be moved to shared or individual physical servers. Large, high availability Microsoft Dynamics CRM environments can span many servers and while this flexibility enables enterprise scale architecture it can incur high management costs.

Through the use of Hyper-V™, logical roles in the CRM server farm can be installed on virtual machines and assigned separate processor and memory resources while sharing hardware. This server consolidation allows IT organizations to deliver a high quality of service while reducing hardware costs, decreasing power consumption and improving manageability within the data center.

For the workload described in this whitepaper, five CRM tenants with 20,000 users each were deployed. Each tenant was run on its own SQL Server instance and was given its own Asynchronous Server. CRM deployments share their application servers across tenants so, to

ensure even scalability, two Web servers were added to the deployment for each tenant. Figure three describes the set of virtual machines deployed for each 20,000 user tenant.



**Figure 3.** Each 20,000 User Tenant Added Four Servers to the Deployment

### Virtual Environment

Based on hypervisor technology, the Hyper-V™ virtualization feature in the Windows Server® 2008 R2 operating system is a thin layer of software between the hardware and the operating system that allows multiple operating systems to run, unmodified, on a host computer at the same time. Hyper-V is a powerful virtualization technology that can enable an efficient enterprise through consolidation of servers, lower total cost of ownership (TCO) and simplified maintenance.

Intel® Xeon® Processors 7500 Series with next-generation Intel Virtualization Technology (Intel VT) enhance virtualization performance with Microsoft Dynamics CRM. Please refer to Appendix D for details.

### Server Distribution

For the workload described in this document, all SQL Server guests were placed on one Dell PowerEdge R910 server while all Web and Asynchronous server guests were placed on another Dell PowerEdge R910 server. During this workload test no performance tuning was done to further balance workloads across physical servers. Since Hyper-V guests can be live migrated from one host to another, the location of virtual machines (VMs) within the environment can be changed over time to improve redundancy or further tune performance.

As noted above, the multi-tenant capabilities of Microsoft Dynamics CRM enable databases from several organizations to be collocated on a single SQL Server instance or spread across several physical servers. In a non-virtualized environment, a single Dell PowerEdge R910 server with an Intel® Xeon® Processor 7500 Series could be configured to run the several database instances required for this workload (indeed, from our testing we believe that a single large CRM organization would perform well in a non-virtualized environment on the same hardware). But with support for a maximum of four virtual processors per VM in Windows Server 2008 R2 Hyper-V, we felt it necessary to distribute databases over several servers. Each database server VM was configured to use the maximum four virtual processors and each CRM organization was configured to use a different virtualized database server.

With the addition of each CRM tenant two Web servers and a CRM Asynchronous Server were added to the deployment. All Web servers were deployed to a single PowerEdge R910 server and load balanced across the multi-tenant environment with a simple round robin scheme using an F5 Big-IP® Local Traffic Manager™ load-balancing appliance. Web servers were deployed using two virtual processors each.

**Storage**

Storage configuration and management proved to be a critical component of system performance. Microsoft Dynamics CRM, like most SQL Server applications, is I/O intensive making the storage subsystem critical for optimal application performance. Within the Hyper-V environment, guest operating systems and guest operating system storage can be located on the server, on attached storage, enclosed in a virtual hard disk file (VHD) or maintained on a separate drive as a pass-through disk.

In addition to the location of the virtual machine operating system images, SQL log file storage and SQL database file storage needed to be accounted for. Based on recommendations in the Microsoft whitepaper [Running SQL Server 2008 in a Hyper-V Environment](#), the SQL Server guests employed a pass-through disk with SSDs for database files (MDFs). Findings in that whitepaper indicate that pass-through disks provide a level of I/O comparable, though only slightly inferior, to that of native performance.

Storage for databases and guest operating systems was divided as shown in Table 1.

**Table 1. Storage Component Information**

Storage Component	Location	Type	Medium
SQL MDF files	Attached storage	Pass-through	SSD
SQL LDF files	Local storage	Fixed size VHD	HDD
SQL Host OS	Local storage	Native storage	HDD
SQL Guest OS	Attached storage	VHD	HDD
Web Host OS	Local storage	Native storage	HDD
Web Guest OS	Local storage	VHD	HDD

During testing it was discovered that the SQL Server guest VMs required more storage than had been planned. Hyper-V guest operating system files require disk space for the VHD file plus drive space equal to the memory footprint of the VM. Additional attached storage was added to fill the Dell PowerVault MD1220 array to account for this additional storage requirement.

### Tuning and Optimization

To simulate an out-of-the-box deployment, no customizations were applied to the CRM application in the test environment. Standard optimization techniques were applied per guidelines contained in the white papers [Optimizing and Maintaining Microsoft Dynamics CRM 4.0](#) and [Improving Microsoft Dynamics CRM Performance and Securing Data with Microsoft SQL Server 2008](#). Depending on the specific business processes involved, higher levels of performance and scalability may be possible through customization to meet specific business and performance requirements and through deeper optimization.

Standard SQL scripts were used to ensure that table indexes on the database were not fragmented and that the statistics were up to date, helping to ensure efficient database operation. Early test runs of the scripts identified several areas in which new or modified indexes could improve query performance. SQL Profiler was used to identify long running queries that were executed frequently, and this information was used to carry out additional tuning of the database server.

## Results

Results across test runs show the system scaling linearly as virtual machines are added.

**Table 2.** Host System Utilization

Server	Host System Counter	25,000 One organization	50,000 Two organizations	100,000 Five organizations
CRM_NHEX1 SQL Servers	% Proc. Time	5%	18%	24%
	Hyper-V HyperVisor Logical Processors	64	64	64
	Hyper-V HyperVisor Virtual Processors	68	72	84
	Avg. Disk sec/Read	.001	.082	.001
	Avg. Disk sec/Transfer	.001	.066	.004
	Avg. Disk sec/Write	.002	.004	.006
	Avg. Memory Utilization	59%	60%	85%

Server	Host System Counter	25,000 One organization	50,000 Two organizations	100,000 Five organizations
CM_NHEX2 Web Servers	% Proc. Time	2%	16%	24%
	Hyper-V HyperVisor Logical Processors	64	64	64
	Hyper-V HyperVisor Virtual Processors	76	88	124
	Avg. Disk sec/Read	.005	.006	.004
	Avg. Disk sec/Transfer	.002	.001	.001
	Avg. Memory Utilization		49%	31%

Note that the number of Hyper-V HyperVisor Virtual Processors is higher than the number of logical processors. The number of virtual processors is calculated with the formula:

$$\text{Hyper-V HyperVisor Virtual Processor} = \text{number of logical processors} + (\text{number of virtual machines} * \text{number of virtual CPU's})$$

With no virtual machines running, each server would have 64 virtual processors.

Values indicated in Table 1 refer to counters on the host servers. As can be seen from the data, the physical servers seem underutilized during the period of testing. A deeper view into the Hyper-V Hypervisor Virtual Processor data for the 100,000 user test run shows higher average processor utilization across the five SQL Server instances.

**Table 3.** 100,000 users, Hyper-V Virtual Processor, 5 SQL Server VMs

CRM NHEX1 (SQL Servers)	SQL01 (vp0:vp3)	SQL02 (vp0:vp3)	SQL03 (vp0:vp3)	SQL04 (vp0:vp3)	SQL05 (vp0:vp3)
% Total Run Time	69.48%	52.52%	56.48%	55.69%	78.34%

This begs the question of whether or not these machines were undersubscribed during the course of testing. Determining whether a machine can be considered undersubscribed or underutilized can be complicated. On a large system, such as those under test, most root VPs will have very little load (e.g., < 5% utilization), assuming a typical configuration where the root partition is only used for management and is not directly under load. The root VPs will always be responsible for a few things such as processing hardware interrupts and running VM worker processes for each VM.

This result leads us to the conclusion that, for this workload, SQL server VMs assigned four virtual processors were in an optimal run state with 20,000 to 25,000 users. With just five CRM organizations the host system continued to have capacity for additional Microsoft Dynamics CRM or other SQL Server application instances. This configuration would allow for additional Microsoft Dynamics CRM server instances, for failover instances or would allow some of the Web servers to be load balanced to the SQL Server host.

## Conclusion

This benchmark demonstrates that Microsoft Dynamics CRM 4.0 on Dell servers with Intel® Xeon® processors 7500 series and solid state drives can scale to support a multi-tenant enterprise implementation of 100,000 concurrent users. By running multiple SQL Server based applications side by side these results also show how Dell PowerEdge servers running Intel® Xeon® processors 7500 series can act as ideal platforms for application consolidation through the use of Hyper-V. This enterprise-scale deployment model can serve the diverse needs of different business units and geographies within a large organization.

The combination of Windows Server 2008 R2 Hyper-V, Dell PowerEdge R910 servers and the Intel® Xeon® processors 7500 series enables a myriad of consolidation options for enterprise organizations. This provides organizations with the ability to develop highly reliable, available and serviceable systems within a small server footprint.

Based on these results, an organization with a similar data and transaction volume can expect similar results. No two enterprise implementations of Microsoft Dynamics CRM are the same. Multiple factors can affect performance, including the following:

- Number of records in the database
- Number, type, and frequency of transactions
- Processing power dedicated to workflows or plug-ins
- Global distribution of clients and network latency

While this benchmark demonstrates scalability under high transaction rates, customers should evaluate the requirements of their own environments before undertaking a large-scale deployment. The Microsoft Dynamics CRM 4.0 Performance and Stress Testing Toolkit provides tools to assist companies in this effort.

## Appendix A: Additional Resources

### Microsoft

- Microsoft Dynamics CRM Web Site  
<http://www.microsoft.com/dynamics/crm/default.aspx>
- Microsoft Windows Server 2008 R2 Hyper-V Web Site  
<http://www.microsoft.com/windowsserver2008/en/us/hyperv-main.aspx>
- Microsoft Dynamics CRM Performance and Scalability Toolkit  
<http://www.codeplex.com/crmperftoolkit>
- *Optimizing and Maintaining Microsoft Dynamics CRM 4.0*  
<http://www.microsoft.com/downloads/details.aspx?FamilyID=ba826cee-eddf-4d6e-842d-27fd654ed893&DisplayLang=en>
- *Running SQL Server 2008 in a Hyper-V Environment*  
<http://download.microsoft.com/download/d/9/4/d948f981-926e-40fa-a026-5bfcf076d9b9/SQL2008inHyperV2008.docx>
- *Improving Microsoft Dynamics CRM Performance and Securing Data with Microsoft SQL Server 2008*  
<http://www.microsoft.com/downloads/details.aspx?FamilyID=b5bb47a4-5ece-4a2a-a9b5-5435264f627d&DisplayLang=en>
- *Investigating Microsoft Dynamics CRM 4.0 Performance*  
<http://blogs.gotdotnet.com/crm/archive/2008/03/04/investigating-crm-v4-performance.aspx>
- *Microsoft Dynamics CRM 4.0 Implementation Guide*  
<http://www.microsoft.com/downloads/details.aspx?FamilyID=1ceb5e01-de9f-48c0-8ce2-51633ebf4714&DisplayLang=en>

### Intel

- *Intel® Microarchitecture, Codenamed Nehalem*  
<http://www.intel.com/technology/architecture-silicon/next-gen/?iid=SEARCH>
- *Server Performance Summary - Intel® Xeon® Processor*  
<http://www.intel.com/performance/server/xeon/summary.htm>
- *Maximizing the Benefits of Virtualization*  
[http://download.intel.com/business/software/testimonials/downloads/xeon5500/microsoft\\_virtualization.pdf](http://download.intel.com/business/software/testimonials/downloads/xeon5500/microsoft_virtualization.pdf)

### Dell

- PowerEdge Site: <http://www.dell.com/poweredge>
- *PowerVault MD1220 data sheet*  
<http://www.dell.com/downloads/global/products/pvaul/en/storage-powervault-md1220-specsheet.pdf>
- PowerEdge R910 Site  
<http://www.dell.com/us/en/enterprise/servers/poweredge-r910/pd.aspx?refid=poweredge-r910&cs=555&s=biz>
- Dell PowerEdge RAID Controller (PERC) site: [www.dell.com/perc](http://www.dell.com/perc)

## Appendix B: Detailed Hardware Environment

**Table 4.** Host 1 (SQL Server Host)

Host for CRM Database Servers	
Manufacturer and Model	Dell PowerEdge R910
Operating System	Microsoft® Windows Server® 2008 R2 Enterprise 64-bit
Processor	4 socket, eight-core Intel® Xeon® X7560, 2.27 GHz*
Network Adapter	1 GB Dual Port NIC
RAM	256 GB (64x4GB) 1066MHz
Software	Microsoft® SQL Server 2008 Enterprise Edition R2

**Table 5.** Storage

Storage Array	
Manufacturer and Model	Dell PowerVault™ MD1220 storage array
Controller	Dell PERC H800
Cache	512 MB
Interface Support	6Gb/s SAS
Drives	16x Pliant Technology 150 GB SSDs

**Table 6.** Host 2 (Web Server Host)

Host for CRM Web Servers	
Manufacturer and Model	Dell PowerEdge R910
Operating System	Microsoft® Windows Server® 2008 R2 Enterprise 64-bit
Processor	4 socket, eight-core Intel® Xeon® X7560, 2.27 GHz*
Network Adapter	1 GB Dual Port NIC
RAM	192 GB (32x4GB + 32x2GB) 1066MHz



**Table 7. CRM SQL Servers (5) Virtual Machines**

CRM Web Servers	
Operating System	Microsoft Windows Server® 2008 Enterprise 64-bit
Processor	4 Virtual Processors
RAM	32 GB
Software	Microsoft Dynamics CRM 4.0 Rollup 7

**Table 8. CRM Web Servers (10) Virtual Machines**

CRM Web Servers	
Operating System	Microsoft Windows Server® 2008 Enterprise 64-bit
Processor	4 Virtual Processors
RAM	8 GB
Software	Microsoft Dynamics CRM 4.0 Rollup 7

**Table 9. CRM Async Server (5) Virtual Machines**

Async Server	
Operating System	Microsoft® Windows Server® 2008 Enterprise 64-bit
Processor	4 Virtual Processors
RAM	8 GB
Software	Microsoft® Dynamics CRM 4.0 Rollup 7

**Table 10. Load Generation Servers (20) Hardware**

Load Generation Servers	
Manufacturer	Dell
Model	PowerEdge 2950
Operating System	Microsoft® Windows Server® 2008
Processor	2 socket, 4 processors, 2.33 GHz
Network Adapter	1 GB NIC
RAM	16 GB (4x4GB)
Software	Microsoft® Visual Studio 2008 Team Test

## Appendix C: Benchmark Testing Detail

All tests executed in the test workload can be found in the Microsoft Dynamics CRM Performance Toolkit. Tests executed for this workload are indicated below.

**Table 11.** Business Scenarios Tested

Business Cases	
AccountActivityRollup	DeleteLead
AccountOppRollup	DeleteNoteOnAccount
AccountSCRollup	DeleteNoteOnContact
AddActivityToAccount	DeleteNoteOnLead
AddActivityToLead	DeleteNoteOnOpportunity
AdvancedFindAccount	DeleteNoteOnTask
AdvancedFindAccountNotes	DeleteOpportunity
AdvancedFindContact	DeleteTask
AdvancedFindProduct	EmailQuote
AssignAccounts	FindAccounts
AssignLead	FindContacts
AssignOpportunity	QuickCreateNewAccount
AssignServiceCase	UpdateAccount
ConvertleadToOppWithAccount	UpdateContact
CreateEmail	UpdateLead
CreateNewAccount	UpdateOpportunity
CreateNewContact	UpdateTask
CreateNewLead	AssignContact
CreateNewNoteForAccount	CreateNewAccountWithCustomAttributes
CreateNewNoteForContact	CreateNewContactWithCustomAttributes
CreateNewNoteForLead	CreateTaskWithCustomAttributes
CreateNewNoteForOpp	UpdateAccountWithCustomAttributes
CreateNewNoteForTask	UpdateContactWithCustomAttributes
CreateNewOpportunity	UpdateTaskWithCustomAttributes
CreateTask	

## Appendix D: Intel® Xeon® Processors 7500 Series High-Performance Virtualization with Intel Virtualization Technology (Intel VT)

The Intel® Xeon® processor 7500 series with Intel® Virtualization Technology (Intel® VT) deliver exceptional performance, energy efficiency and reliability in a virtualized environment.

Intel® Virtualization Technology (Intel® VT) provides hardware assistance to virtualization software, helping to reduce the size and complexity of the virtual machine manager and enabling less expensive, more efficient and more powerful virtualization solutions.

Specifically, next generation Intel VT enhances virtualization performance in several ways:

- Reduces the need for compute-intensive software translations between the guest and host operating systems in a virtual environment
- Decreases overhead by allowing the guest operating system to directly access CPU cycles
- Allows more virtual machines to run on a host server at near-native performance
- Provides unprecedented flexibility and control through multi-platform support and live virtual machine migration
- Enhances overall server performance

Intel® Virtualization Technology (Intel® VT) offers hardware assistance to increase virtualization performance, such as Intel Extended Page Tables (Intel® EPT), which enhance virtualization by providing hardware support for memory management for VMs. Extended Page Tables reduce memory footprint and improve performance on most workloads because Hyper-V doesn't need to maintain shadow page tables for doing virtual-to-physical memory translation.

With Intel VT FlexPriority, data centers can see even greater performance improvements. FlexPriority minimizes the impact of requests, or "interrupts," from other devices or applications to the processor by using a special register to monitor the priority of tasks so that only interrupts with the highest priority get immediate attention.

One of the key benefits of virtualization is the ability to migrate running applications from one physical server to another without downtime. Intel® VT FlexMigration enables seamless migrations among current and future Intel® processor-based servers. With this technology, hypervisors can establish a consistent set of instructions across all servers in the migration pool, creating a more flexible and unified pool of server resources that functions seamlessly across multiple hardware generations.

## Appendix E: Configuration Details from Previous Study

Figure 4<sup>2</sup> details the configuration used a May 2009 Microsoft study using HP servers. Details of the study can be found in the white paper [Microsoft Dynamics CRM Performance and Scalability with Intel Processor and Solid-State Drive Technologies](#).

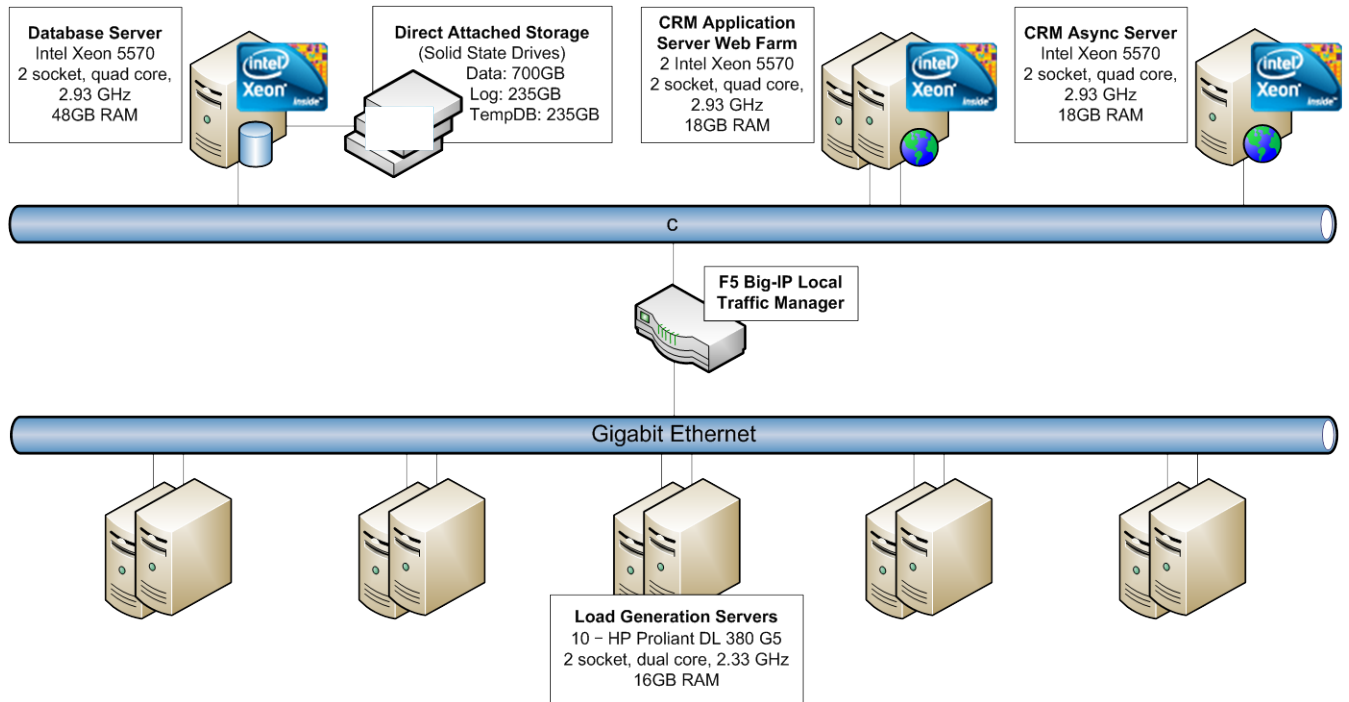


Figure 4. Configuration Details from Previous Study

<sup>2</sup> Graphic reprinted with permission from Microsoft Corporation.