

ESRP Storage Program
EMC Celerra NS40 (3,000 User) Storage Solution for
Microsoft Exchange Server 2007 SP1

Tested with: ESRP – Storage Version 2.1
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Content

Overview	4
Disclaimer	4
Features	4
Solution Description	5
Targeted Customer Profile	8
Tested Deployment	9
Simulated Exchange Configuration	9
Primary Storage Hardware	10
Primary Storage Software	10
Primary Storage Disk Configuration (Mailbox Store Disks)	11
Primary Storage Disk Configuration (Transactional Log Disks)	11
Streaming backup	11
Replication Configuration	11
Best Practices	12
Core Storage	12
Backup Strategy	12
Test Result Summary	13
Reliability	13
Primary Storage Performance Results	13
Streaming Backup/Recovery Performance	14
Database Read-Only Performance	14
Log Read-only Performance	14
Conclusion	15
Contact Information	15
Appendix A: Stress Test Reports (24 hrs Performance Test)	16
Appendix B: Performance Test Reports (2 hrs)	22
Appendix C: Database Read-only Performance	28
Appendix D: Log Read-only Performance Test Reports	31
Appendix E: Maximum Solution IOPS Testing	35

Overview

This document provides information on an EMC® Celerra® NS40 storage solution for Microsoft Exchange Server 2007, based on the *Microsoft Exchange Solution Reviewed Program (ESRP) – Storage program**. For any questions or comments regarding the contents of this document, see the [Contact Information](#).

*The *ESRP – Storage* program was developed by Microsoft Corporation to provide a common storage testing framework for vendors to provide information on its storage solutions for Microsoft Exchange Server software. For more details on the *Microsoft ESRP- Storage program*, visit the website

<http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.mspx>

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Features

This document describes an approach that can be used to configure Microsoft Exchange 2007 SP1 with an EMC Celerra NS40 storage system. The EMC Celerra NS40 meets the storage needs of a wide range of applications that include:

- Mail/Messaging
- Databases
- File/Print and Web services
- Distributed applications
- Remote replication

In addition, the NS40 supports a wide range of server operating environments such as Microsoft Windows, Linux, Solaris, AIX, HP-UX and VMware ESX Server.

The Celerra NS40 is a high-performance, full function IP storage platform. It delivers NAS and iSCSI capabilities to consolidate application storage and file

servers in either an integrated configuration, or as a gateway connected to a CLARiiON® or Symmetrix® storage system.

Easy to deploy and simple to manage, the NS40 integrated system is all-in-one IP storage for customers looking for enterprise-class capabilities packaged for specific applications, departments, or locations. The NS40 integrated system provides customers the flexibility to combine Fibre Channel SAN connectivity with a NAS environment. The NS40 gateway is the most cost-effective way to add NAS and iSCSI to an existing EMC SAN environment. Both offerings are available in single- and dual-blade configurations.

Regardless of the configuration, Celerra platforms offer a full suite of advanced functionality:

- Robust snap and replication capabilities offer protection of data.
- Celerra File Mover API allows automated policy-based movement of files between tiers of storage.
- File-level retention provides disk-based Write Once Read Many (WORM) functionality, which is useful for archiving Exchange emails.
- Automated Volume Management and Virtual Provisioning™ improve storage utilization.

The performance results and best practices discussed in this document provide proven guidelines for configuring the Celerra NS40 for high-performance Exchange environments. For this solution, an integrated Celerra NS40 storage system was used and configured for 3,000 Exchange 2007 users. Each of the 3,000 users had a profile of 0.5 IOPS and a 250 MB mailbox.

Solution Description

Sizing and configuring storage for use with Microsoft Exchange Server is a complicated process, driven by many variables and factors, which vary from organization to organization.

One method often used to simplify the sizing and configuration of large amounts of EMC Celerra NS40 storage for use with Microsoft Exchange Server 2007 is to define a unit of measure. This unit of measure is known as a building block. The Microsoft Exchange Server 2007 building block is defined as six disk spindles, four spindles for Exchange database and two spindles for Exchange log.

The testing in this document proves that two building blocks (eight spindles for the databases and four spindles for logs) can integrate and exceed the

Microsoft Exchange Server recommended metrics for reliability, scalability, and performance.

This unit of measure or building block needs to be scalable. In that way, an organization can simply take this block of work and multiply it by some factor until the desired number of Microsoft Exchange Server users has been properly met or configured to satisfy the Microsoft Exchange Server recommended performance metrics.

If each unit is properly configured, it will match the Microsoft Exchange Server recommendations for a healthy-performing system – from both a disk and an end-user perspective.

[Table 1](#) describes the characteristics of the storage configuration defined on the server.

Table 1: Single Server Characteristics

Number of users	3,000
Number of Exchange Servers	1
IOPS per user	0.5
Mailbox size	250 MB
Number of disks required for Logs and Database	24 (16 for database and 8 for log)
Disk type	300 GB 15k Fibre Channel
RAID type	1

Using the performance characteristics of the Celerra NS40 architecture and the I/O capability of the 300 GB, 15k disk drives, 24 spindles are required to provide the necessary performance to match the I/O requirements of 3,000; 0.5 IOPS users with a 1:1 read/write ratio.

See [Figure 1 on page 7](#) for a view of the four building block disk layout on a Celerra NS40.

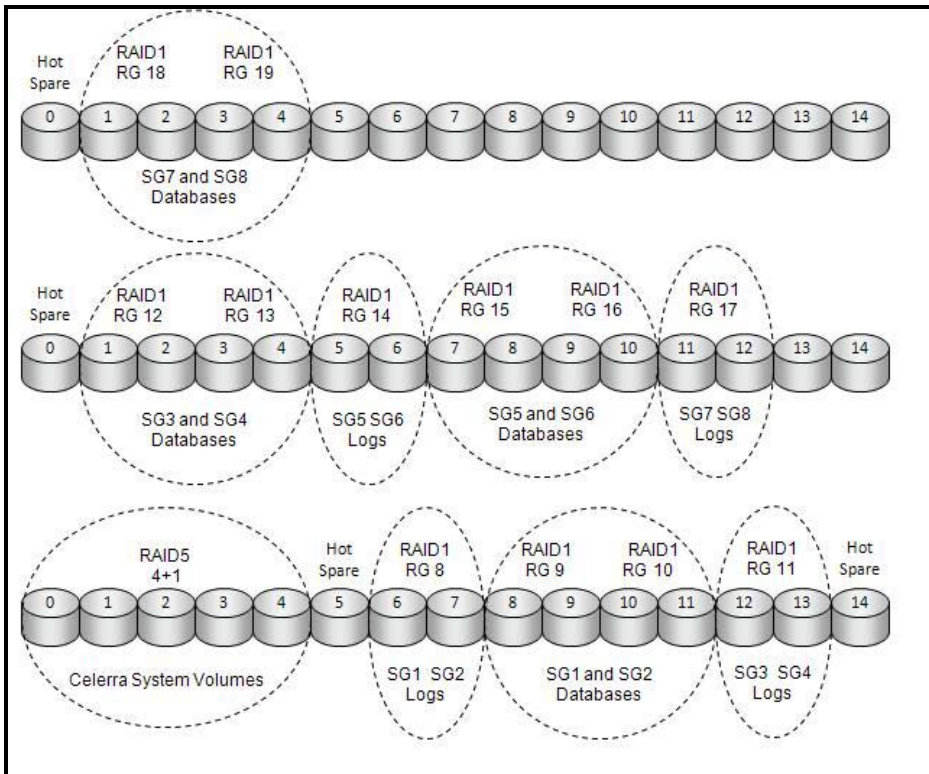


Figure 1: Disk Configuration

The Exchange databases for SG1 and SG2 are striped over four disk spindles from two 1+1 RAID 1 groups. The Exchange databases for SG3 and SG4 are striped over another four disk spindles from an additional two 1+1 RAID 1 groups. The logs for SG1 and SG2 will be stored on a single 1+1 RAID 1 group. The logs for SG3 and SG4 will be stored on another single 1+1 RAID 1 group.

The ESRP-Storage program focuses on storage solutions testing to address performance and reliability issues with storage design. However, storage is not the only factor to take into consideration when designing a scalable Exchange solution.

Other factors that affect the server scalability are:

- Server processor utilization
- Server physical and virtual memory limitations
- Resource requirements for other applications
- Directory and network service latencies
- Network infrastructure limitations
- Replication and recovery requirements
- Client usage profiles

Due to such variables, the number of mailboxes hosted per server, as part of the tested configuration, may not necessarily be viable for some customer deployments.

For more information on identifying and addressing performance bottlenecks in an Exchange system, refer to Microsoft's Troubleshooting Microsoft Exchange Server Performance, available at <http://go.microsoft.com/fwlink/?LinkId=23454>

Targeted Customer Profile

The solution is intended for medium-to-large Enterprise Exchange customers who would like to consolidate their Exchange users on a high-performance, highly available storage platform. This configuration is designed to support 3,000 Exchange users, with the following assumptions:

- One Exchange Jetstress Server
- 3,000 users per Exchange Server
- User I/O profile for testing – 0.42 (0.5 IOPs tested)
- User mailbox size for testing - 250 MB
- 8 Exchange storage groups
- One Mailbox database per storage group

Tested Deployment

The tables in this section summarize the testing environment.

Simulated Exchange Configuration

Table 2 lists the simulated Exchange configuration details.

Table 2: Simulated Exchange Configuration

Number of Exchange mailboxes simulated	3,000
Number of hosts	1
Number of mailboxes/host	3,000
Number of storage groups/host	8
Number of mailbox stores/storage group	1
Number of mailboxes/mailbox store	375
Number of mailbox store LUNs/storage group	1
Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)	0.5
Database LUN size	237.8 GB
Log LUN size	119 GB
Backup LUN size/storage group	N/A
Total database size for performance testing	1522.26 GB
% formatted storage capacity used by Exchange database**	80%

**Storage performance characteristics change based on the percentage utilization of the individual disks. Tests that use a small percentage of the storage (~25 percent) may exhibit reduced throughput if the storage capacity utilization is significantly increased beyond what is tested in this paper.

Primary Storage Hardware

Table 3 lists the hardware used in the environment.

Table 3: Hardware (list of all hardware used for the test)

Storage Connectivity (Fibre Channel, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	EMC Celerra Version 5.6.39.5
Storage cache	2 GB spilt for Write/Read
Number of storage controllers	4 (2 Frontend, 2 Backend)
Number of storage ports	4 (of the total 8 ports, 4 are passive/redundant)
Maximum bandwidth of storage connectivity to host	4x1 Gb iSCSI Total Bandwidth 4 Gb/s
Switch type/model/firmware revision	Cisco/ 6509E/IOS-12.2
HBA model and firmware	Intel PRO/1000 PT Dual Core
Number of HBAs/host	2 Quad Port HBAs
Host server type	Server 2950
Total number of disks tested in solution	24
Maximum number of spindles can be hosted in the storage	60

Primary Storage Software

Table 4 lists the software used in the environment.

Table 4: Primary Storage Software

HBA driver	Microsoft iSCSI Initiator 2.07
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	Multiple connections per session
Host OS	Microsoft Windows Server 2008 Enterprise 6.0.6001 Service Pack1 Build 6001
ESE.dll file version	08.01.0240.006
Replication solution name/version	N/A

Primary Storage Disk Configuration (Mailbox Store Disks)

Table 5 lists the disk configuration (mailbox store disks) for the environment.

Table 5: Storage Disk Configuration (mailbox store)

Disk type, speed and firmware revision	4 GB/s FC 15k rpm - 60AC
Raw capacity per disk (GB)	300 GB
Number of physical disks in test	16
Total raw storage capacity (GB)	4800 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	2 Disks per LUN
Raid level	RAID 1
Total formatted capacity	1902.4 GB
Storage capacity utilization	39.63%
Database capacity utilization	31.71%

Primary Storage Disk Configuration (Transactional Log Disks)

Table 6 lists the disk configuration (transactional log disks) for the environment.

Table 6: Storage Disk Configuration (Transactional Log Disks)

Disk type, speed and firmware revision	4 GB/s FC 15k rpm- 60AC
Raw capacity per disk (GB)	300 GB
Number of spindles in test	8
Total raw storage capacity (GB)	2400 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	2 disks per LUN
Raid level	RAID 1
Total formatted capacity	476 GB

Streaming Backup

N/A

Replication Configuration

N/A

Best Practices

Exchange Server is a disk-intensive application. Based on the testing run using the ESRP framework, EMC recommends the Exchange 2007 SP1 best practices to improve the storage performance.

For Exchange 2007 best practices on storage design, visit the website <http://technet.microsoft.com/en-us/library/bb124518.aspx>

Core Storage

Based on the testing run using an ESRP framework, EMC recommends the following best practices to improve the storage performance with Exchange solutions:

1. Isolate the Microsoft Exchange Server database workload from other I/O-intensive applications or workloads. This ensures the highest levels of performance for Microsoft Exchange and simplifies troubleshooting in the event of a disk-related Microsoft Exchange performance problem.
2. The Microsoft Exchange Server logs and databases should be separated onto different physical disks and in different RAID groups.
3. Size and configure the environment based on disk spindle performance as a primary consideration, with spindle or storage capacity as secondary issue. In other words, size the disk for performance first and make the capacity requirements work.

For Microsoft's Exchange 2007 best practices on storage design, visit the website <http://technet.microsoft.com/en-us/library/bb124518.aspx>

Backup Strategy

A well-designed and implemented disaster recovery strategy should be a top priority for every Microsoft Exchange Server deployment. Proper planning must be done prior to configuration to meet the required service-level agreements (SLAs) for server downtime. Various backup and restore strategies can be implemented, depending on the requirements of the environment. EMC offers multiple solutions to protect an Exchange environment. EMC Replication Manager can manage snapshot and replication in an Exchange environment. EMC NetWorker® allows an Exchange environment to be backed up to tape or to disk. Both of these products have been proven to work in conjunction with Volume Shadow Copy Services (VSS), having undergone vigorous testing.

Test Result Summary

This section provides a high-level summary of the test data from ESRP, and provides links to the detailed reports, which are generated by the ESRP testing Framework.

Reliability

A number of the tests in the framework are designed to test reliability over a 24-hour period. The goal of these tests is to verify that the storage can handle high I/O load for long period of time. Following the stress test, both the log and database are analyzed for integrity to ensure that there is no database/log corruption.

The following are the results of the reliability test executed on the Celerra NS40:

- No errors were reported in the event log file for the storage reliability testing
- No errors were reported for the database and log checksum

The following tests are out-of-scope of this test scenario:

- Back-to-disk test
- Database checksum on the remote storage database

The Jetstress performance results (24-hour performance test) can be found in [Appendix A: Stress Test Reports on page 16](#).

Primary Storage Performance Results

The Primary Storage performance testing is designed to exercise the storage with maximum sustainable Exchange-type I/O for two hours. The test is used to show how long it takes for the storage to respond to an I/O under load. The data included in the following tables is a sample taken from each of the attached hosts. It is the average of all the logical disks in the two-hour test duration.

Table 7: Performance Test Results

Database I/O	
Average Database Disk Transfers/sec	1773.39
Average Database Disk Reads/sec	938.93
Average Database Disk Writes/sec	834.46
Average Database Disk Read Latency (ms)	12.8750
Average Database Disk Write Latency (ms)	4.00

Transaction Log I/O	
Average Log Disk Writes/sec	550.84
Average Log Disk Write Latency (ms)	2.00

To view the Jetstress performance results (2-hour performance test), refer to [Appendix B: Performance Test Reports \(2 hrs\) on page 19](#).

To view the results that characterize the maximum performance of the disk layout, refer to [Appendix E: Maximum Solution IOPS Testing on page 31](#).

Streaming Backup/Recovery Performance

There are two tests in this section. The first test is to measure the read I/O performance metrics by running checksum on all the databases and log files. The second test is to measure the end-to-end performance when the databases are backed up to disks.

Database Read-Only Performance

The test is to measure the maximum rate at which databases could be streaming backed up. The following table shows the average rate for a single database file.

Table 8: Database Read-Only Performance

MB Read/sec per storage group	23.33
MB Read/sec total	186.65
File Size/sec taken	1558779.2

To view the Jetstress Streaming Backup Test results, refer to [Appendix C: Database Read-only Performance on page 28](#).

Log Read-only Performance

To view the Jetstress Soft Recovery Test results, refer to the section [Appendix D: Log Read-only Performance Test Reports on page 31](#).

Log Read-only Performance test measures the log replay rate for each Storage group. The test also exercises the log file checksum performance, DB checksum performance and log generation performance. After the Log Read-Only Performance test, the databases are cleanly shutdown, and the log files are deleted.

The following table shows the average rate for 500 log files played in a single storage group for each server. Each Log file is 1 MB in size.

Table 9: Log Read-Only Performance

Average time to play one log file (sec)	3.23
---	------

Conclusion

As this document illustrates, EMC's Celerra NS40 is more than capable of supporting deployments of up to 3,000 users at 0.5 IOPs per user. A careful analysis of each environment must be performed to understand the specific requirements of the architecture and to adopt a solution that best fits those needs. The information included in this document verifies that the NS40 can support a high-performance Exchange configuration. This solution does not include local or remote replication. The addition of those features may affect performance.

Note that neither local nor remote replication were part of the solution.

This document is developed by EMC, and reviewed by the Microsoft Exchange Product team. The test results/data presented in this document are based on the tests introduced in the ESRP framework. The customer should not quote the data directly for the pre-deployment verification. It is still necessary to go through the exercises to validate the storage design for a specific customer environment.

The ESRP program is not designed to be a benchmark program; tests are not designed to get the maximum throughput for a given solution. Rather, it is focused on producing recommendations from vendors for the exchange application. Therefore, the data presented in this document should not be used for direct comparisons among the solutions.

Contact Information

EMC recommends that you consult with EMC Professional Services to assist with the design and deployment of a similar solution. For information regarding this or any other EMC Solution, please use the following numbers:

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<http://EMC.com> or
<http://powerlink.EMC.com>

Appendix A: Stress Test Reports (24 hrs Performance Test)

Microsoft Exchange Server Jetstress
Stress Test Result Report
Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 11/7/2008 5:30:03 AM

Test End Time 11/8/2008 5:45:10 AM

Jetstress Version 08.02.0060.000

Ese Version 08.01.0240.005

Operating System Windows Server (R) 2008 Enterprise Service Pack 1
(6.0.6001.65536)

Performance Log C:\Program Files\Exchange
Jetstress\Stress_2008_11_7_5_30_23.blg
C:\Program Files\Exchange
Jetstress\DBChecksum_2008_11_8_5_45_10.blg

Database Sizing and Throughput

Achieved I/O per Second 1736.07

Capacity Percentage 100%

Throughput Percentage 100%

Initial database size 1634481602560

Final database size 1699783770112

Database files (count) 8

Jetstress System Parameters

Thread count 7 (per-storage group)

Log buffers 9000

Minimum database cache 256.0 MB

Maximum database cache 2048.0 MB

Insert operations 40%

Delete operations 30%

Replace operations 5%

Read operations 25%

Lazy commits 55%

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.013	0.004	118.065	99.328	(n/a)
Database (F:)	0.013	0.004	118.155	99.362	(n/a)
Database (G:)	0.013	0.004	118.094	99.443	(n/a)
Database (H:)	0.014	0.004	117.969	99.020	(n/a)
Database (I:)	0.013	0.004	117.694	98.551	(n/a)
Database (J:)	0.013	0.004	117.913	99.152	(n/a)
Database (K:)	0.014	0.004	117.880	98.725	(n/a)
Database (L:)	0.014	0.004	117.835	98.884	(n/a)
Log (M:)	0.003	0.002	0.972	66.038	4418.453
Log (N:)	0.003	0.002	0.967	66.170	4412.969
Log (O:)	0.003	0.002	0.969	66.442	4402.892
Log (P:)	0.003	0.002	0.978	66.382	4401.528
Log (Q:)	0.003	0.002	0.968	66.143	4390.389
Log (R:)	0.003	0.002	0.965	66.446	4392.248
Log (S:)	0.003	0.002	0.961	66.159	4377.044
Log (T:)	0.003	0.002	0.969	66.359	4382.913

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.621	2.367	27.106
Available MBytes	28179.799	28020.000	28409.000
Free System Page Table Entries	33558461.136	33557430.000	33559237.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	56689111.712	54468608.000	58040320.000
Pool Paged Bytes	113931781.069	113377280.000	144072704.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/7/2008 5:29:32 AM -- Jetstress testing begins ...

11/7/2008 5:30:03 AM -- Jetstress testing begins ...

11/7/2008 5:30:03 AM -- Prepare testing begins ...

11/7/2008 5:30:12 AM -- Attaching databases ...
 11/7/2008 5:30:12 AM -- Prepare testing ends.
 11/7/2008 5:30:12 AM -- Dispatching transactions begins ...
 11/7/2008 5:30:12 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
 11/7/2008 5:30:12 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
 11/7/2008 5:30:23 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).
 11/7/2008 5:30:23 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).
 11/7/2008 5:30:25 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
 11/7/2008 5:30:25 AM -- Performance logging begins (interval: 15000 ms).
 11/7/2008 5:30:25 AM -- Attaining prerequisites:
 11/7/2008 5:45:03 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1933337000.0 (lower bound: 1932735000.0, upper bound: none)
 11/8/2008 5:45:04 AM -- Performance logging ends.
 11/8/2008 5:45:04 AM -- JetInterop batch transaction stats: 281085, 281352, 281618, 280734, 280143, 281156, 280012, and 280773.
 11/8/2008 5:45:04 AM -- Dispatching transactions ends.
 11/8/2008 5:45:04 AM -- Shutting down databases ...
 11/8/2008 5:45:10 AM -- Instance3796.1 (complete), Instance3796.2 (complete), Instance3796.3 (complete), Instance3796.4 (complete), Instance3796.5 (complete), Instance3796.6 (complete), Instance3796.7 (complete), and Instance3796.8 (complete)
 11/8/2008 5:45:12 AM -- Performance logging begins (interval: 30000 ms).
 11/8/2008 5:45:12 AM -- Verifying database checksums ...
 11/8/2008 8:13:12 AM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
 11/8/2008 8:13:13 AM -- Performance logging ends.
 11/8/2008 8:13:13 AM -- C:\Program Files\Exchange Jetstress\DBChecksum 2008 11 8 5 45 10.blg has 295 samples.
 11/8/2008 8:13:18 AM -- C:\Program Files\Exchange Jetstress\DBChecksum 2008 11 8 5 45 10.html is saved.
 11/8/2008 8:13:18 AM -- Verifying log checksums ...
 11/8/2008 8:13:19 AM -- M:\ (2 logs passed), N:\ (3 logs passed), O:\ (2 logs passed), P:\ (2 logs passed), Q:\ (2 logs passed), R:\ (2 logs passed), S:\ (2 logs passed), and T:\ (3 logs passed)
 11/8/2008 8:13:19 AM -- C:\Program Files\Exchange Jetstress\Stress 2008 11 7 5 30 23.blg has 5815 samples.
 11/8/2008 8:13:19 AM -- Creating test report ...
 11/8/2008 8:13:53 AM -- Volume E: has 0.0128 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume F: has 0.0130 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume G: has 0.0134 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume H: has 0.0135 for Avg. Disk sec/Read.

11/8/2008 8:13:53 AM -- Volume I: has 0.0135 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume J: has 0.0134 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume K: has 0.0136 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume L: has 0.0135 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume M: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume M: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume N: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume N: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume O: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume O: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume P: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume P: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume Q: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume Q: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume R: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume R: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume S: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume S: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Volume T: has 0.0020 for Avg. Disk sec/Write.
 11/8/2008 8:13:53 AM -- Volume T: has 0.0030 for Avg. Disk sec/Read.
 11/8/2008 8:13:53 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 11/8/2008 8:13:53 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 11/8/2008 8:13:53 AM -- C:\Program Files\Exchange Jetstress\Stress_2008_11_7_5_30_23.xml has 5756 samples queried.

Microsoft Exchange Server Jetstress

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
E:\Jetstress1.edb	25939394	0	0	0	202651 MBytes / 8878 seconds
F:\Jetstress1.edb	25938114	0	0	0	202641 MBytes / 8879 seconds
G:\Jetstress1.edb	25941698	0	0	0	202669 MBytes / 8859 seconds
H:\Jetstress1.edb	25939138	0	0	0	202649 MBytes /

					8858 seconds
I:\Jetstress1.edb	25934274	0	0	0	202611 MBytes / 8854 seconds
J:\Jetstress1.edb	25938882	0	0	0	202647 MBytes / 8864 seconds
K:\Jetstress1.edb	25927618	0	0	0	202559 MBytes / 8870 seconds
L:\Jetstress1.edb	25934018	0	0	0	202609 MBytes / 8869 seconds
(Sum)	207493136	0	0	0	1621040 MBytes / 8880 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
E:	0.084	0.000	365.080	0.000
F:	0.086	0.000	364.882	0.000
G:	0.087	0.000	366.723	0.000
H:	0.088	0.000	366.296	0.000
I:	0.088	0.000	366.883	0.000
J:	0.087	0.000	366.367	0.000
K:	0.086	0.000	365.815	0.000
L:	0.085	0.000	365.932	0.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	19.782	10.267	22.507
Available MBytes	30258.773	30170.000	30306.000
Free System Page Table Entries	33558965.156	33558425.000	33559549.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	57980768.325	57933824.000	58187776.000
Pool Paged Bytes	114248006.292	113995776.000	114720768.000

Test Log11/7/2008 5:29:32 AM -- Jetstress testing begins ...

11/7/2008 5:30:03 AM -- Jetstress testing begins ...

11/7/2008 5:30:03 AM -- Prepare testing begins ...

11/7/2008 5:30:12 AM -- Attaching databases ...
11/7/2008 5:30:12 AM -- Prepare testing ends.
11/7/2008 5:30:12 AM -- Dispatching transactions begins ...
11/7/2008 5:30:12 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/7/2008 5:30:12 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/7/2008 5:30:23 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).
11/7/2008 5:30:23 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).
11/7/2008 5:30:25 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/7/2008 5:30:25 AM -- Performance logging begins (interval: 15000 ms).
11/7/2008 5:30:25 AM -- Attaining prerequisites:
11/7/2008 5:45:03 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1933337000.0 (lower bound: 1932735000.0, upper bound: none)
11/8/2008 5:45:04 AM -- Performance logging ends.
11/8/2008 5:45:04 AM -- JetInterop batch transaction stats: 281085, 281352, 281618, 280734, 280143, 281156, 280012, and 280773.
11/8/2008 5:45:04 AM -- Dispatching transactions ends.
11/8/2008 5:45:04 AM -- Shutting down databases ...
11/8/2008 5:45:10 AM -- Instance3796.1 (complete), Instance3796.2 (complete), Instance3796.3 (complete), Instance3796.4 (complete), Instance3796.5 (complete), Instance3796.6 (complete), Instance3796.7 (complete), and Instance3796.8 (complete)
11/8/2008 5:45:12 AM -- Performance logging begins (interval: 30000 ms).
11/8/2008 5:45:12 AM -- Verifying database checksums ...
11/8/2008 8:13:12 AM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
11/8/2008 8:13:13 AM -- Performance logging ends.
11/8/2008 8:13:13 AM -- C:\Program Files\Exchange Jetstress\DBChecksum 2008 11 8 5 45 10.blg has 295 samples.

Appendix B: Performance Test Reports (2 hrs)

Microsoft Exchange Server Jetstress

Performance Test Result Report

Test Summary

Overall Test Result	Pass
Machine Name	RTPSOL395
Test Description	
Test Start Time	11/11/2008 7:35:06 AM
Test End Time	11/11/2008 9:49:51 AM
Jetstress Version	08.02.0060.000
Ese Version	08.01.0240.005
Operating System	Windows Server (R) 2008 Enterprise Service Pack 1 (6.0.6001.65536)
Performance Log	<u>C:\Program Files\Exchange Jetstress\Performance_2008_11_11_7_35_26.blg</u> <u>C:\Program Files\Exchange Jetstress\DBChecksum_2008_11_11_9_49_51.blg</u>

Database Sizing and Throughput

Achieved I/O per Second	1776.887
Capacity Percentage	100%
Throughput Percentage	100%
Initial database size	1634515156992
Final database size	1641081339904
Database files (count)	8

Jetstress System Parameters

Thread count	7 (per-storage group)
Log buffers	9000
Minimum database cache	256.0 MB
Maximum database cache	2048.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%

Lazy commits

55%

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.013	0.004	117.128	103.545	(n/a)
Database (F:)	0.013	0.004	117.416	104.193	(n/a)
Database (G:)	0.014	0.004	119.123	105.171	(n/a)
Database (H:)	0.013	0.004	117.752	104.488	(n/a)
Database (I:)	0.013	0.004	116.727	103.908	(n/a)
Database (J:)	0.013	0.004	117.924	105.341	(n/a)
Database (K:)	0.013	0.004	117.831	103.749	(n/a)
Database (L:)	0.013	0.004	117.877	104.716	(n/a)
Log (M:)	0.003	0.002	1.030	68.198	4539.798
Log (N:)	0.003	0.002	1.015	68.350	4526.632
Log (O:)	0.003	0.002	1.027	69.269	4509.294
Log (P:)	0.003	0.002	1.043	69.374	4482.576
Log (Q:)	0.003	0.002	1.046	68.825	4506.677
Log (R:)	0.003	0.002	1.018	69.268	4475.984
Log (S:)	0.003	0.002	1.018	68.863	4505.568
Log (T:)	0.003	0.002	1.020	69.560	4466.114

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.199	2.833	10.009
Available MBytes	28321.073	28251.000	28486.000
Free System Page Table Entries	33557864.380	33557326.000	33558375.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	54953569.269	53567488.000	55209984.000
Pool Paged Bytes	111471100.793	111312896.000	111718400.000
Database Page Fault	0.000	0.000	0.000

Stalls/sec

Test Log 11/11/2008 7:35:06 AM -- Jetstress testing begins ...
11/11/2008 7:35:06 AM -- Prepare testing begins ...
11/11/2008 7:35:15 AM -- Attaching databases ...
11/11/2008 7:35:15 AM -- Prepare testing ends.
11/11/2008 7:35:15 AM -- Dispatching transactions begins ...
11/11/2008 7:35:15 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/11/2008 7:35:15 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/11/2008 7:35:26 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
11/11/2008 7:35:26 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
11/11/2008 7:35:28 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/11/2008 7:35:28 AM -- Performance logging begins (interval: 15000 ms).
11/11/2008 7:35:28 AM -- Attaining prerequisites:
11/11/2008 7:49:46 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1934500000.0 (lower bound: 1932735000.0, upper bound: none)
11/11/2008 9:49:46 AM -- Performance logging ends.
11/11/2008 9:49:46 AM -- JetInterop batch transaction stats: 25702, 25797, 26166, 26056, 25707, 25831, 25874, and 25979.
11/11/2008 9:49:47 AM -- Dispatching transactions ends.
11/11/2008 9:49:47 AM -- Shutting down databases ...
11/11/2008 9:49:51 AM -- Instance2572.1 (complete), Instance2572.2 (complete), Instance2572.3 (complete), Instance2572.4 (complete), Instance2572.5 (complete), Instance2572.6 (complete), Instance2572.7 (complete), and Instance2572.8 (complete)
11/11/2008 9:49:53 AM -- Performance logging begins (interval: 30000 ms).
11/11/2008 9:49:53 AM -- Verifying database checksums ...
11/11/2008 12:13:11 PM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
11/11/2008 12:13:12 PM -- Performance logging ends.
11/11/2008 12:13:12 PM -- C:\Program Files\Exchange Jetstress\DBChecksum_2008_11_11_9_49_51.blg has 286 samples.
11/11/2008 12:13:17 PM -- C:\Program Files\Exchange Jetstress\DBChecksum_2008_11_11_9_49_51.html is saved.
11/11/2008 12:13:17 PM -- Verifying log checksums ...
11/11/2008 12:13:18 PM -- M:\ (2 logs passed), N:\ (2 logs passed), O:\ (2 logs passed), P:\ (2 logs passed), Q:\ (2 logs passed), R:\ (2 logs passed), S:\ (2 logs passed), and T:\ (2 logs passed)
11/11/2008 12:13:18 PM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_11_7_35_26.blg has 536 samples.
11/11/2008 12:13:18 PM -- Creating test report ...

11/11/2008 12:13:21 PM -- Volume E: has 0.0125 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume F: has 0.0126 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume G: has 0.0135 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume H: has 0.0131 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume I: has 0.0133 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume J: has 0.0132 for Avg. Disk sec/Read.
 11/11/2008 12:13:21 PM -- Volume K: has 0.0133 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume L: has 0.0132 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume M: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume M: has 0.0030 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume N: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume N: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume O: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume O: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume P: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume P: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume Q: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume Q: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume R: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume R: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume S: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume S: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Volume T: has 0.0020 for Avg. Disk sec/Write.
 11/11/2008 12:13:22 PM -- Volume T: has 0.0029 for Avg. Disk sec/Read.
 11/11/2008 12:13:22 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 11/11/2008 12:13:22 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 11/11/2008 12:13:22 PM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_11_7_35_26.xml has 478 samples queried.

Microsoft Exchange Server Jetstress

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
E:\Jetstress1.edb	25040562	0	0	0	195629 MBytes / 8594 seconds
F:\Jetstress1.edb	25041074	0	0	0	195633 MBytes / 8596 seconds
G:\Jetstress1.edb	25041586	0	0	0	195637 MBytes / 8581 seconds
H:\Jetstress1.edb	25040562	0	0	0	195629 MBytes / 8580 seconds

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
I:\Jetstress1.edb	25040818	0	0	0	195631 MBytes / 8574 seconds
J:\Jetstress1.edb	25040818	0	0	0	195631 MBytes / 8577 seconds
K:\Jetstress1.edb	25041074	0	0	0	195633 MBytes / 8588 seconds
L:\Jetstress1.edb	25040818	0	0	0	195631 MBytes / 8591 seconds
(Sum)	200327312	0	0	0	1565057 MBytes / 8598 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
E:	0.084	0.000	364.275	0.001
F:	0.087	0.000	363.929	0.000
G:	0.088	0.000	365.498	0.000
H:	0.089	0.000	365.472	0.000
I:	0.089	0.000	365.791	0.000
J:	0.088	0.000	365.643	0.000
K:	0.087	0.000	365.011	0.000
L:	0.085	0.000	364.629	0.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	19.867	4.527	22.106
Available MBytes	30410.171	30334.000	30462.000
Free System Page Table Entries	33558845.322	33557782.000	33559865.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	55341800.727	55296000.000	55525376.000
Pool Paged Bytes	110743552.000	110120960.000	110903296.000

Test Log

11/11/2008 7:35:06 AM -- Jetstress testing begins ...

11/11/2008 7:35:06 AM -- Prepare testing begins ...

11/11/2008 7:35:15 AM -- Attaching databases ...

11/11/2008 7:35:15 AM -- Prepare testing ends.
11/11/2008 7:35:15 AM -- Dispatching transactions begins ...
11/11/2008 7:35:15 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/11/2008 7:35:15 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/11/2008 7:35:26 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
11/11/2008 7:35:26 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
11/11/2008 7:35:28 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/11/2008 7:35:28 AM -- Performance logging begins (interval: 15000 ms).
11/11/2008 7:35:28 AM -- Attaining prerequisites:
11/11/2008 7:49:46 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1934500000.0 (lower bound: 1932735000.0, upper bound: none)
11/11/2008 9:49:46 AM -- Performance logging ends.
11/11/2008 9:49:46 AM -- JetInterop batch transaction stats: 25702, 25797, 26166, 26056, 25707, 25831, 25874, and 25979.
11/11/2008 9:49:47 AM -- Dispatching transactions ends.
11/11/2008 9:49:47 AM -- Shutting down databases ...
11/11/2008 9:49:51 AM -- Instance2572.1 (complete), Instance2572.2 (complete), Instance2572.3 (complete), Instance2572.4 (complete), Instance2572.5 (complete), Instance2572.6 (complete), Instance2572.7 (complete), and Instance2572.8 (complete)
11/11/2008 9:49:53 AM -- Performance logging begins (interval: 30000 ms).
11/11/2008 9:49:53 AM -- Verifying database checksums ...
11/11/2008 12:13:11 PM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
11/11/2008 12:13:12 PM -- Performance logging ends.
11/11/2008 12:13:12 PM -- C:\Program Files\Exchange Jetstress\DBChecksum 2008 11 11 9 49 51.blg has 286 samples.

Appendix C: Database Read-only Performance

Microsoft Exchange Server Jetstress

Streaming backup Test Result Report

Streaming Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance3180.1	194845.40	02:36:27	20.76
Instance3180.2	194845.40	02:34:41	20.99
Instance3180.3	194845.40	02:34:50	20.97
Instance3180.4	194845.40	02:34:49	20.98
Instance3180.5	194845.40	02:35:54	20.83
Instance3180.6	194845.40	02:35:30	20.88
Instance3180.7	194845.40	02:36:03	20.81
Instance3180.8	194845.40	02:35:57	20.82

Jetstress System Parameters

Thread count	7 (per-storage group)
Log buffers	9000
Minimum database cache	256.0 MB
Maximum database cache	2048.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%
Lazy commits	55%

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.006	0.000	165.429	0.000	(n/a)
Database (F:)	0.006	0.000	166.444	0.004	(n/a)
Database (G:)	0.006	0.000	166.448	0.004	(n/a)
Database (H:)	0.006	0.000	166.442	0.004	(n/a)
Database	0.006	0.000	166.448	0.003	(n/a)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
(I:)					
Database	0.006	0.000	166.453	0.003	(n/a)
(J:)					
Database	0.006	0.000	166.471	0.002	(n/a)
(K:)					
Database	0.006	0.000	166.467	0.003	(n/a)
(L:)					
Log (M:)	0.000	0.000	0.000	0.000	13.170
Log (N:)	0.000	0.000	0.000	0.004	49.320
Log (O:)	0.000	0.000	0.000	0.004	47.936
Log (P:)	0.000	0.000	0.000	0.004	48.436
Log (Q:)	0.000	0.000	0.000	0.003	21.299
Log (R:)	0.000	0.000	0.000	0.003	34.133
Log (S:)	0.000	0.000	0.000	0.003	21.596
Log (T:)	0.000	0.000	0.000	0.002	21.596

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	21.521	17.857	24.171
Available MBytes	30571.923	29846.000	30607.000
Free System Page Table Entries	33558106.234	33557046.000	33558273.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	48864505.436	48783360.000	48971776.000
Pool Paged Bytes	117107029.333	109568000.000	895565824.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/18/2008 4:47:33 AM -- Jetstress testing begins ...
11/18/2008 4:47:34 AM -- Prepare testing begins ...
11/18/2008 4:47:43 AM -- Attaching databases ...
11/18/2008 4:47:43 AM -- Prepare testing ends.
11/18/2008 4:47:54 AM -- Performance logging begins (interval: 30000 ms).
11/18/2008 4:47:54 AM -- Streaming backup databases ...
11/18/2008 7:24:21 AM -- Performance logging ends.
11/18/2008 7:24:21 AM -- Instance3180.1 (100% processed),
Instance3180.2 (100% processed), Instance3180.3 (100% processed),
Instance3180.4 (100% processed), Instance3180.5 (100% processed),
Instance3180.6 (100% processed), Instance3180.7 (100% processed), and
Instance3180.8 (100% processed)
11/18/2008 7:24:21 AM -- C:\Program Files\Exchange
Jetstress\StreamingBackup_2008_11_18_4_47_43.blg has 312 samples.
11/18/2008 7:24:21 AM -- Creating test report ...

Appendix D: Log Read-only Performance Test Reports

Microsoft Exchange Server Jetstress

SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance3648.1	502	1618.6166034
Instance3648.2	500	1631.6116533
Instance3648.3	508	1635.0593196
Instance3648.4	511	1636.6505502
Instance3648.5	500	1636.6505502
Instance3648.6	515	1640.0982165
Instance3648.7	506	1637.7113706
Instance3648.8	502	1630.2856278

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.247	0.059	136.572	3.322	(n/a)
Database (F:)	0.254	0.060	135.730	3.310	(n/a)
Database (G:)	0.252	0.064	136.511	3.269	(n/a)
Database (H:)	0.255	0.058	139.291	3.277	(n/a)
Database (I:)	0.239	0.068	135.346	3.282	(n/a)
Database (J:)	0.246	0.060	135.109	3.234	(n/a)
Database (K:)	0.245	0.055	136.496	3.314	(n/a)
Database (L:)	0.258	0.054	136.285	3.317	(n/a)
Log (M:)	0.037	0.000	10.158	0.025	90.505
Log (N:)	0.036	0.001	10.118	0.021	57.818
Log (O:)	0.037	0.001	10.281	0.023	69.620
Log (P:)	0.040	0.001	10.331	0.015	65.644
Log (Q:)	0.042	0.001	10.117	0.017	45.943

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Log (R:)	0.041	0.000	10.213	0.007	40.256
Log (S:)	0.043	0.001	10.204	0.012	56.295
Log (T:)	0.039	0.001	10.160	0.023	59.830

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.097	0.000	41.989
Available MBytes	28572.083	27820.000	30360.000
Free System Page Table Entries	33558218.988	33557733.000	33558388.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	62407238.275	59170816.000	62746624.000
Pool Paged Bytes	130989829.020	115126272.000	1050820608.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log11/19/2008 6:52:43 AM -- Jetstress testing begins ...
11/19/2008 6:52:43 AM -- Prepare testing begins ...
11/19/2008 6:52:52 AM -- Attaching databases ...
11/19/2008 6:52:52 AM -- Prepare testing ends.
11/19/2008 6:52:52 AM -- Dispatching transactions begins ...
11/19/2008 6:52:52 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/19/2008 6:52:52 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/19/2008 6:53:02 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
11/19/2008 6:53:02 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
11/19/2008 6:53:05 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/19/2008 6:53:05 AM -- Performance logging begins (interval: 15000 ms).
11/19/2008 6:53:05 AM -- Generating log files ...
11/19/2008 8:02:47 AM -- M:\ (100.6% generated), N:\ (100.2% generated), O:\ (101.8% generated), P:\ (102.4% generated), Q:\ (100.2% generated), R:\ (103.2% generated), S:\ (101.4% generated), and T:\ (100.6% generated)
11/19/2008 8:02:47 AM -- Performance logging ends.
11/19/2008 8:02:47 AM -- JetInterop batch transaction stats: 12709, 12734, 12682, 12913, 12716, 12780, 12885, and 12719.
11/19/2008 8:02:47 AM -- Dispatching transactions ends.

11/19/2008 8:02:47 AM -- Shutting down databases ...
 11/19/2008 8:02:52 AM -- Instance3648.1 (complete), Instance3648.2 (complete), Instance3648.3 (complete), Instance3648.4 (complete), Instance3648.5 (complete), Instance3648.6 (complete), Instance3648.7 (complete), and Instance3648.8 (complete)
 11/19/2008 8:02:52 AM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_19_6_53_2.blg has 278 samples.
 11/19/2008 8:02:52 AM -- Creating test report ...
 11/19/2008 8:02:55 AM -- Volume E: has 0.0118 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume F: has 0.0119 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume G: has 0.0124 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume H: has 0.0125 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume I: has 0.0117 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume J: has 0.0122 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume K: has 0.0122 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume L: has 0.0121 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume M: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume M: has 0.0030 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume N: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume N: has 0.0028 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume O: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume O: has 0.0028 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume P: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume P: has 0.0030 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume Q: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume Q: has 0.0028 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume R: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume R: has 0.0029 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume S: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume S: has 0.0029 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Volume T: has 0.0020 for Avg. Disk sec/Write.
 11/19/2008 8:02:55 AM -- Volume T: has 0.0029 for Avg. Disk sec/Read.
 11/19/2008 8:02:55 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 11/19/2008 8:02:55 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 11/19/2008 8:02:55 AM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_19_6_53_2.xml has 277 samples queried.
 11/19/2008 8:02:55 AM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_19_6_53_2.html is saved.
 11/19/2008 8:02:58 AM -- Performance logging begins (interval: 4000 ms).
 11/19/2008 8:02:58 AM -- Recovering databases ...
 11/19/2008 8:30:18 AM -- Performance logging ends.
 11/19/2008 8:30:18 AM -- Instance3648.1 (1618.6166034), Instance3648.2 (1631.6116533), Instance3648.3 (1635.0593196), Instance3648.4 (1636.6505502), Instance3648.5 (1636.6505502), Instance3648.6 (1640.0982165), Instance3648.7 (1637.7113706), and Instance3648.8 (1630.2856278)

11/19/2008 8:30:18 AM -- C:\Program Files\Exchange
Jetstress\SoftRecovery_2008_11_19_8_2_55.blg has 408 samples.
11/19/2008 8:30:18 AM -- Creating test report ...

Appendix E: Maximum Solution IOPS Testing

The building block illustrated in [Figure 1 on page 7](#) is the EMC recommended configuration for 3,000 Exchange user workload at 0.5 IOPS per user. The results shown in [Appendix A: Stress Test Reports \(24 hrs Performance Test\) on page 16](#) illustrate that this configuration achieved excellent results, with considerable room for growth.

Often the observed user workload in customer environments is greater than expected. For example, the use of Blackberry or MAPI journaling devices can significantly increase the I/O workload generated by a set of users. EMC prides itself on delivering solutions that meet and exceed customer requirements and hence the configurations are designed with considerable headroom.

After providing that the building block could easily satisfy the ESRP criteria, subsequent tests were run to determine the upper limits of the configuration. The number of Jetstress threads was increased from 7 to 15 without modifying any of the other components. The achieved IOPS increased from 1,773 to 2623, with a 32 percent increase. While this workload is not recommended for customers, as it is close to the maximum acceptable latency for ESRP, it highlights the headroom in the recommended building block.

Maximum Performance Test Report

Microsoft Exchange Server Jetstress

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 11/17/2008 5:09:46 AM

Test End Time 11/17/2008 7:23:52 AM

Jetstress Version 08.02.0060.000

Ese Version 08.01.0240.005

Operating System Windows Server (R) 2008 Enterprise Service Pack 1 (6.0.6001.65536)

Performance C:\Program Files\Exchange

Log Jetstress\Performance_2008_11_17_5_10_4.blg
C:\Program Files\Exchange
Jetstress\DBChecksum_2008_11_17_7_23_52.blg

Database Sizing and Throughput

Achieved I/O per Second 2635.964
Capacity Percentage 100%
Throughput Percentage 100%
Initial database size 1634481602560
Final database size 1643618893824
Database files (count) 8

Jetstress System Parameters

Thread count 15 (per-storage group)
Log buffers 9000
Minimum database cache 256.0 MB
Maximum database cache 2048.0 MB
Insert operations 40%
Delete operations 30%
Replace operations 5%
Read operations 25%
Lazy commits 55%

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.018	0.007	165.732	163.634	(n/a)
Database (F:)	0.018	0.007	166.859	163.650	(n/a)
Database (G:)	0.019	0.007	166.413	163.631	(n/a)
Database (H:)	0.019	0.007	166.352	163.590	(n/a)
Database (I:)	0.017	0.007	166.889	161.849	(n/a)
Database (J:)	0.019	0.007	167.996	165.198	(n/a)
Database (K:)	0.019	0.007	166.149	163.115	(n/a)
Database (L:)	0.019	0.007	164.534	160.372	(n/a)

Log (M:)	0.000	0.003	0.000	89.773	4953.885
Log (N:)	0.000	0.003	0.000	89.661	4940.867
Log (O:)	0.000	0.003	0.000	90.185	4867.809
Log (P:)	0.000	0.003	0.000	90.568	4857.726
Log (Q:)	0.000	0.003	0.000	88.995	4936.520
Log (R:)	0.000	0.003	0.000	90.608	4909.922
Log (S:)	0.000	0.003	0.000	90.375	4940.126
Log (T:)	0.000	0.003	0.000	89.744	4898.592

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	6.489	3.690	10.136
Available MBytes	28200.029	28124.000	28491.000
Free System Page Table Entries	33557805.754	33557243.000	33558299.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	51652224.000	49983488.000	52015104.000
Pool Paged Bytes	109983283.200	109772800.000	110141440.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/17/2008 5:09:46 AM -- Jetstress testing begins ...
11/17/2008 5:09:46 AM -- Prepare testing begins ...
11/17/2008 5:09:55 AM -- Attaching databases ...
11/17/2008 5:09:55 AM -- Prepare testing ends.
11/17/2008 5:09:55 AM -- Dispatching transactions begins ...
11/17/2008 5:09:55 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/17/2008 5:09:55 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/17/2008 5:10:04 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
11/17/2008 5:10:04 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
11/17/2008 5:10:07 AM -- Operation mix: Sessions 15, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/17/2008 5:10:07 AM -- Performance logging begins (interval: 15000 ms).
11/17/2008 5:10:07 AM -- Attaining prerequisites:
11/17/2008 5:23:49 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1933664000.0 (lower bound: 1932735000.0, upper bound: none)
11/17/2008 7:23:50 AM -- Performance logging ends.
11/17/2008 7:23:50 AM -- JetInterop batch transaction stats: 36868, 36948,

36904, 36864, 36846, 37219, 37000, and 36731.
11/17/2008 7:23:50 AM -- Dispatching transactions ends.
11/17/2008 7:23:50 AM -- Shutting down databases ...
11/17/2008 7:23:52 AM -- Instance1640.1 (complete), Instance1640.2 (complete), Instance1640.3 (complete), Instance1640.4 (complete), Instance1640.5 (complete), Instance1640.6 (complete), Instance1640.7 (complete), and Instance1640.8 (complete)
11/17/2008 7:23:53 AM -- Performance logging begins (interval: 30000 ms).
11/17/2008 7:23:53 AM -- Verifying database checksums ...
11/17/2008 10:01:52 AM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
11/17/2008 10:01:52 AM -- Performance logging ends.
11/17/2008 10:01:52 AM -- C:\Program Files\Exchange Jetstress\DBChecksum_2008_11_17_7_23_52.blg has 315 samples.
11/17/2008 10:01:58 AM -- C:\Program Files\Exchange Jetstress\DBChecksum_2008_11_17_7_23_52.html is saved.
11/17/2008 10:01:58 AM -- Verifying log checksums ...
11/17/2008 10:01:59 AM -- M:\ (3 logs passed), N:\ (2 logs passed), O:\ (2 logs passed), P:\ (3 logs passed), Q:\ (2 logs passed), R:\ (2 logs passed), S:\ (2 logs passed), and T:\ (2 logs passed)
11/17/2008 10:01:59 AM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_17_5_10_4.blg has 534 samples.
11/17/2008 10:01:59 AM -- Creating test report ...
11/17/2008 10:02:03 AM -- Volume E: has 0.0180 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume F: has 0.0180 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume G: has 0.0190 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume H: has 0.0194 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume I: has 0.0174 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume J: has 0.0192 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume K: has 0.0189 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume L: has 0.0188 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume M: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume M: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume N: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume N: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume O: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume O: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume P: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume P: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume Q: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume Q: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume R: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume R: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume S: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume S: has 0.0000 for Avg. Disk sec/Read.
11/17/2008 10:02:03 AM -- Volume T: has 0.0031 for Avg. Disk sec/Write.
11/17/2008 10:02:03 AM -- Volume T: has 0.0000 for Avg. Disk sec/Read.

11/17/2008 10:02:03 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.

11/17/2008 10:02:03 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

11/17/2008 10:02:03 AM -- C:\Program Files\Exchange Jetstress\Performance_2008_11_17_5_10_4.xml has 479 samples queried.

Microsoft Exchange Server Jetstress

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
E:\Jetstress1.edb	25080242	0	0	0	195939 MBytes / 9473 seconds
F:\Jetstress1.edb	25079730	0	0	0	195935 MBytes / 9461 seconds
G:\Jetstress1.edb	25078706	0	0	0	195927 MBytes / 9471 seconds
H:\Jetstress1.edb	25079218	0	0	0	195931 MBytes / 9477 seconds
I:\Jetstress1.edb	25078450	0	0	0	195925 MBytes / 9475 seconds
J:\Jetstress1.edb	25081266	0	0	0	195947 MBytes / 9479 seconds
K:\Jetstress1.edb	25081010	0	0	0	195945 MBytes / 9473 seconds
L:\Jetstress1.edb	25078450	0	0	0	195925 MBytes / 9472 seconds
(Sum)	200637072	0	0	0	1567477 MBytes / 9479 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec

E:	0.092	0.000	331.630	0.001
F:	0.094	0.000	332.140	0.001
G:	0.096	0.000	331.719	0.001
H:	0.097	0.000	331.156	0.001
I:	0.097	0.000	331.489	0.001
J:	0.097	0.000	330.729	0.001
K:	0.096	0.000	331.674	0.001
L:	0.093	0.000	331.654	0.001

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	19.301	6.394	21.011
Available MBytes	30453.133	30359.000	30605.000
Free System Page Table Entries	33559710.975	33558252.000	33560393.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	52178631.924	52121600.000	52232192.000
Pool Paged Bytes	109455795.606	108797952.000	109617152.000

Test Log 11/17/2008 5:09:46 AM -- Jetstress testing begins ...
11/17/2008 5:09:46 AM -- Prepare testing begins ...
11/17/2008 5:09:55 AM -- Attaching databases ...
11/17/2008 5:09:55 AM -- Prepare testing ends.
11/17/2008 5:09:55 AM -- Dispatching transactions begins ...
11/17/2008 5:09:55 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
11/17/2008 5:09:55 AM -- Database flush thresholds: (start: 20.5 MB, stop: 41.0 MB)
11/17/2008 5:10:04 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
11/17/2008 5:10:04 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
11/17/2008 5:10:07 AM -- Operation mix: Sessions 15, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.
11/17/2008 5:10:07 AM -- Performance logging begins (interval: 15000 ms).
11/17/2008 5:10:07 AM -- Attaining prerequisites:
11/17/2008 5:23:49 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1933664000.0 (lower bound: 1932735000.0, upper bound: none)
11/17/2008 7:23:50 AM -- Performance logging ends.
11/17/2008 7:23:50 AM -- JetInterop batch transaction stats: 36868, 36948, 36904, 36864, 36846, 37219, 37000, and 36731.
11/17/2008 7:23:50 AM -- Dispatching transactions ends.
11/17/2008 7:23:50 AM -- Shutting down databases ...

11/17/2008 7:23:52 AM -- Instance1640.1 (complete), Instance1640.2 (complete), Instance1640.3 (complete), Instance1640.4 (complete), Instance1640.5 (complete), Instance1640.6 (complete), Instance1640.7 (complete), and Instance1640.8 (complete)
11/17/2008 7:23:53 AM -- Performance logging begins (interval: 30000 ms).
11/17/2008 7:23:53 AM -- Verifying database checksums ...
11/17/2008 10:01:52 AM -- E: (100% processed), F: (100% processed), G: (100% processed), H: (100% processed), I: (100% processed), J: (100% processed), K: (100% processed), and L: (100% processed)
11/17/2008 10:01:52 AM -- Performance logging ends.
11/17/2008 10:01:52 AM -- C:\Program Files\Exchange Jetstress\DBChecksum 2008 11 17 7 23 52.blg has 315 samples.