

Performance

Microsoft Dynamics CRM 4.0

Microsoft Dynamics CRM Performance and Scalability with Intel Processor and Solid-State Drive Technologies

White Paper

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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 user scalability.

Microsoft, working with Intel[®] Corporation, completed benchmark testing of Microsoft Dynamics CRM 4.0 running on Intel[®] server and solid state drive (SSD) hardware. The Microsoft Dynamics CRM 4.0 implementation was not customized (simulating an “out-of-the-box deployment”), though standard optimizations were applied per guidelines published 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*.

Results Summary

Benchmark testing was performed on a Microsoft Dynamics CRM 4.0 implementation that included the latest versions of Microsoft[®] Windows Server[®] and Microsoft SQL Server[®], as well as Intel[®] Xeon[®] Processor 5500 series-based servers and Intel[®] X25-E Extreme SATA SSDs.

In this test environment, Microsoft Dynamics CRM 4.0 demonstrated the following performance characteristics:

Concurrent Users	Average Response Time	Web Requests	Business Transactions	Average SQL Server Utilization	Average CRM Server Utilization
50,000	.12 seconds	2.4 M/hr	374,400/hr	57.2%	60.9%

Benchmark results demonstrate that a single Microsoft Dynamics CRM 4.0 instance can achieve sub-second response times with 50,000 concurrent users executing a heavy workload against a large, complex database.

Large enterprises often deploy multiple parallel CRM instances to meet the diverse needs of different business units or geographies. Distributed across multiple instances, a Microsoft Dynamics CRM deployment can scale to meet the needs of the largest enterprises.

This white paper details the results of benchmark testing conducted on Microsoft Dynamics CRM 4.0 running on Intel[®] server and solid state drive hardware. 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.

Important: These results reflect the scalability and performance of a specific Microsoft Dynamics CRM 4.0 implementation running in a particular test environment. 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.

Testing Methodology

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

- Microsoft® Windows Server® 2008
- Microsoft SQL Server® 2008
- Intel® Xeon® Processor 5500 series-based servers
- Intel® X25-E Extreme SATA solid state drives

Test Scenarios

Based on extensive 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.

Note: The Toolkit includes all of the test cases used in this benchmark, and customers can use them as a basis for their own 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 users in this benchmark executed real business transactions, touching capabilities across Microsoft Dynamics CRM sales functionality. Each business transaction in the testing consists of several discrete atomic 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, each of which takes approximately .1 seconds to execute. These commands are executed at a rate of up to 2.4 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. The entire group of 50,000 users was logged on rapidly (within eight minutes) to assess the impact of a large number of CRM users logging on to the system in a brief time period.

The workload executed resulted in over 374,400 complex business transactions, or over 2.4 million Web requests per hour for the 50,000 active concurrent users test. In a follow-the-sun global deployment, this translates to a projected average of over 8.98 million business transactions, or over 57.6 million Web requests in a 24 hour period.

There were multiple workflows active during the benchmark runs and workflow activities were being executed at a rate of 5.5 activities per second.

Note: For a list of the business scenarios selected for testing, in *Appendix B: Benchmark Testing Detail*, see Table 4.

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 database included over 140 million business records with a total size of 340 GB.

Note: For a list of row counts for all tables with more than 10,000 rows at the completion of the test, in *Appendix B: Benchmark Testing Detail*, see Table 3.

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.

Note: For additional information, see the following white papers:

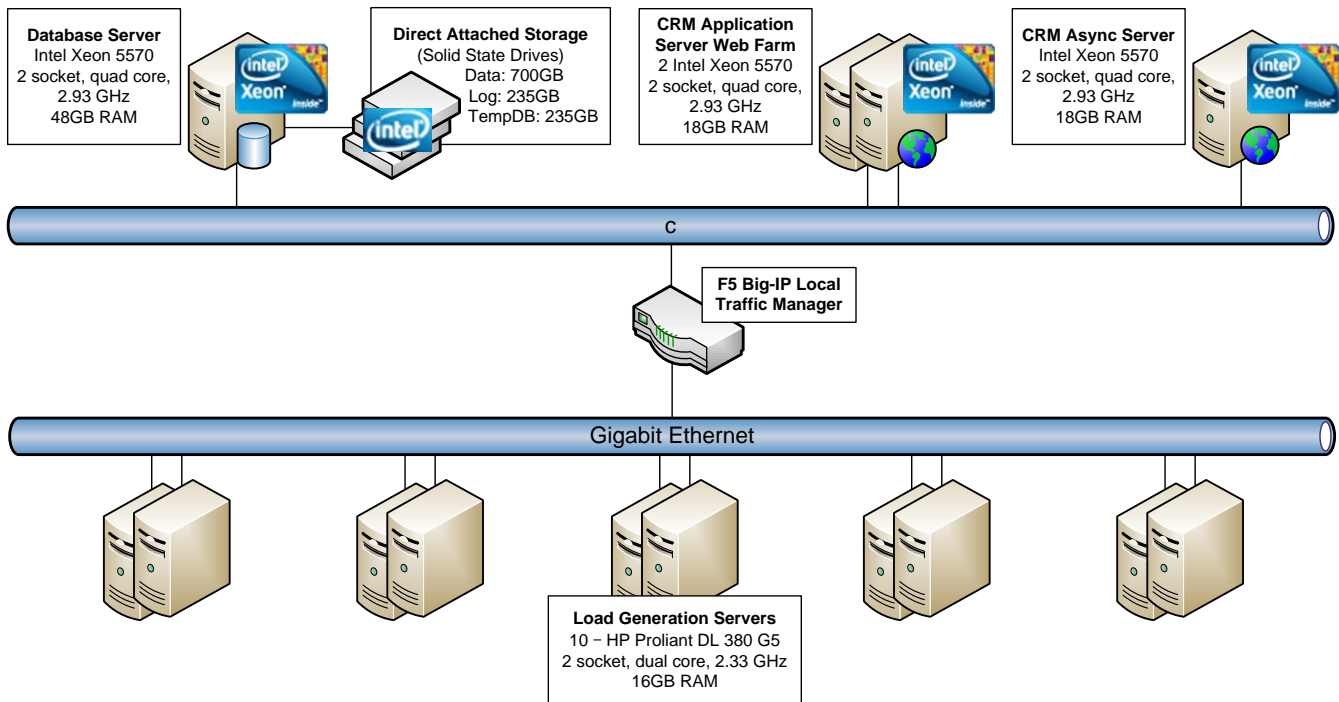
- *Optimizing and Maintaining Microsoft Dynamics CRM 4.0*
<http://www.microsoft.com/downloads/details.aspx?FamilyID=ba826cee-eddf-4d6e-842d-27fd654ed893&DisplayLang=en>
- *Improving Microsoft Dynamics CRM Performance and Securing Data with Microsoft SQL Server 2008*
<http://www.microsoft.com/downloads/details.aspx?FamilyID=b5bb47a4-5ece-4a2a-a9b5-5435264f627d&DisplayLang=en>

Hardware Environment

The application tier was deployed in a Web farm with two application servers. The application Web farm used an F5 Big-IP Local Traffic Manager configured for round-robin load balancing to ensure that each server received a similar level of utilization. The database tier was deployed on a single, two (2) socket Intel® Xeon® Processor 5570 series server. Ten load generation servers running Microsoft Visual Studio® Team Test were used to reliably generate the simulated 50,000 user workload.

Note: Microsoft SQL Server™ 2008 Reporting Services (SSRS) was placed on a separate tier, which reflects a configuration that is common in enterprise environments.

The hardware environment used in the benchmark testing is illustrated in the following graphic.



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Note: For additional information about the hardware used in this test, see *Appendix B: Benchmark Testing Detail* and *Appendix C: Intel and F5 Hardware Component Details*.

Test Results

The results of the benchmark study validate that a Microsoft Dynamics CRM 4.0 implementation that includes Microsoft Windows Server 2008, Microsoft SQL Server 2008 Enterprise Edition, Intel® Xeon® Processor 5500 series-based servers, and Intel® X25-E Extreme SATA solid state drives can scale to support 50,000 concurrent users in a single instance while averaging sub-second response times.

With 50,000 concurrent users, the application executed at a projected rate of 8,985,600 business transactions per day.

Important: The test results were achieved with minimal tuning and optimization. Advanced tuning and optimization may deliver better user scalability.

Conclusion

This benchmark demonstrates that a single instance of Microsoft Dynamics CRM 4.0 on Intel® server and Intel® solid state drive hardware can scale to support an enterprise implementation of 50,000 concurrent users, achieving discrete atomic response times under one second. Enterprises often deploy multiple CRM instances to serve the diverse needs of different business units and geographies.

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

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.

Important: The test cases, metrics, and usage patterns contained in this document were defined by the CRM Product Team during the discovery phase of the testing process. Only the test scenarios and processes that are defined in this document were provided for testing and evaluated for performance. Scenarios or processes that are not defined in this document have not been tested with regard to performance. Microsoft cannot predict or guarantee how additional scenarios or processes may affect system performance.

Appendix A: Additional Resources

Microsoft

- Microsoft Dynamics CRM Web Site
<http://www.microsoft.com/dynamics/crm/default.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>
- *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>
- *Intel® Xeon® Processor 5500 Series Intelligently Scales Performance and Energy Use*
http://download.intel.com/pressroom/kits/xeon/5500series/pdf/PerformanceBrief_Xeon5500.pdf
- Solid-State Drive Info Center
<http://www.intel.com/design/flash/nand/ssd-info-center.htm>

F5

- *Why do I need F5 for my Microsoft Dynamics CRM deployment?*
<http://www.f5.com/solutions/applications/microsoft/dynamics-crm/>
- *F5 Solutions for Microsoft Applications*
<http://www.f5.com/microsoft>

Appendix B: Benchmark Testing Detail

Table 1: Key Benchmark Test Parameters

Test Parameter	
Concurrent Users Tested	50,000
CRM Business Transaction Rate	374,400/hour
CRM Web Request Rate	2.4 million/hour
Database Size	340 GB
CRM Database Server	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*; 48GB RAM (12x4GB) 1066 MHz
CRM Web Servers	
▪ Server 1:	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*; 18GB RAM (18x1GB) 1066 MHz
▪ Server 2:	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*; 18GB RAM (18x1GB) 1066 MHz
CRM Async Server	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*; 18GB RAM (18x1GB) 1066 MHz

**2 socket, quad-core Intel Xeon 5570 with HyperThreading technology, 16 processor threads, 2.93 GHz*

Table 2: Key Benchmark Results

Metric	Result*
Atomic Web Request response time	.12 seconds
CPU Utilization – CRM Servers	50.9%
CPU Utilization – CRM Async Server	24%
CPU Utilization – SQL Server	57.2%

**Average value over the duration of the testing process*

Table 3: Row counts for tables with 10,000+ rows at test completion

Table	Total Rows
ActivityPartyBase	42490992
ActivityPointerBase	17264973
AnnotationBase	14140254
QueueItemBase	7445824
QuoteBase	6955078
CustomerAddressBase	5300252
QuoteCloseBase	4909655
TaskBase	4852155
TaskExtensionBase	4852155
OpportunityBase	4597937
QuoteDetailBase	4500224
OpportunityProductBase	4489000

Table 3: Row counts for tables with 10,000+ rows at test completion (cont.)

Table	Total Rows
UserQueryBase	2940049
OpportunityCloseBase	2454811
EmailBase	2365908
LeadAddressBase	1877344
ContactExtensionBase	1447786
ContactBase	1447786
SalesOrderBase	1227479
AccountBase	1202341
AccountExtensionBase	1202340
PrincipalObjectAccess	1114887
LeadBase	950702
OrderCloseBase	818313
IncidentBase	818151
PhoneCallBase	612649
SubjectBase	409268
FaxBase	409165
LetterBase	409162
AppointmentBase	409161
InvoiceBase	409156
SalesOrderDetailBase	409153
InvoiceDetailBase	409152
AsyncOperationBase	383565
SyncEntry_8360599ead36de11979e001cc46afa5e	306911
WorkflowLogBase	273011
SystemUserPrincipals	180003
CalendarBase	120123
CalendarRuleBase	120122
InternalAddressBase	120044
QueueBase	120002

Table 4: Business Scenarios Tested

Business Cases	
AccountActivityRollup	DeleteLead
AccountOppRollup	DeleteNoteOnAccount
AccountSCRollup	DeleteNoteOnContact
AddActivityToAccount	DeleteNoteOnLead
AddActivityToLead	DeleteNoteOnOpportunity
AdvancedFindAccount	DeleteNoteOnTask

Table 4: Business Scenarios Tested (cont.)

Business Cases	
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	

Table 5: CRM Database Server hardware

CRM Database Server	
Manufacturer	Intel
Operating System	Microsoft Windows Server® 2008 Enterprise 64-bit
Processor	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*
Network Adapter	1 GB Dual Port NIC
RAM	48 GB (12x4GB) 1066MHz
Software	Microsoft SQL Server 2008 Enterprise Edition SP1
Direct Attached Storage:	
Disk Array Enclosure	Newisys JBOD NDS-2240
I/O Controller	LSI 8888ELP
Intel X25-E SSDs	20
▪ Data	3 X 234.69 GB (~340 GB SQL Data)
▪ Log	234.69GB
▪ TempDb	234.69GB

*2 socket, quad-core Intel Xeon 5570with HyperThreading technology, 16 processor threads, 2.93 GHz

Table 6: CRM Web Servers (2) hardware

CRM Web Servers	
Manufacturer	Intel
Operating System	Microsoft Windows Server® 2008 Enterprise 64-bit
Processor	2 socket, quad-core Intel Xeon 5570, 2.93 GHz*
Network Adapter	1 GB NIC
RAM	18 GB (18x1GB)
Software	Microsoft Dynamics CRM 4.0 Rollup 4

*2 socket, quad-core Intel Xeon 5570with HyperThreading technology, 16 processor threads, 2.93 GHz

Table 7: CRM Async Server hardware

Async Server	
Manufacturer	Intel
Operating System	Microsoft Windows Server® 2008 Enterprise 64-bit
Processor	2 socket, quad-core Intel Xeon 5570, 2.93 GHz
Network Adapter	1 GB NIC
RAM	18 GB (18x1GB)
Software	Microsoft Dynamics CRM 4.0 Rollup 4

*2 socket, quad-core Intel Xeon 5570with HyperThreading technology, 16 processor threads, 2.93 GHz

Table 8: Load Balancer Hardware

Load Balancer	
Manufacturer	F5
Model	BIG-IP Local Traffic Manager
Balancing algorithm	Round Robin

Table 9: Load Generation Servers (10) hardware

Load Generation Servers	
Manufacturer	HP
Model	DL 380 G5
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: Key Benchmark Component Details

This benchmark testing effort leveraged a number of key hardware components, as well as Microsoft SQL Server 2008 Enterprise Edition, which are described in greater detail in the following sections.

Intel® Xeon® Processor 5500 Series

The Intel® Xeon® Processor 5500 series brings together a number of innovative technologies to deliver intelligent performance:

- Intel® Turbo Boost Technology, together with Intel® Intelligent Power Technology, delivers performance on demand, letting processors operate above the rated frequency to speed specific workloads and reduce power consumption during low utilization periods.
- Intel® Hyper-Threading Technology† benefits from larger caches and massive memory bandwidth, delivering greater throughput and responsiveness for multi-threaded applications.
- Intel® QuickPath Technology and an integrated memory controller speed traffic between processors and I/O controllers for bandwidth intensive applications, delivering up to 3.5x the bandwidth for technical computing.

Note: For additional information about these technologies, see the paper *Intel® Xeon® Processor 5500 Series: An Intelligent Approach to IT Challenges* at: <http://www.intel.com/Assets/PDF/prodbrief/xeon-5500.pdf>

The following lists highlight the key benefits, technologies, and applications associated with the Intel® Xeon® Processor 5500 series.

Key Benefits

- Up to 2.25x more performance for enterprise applications
- Up to 50 percent lower system idle power²⁰
- Up to 18 slots DIMM with up to 144 GB DDR3 memory
- Up to 42 lanes PCI Express (36 lanes PCI Express 2.0)

Key Technologies

- Two Intel® Xeon® Processor 5500 series
- Intel® Turbo Boost Technology
- Intel® Hyper-Threading Technology
- 8 MB shared L3 cache featuring Enhanced Smart Cache
- Intel® QuickPath Technology
- Intel® Intelligent Power Technology
- Intel® Virtualization Technology

Key Applications

- Exceptional performance / efficiency for general-purpose business computing including:
 - E-mail servers
 - Web servers
 - File server
 - Business applications
- Flexible infrastructure for virtualization



Intel® X25-E Extreme SATA Solid State Drives

The Intel X25-E Extreme SATA Solid-State Drive (SSD) features the latest-generation native SATA interface with an architecture using 10 parallel NAND flash channels equipped with single-level cell NAND flash memory lithography (50nm). With powerful Native Command Queuing to enable up to 32 concurrent operations, these Intel SSDs drastically outperform traditional hard disk drives.

SSDs contain no moving parts; they are silicon-based storage devices that are comprised of an array of NAND FLASH parts. Intel's SSD control logic can exploit parallelism, such that several small IO requests can be handled simultaneously, or one large request can be aggregated, across multiple NAND components.

From a solutions perspective, SSD-based storage provides significantly better price/performance and TCO benefits than do traditional hard disk drives (HDDs), especially for the right classes of application. For example, when handling random IO request traffic, HDDs have to seek out a new location for each operation, which can impose substantial latency.

The highly concurrent but typically unrelated queries found in many CRM applications (such as Microsoft Dynamics CRM 4.0) result in many random IO requests to the storage subsystem. Intel SSDs can provide very low response latency for these requests, even when multiple outstanding requests are queued at each device. This enables the SQL middleware running under the CRM application to operate more efficiently, allowing higher application throughput with less CPU resource utilization. In addition, because SSDs can handle many more IO requests than HDDs, the storage subsystem can be comprised of considerably fewer devices, reducing both space and thermal demands.

Microsoft SQL Server 2008 Enterprise Edition

Microsoft SQL Server 2008 Enterprise Edition provides a trusted, productive, and intelligent data platform that enables you to run your most demanding mission critical applications, reduce time and cost of development and management of applications, and deliver actionable insight to your entire organization. SQL Server 2008 Enterprise provides the highest levels of security, reliability, and scalability.

SQL Server 2008 Enterprise offers a variety of enterprise-only features, including:

- Unlimited Virtualization
- Data and Backup Compression
- Resource Governor
- Transparent Data Encryption
- All actions audited
- Extensible Key Management
- Advanced Data Mining algorithms
- Mirrored Backups
- Oracle Publishing
- IA64 hardware support

Note: For additional information about Microsoft SQL Server 2008 Enterprise Edition, see the Microsoft SQL Server 2008 Enterprise Edition home page at:

<http://www.microsoft.com/sqlserver/2008/en/us/enterprise.aspx>

F5 Big IP Local Traffic Manager

F5's BIG-IP Local Traffic Manager (LTM) is designed to allow customers to leverage the power of the network to provide high availability, scalability, and increased performance for applications and services such as Microsoft Dynamics. As part of F5's commitment to supporting Microsoft technologies, F5 regularly participates in joint test engagements like these in order to ensure continuing compatibility.

The BIG-IP LTM is a port dense network appliance with a custom architecture built specifically for consistent and accelerated network performance. The model used in this testing was the BIG-IP LTM 3600, which is capable of nearly 2 G/s of sustained traffic by using its dual core CPU architecture. With 8 tri-speed copper ports and 2 optional fiber ports, the LTM 3600 can attach to multiple networks, allowing separate access paths for internal and external users. The LTM 3600 is one of 5 different BIG-IP LTM platforms that allow customers to find the model that best suits their needs.

Note: For additional information about F5's BIG IP LTM, see the following resources:

- *Why do I need F5 for my Microsoft Dynamics CRM deployment?*
<http://www.f5.com/solutions/applications/microsoft/dynamics-crm/>
- *F5 Solutions for Microsoft Applications*
<http://www.f5.com/microsoft>