

ESRP Storage Program  
EMC Celerra NS40 (1100 User) iSCSI Storage Solution for  
Microsoft Exchange Server 2007

**Tested with:** ESRP – Storage Version 2.0  
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## Overview

This document provides information on 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 section [Contact Information](#).

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

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

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## Features

This document describes an approach that can be used to configure Microsoft Exchange 2007 with EMC's 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 like 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** is all-in-one IP storage for customers looking for enterprise-class capabilities packaged for specific applications, departments, or locations. It provides customers the flexibility to upgrade to a **NS40G** gateway if they want to add Fibre Channel SAN capabilities. The **NS40G** gateway is the most cost-effective way to add NAS and iSCSI to existing EMC SAN environments. Both offerings are available in single- and dual-blade configurations. Regardless of the configuration, Celerra platforms offer a full suite of advanced functionality:

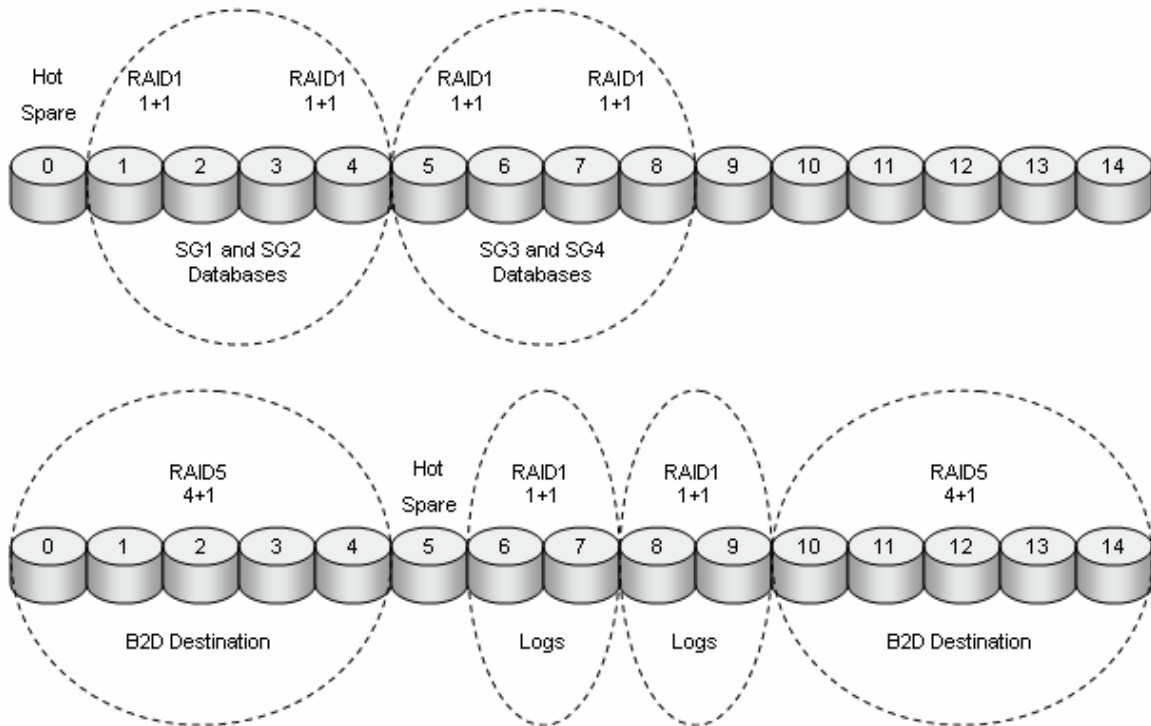
- Robust snap and replication capabilities offer protection of data.
- Celerra FileMover API allows automated policy-based movement of files between tiers of storage.
- File Level Retention provides disk-based WORM functionality.
- Automated Volume Management and Virtual Provisioning improve storage utilization.
- Celerra Multi-path File System for iSCSI (MPFSi) accelerates file access up to four times faster than standard NAS, without the need to recode applications.

The performance results and best practices discussed in this document provides 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 1100 Exchange 2007 users. Each of the 1100 users had a profile of 0.5 IOPS and a 250 MB mailbox.

## Solution Description

Sizing and configuring storage for use with Microsoft Exchange is a complicated process. It is driven by many variables and factors, which vary from organization to organization. One method often used to simplify the sizing and configuration is to define a building block. In this case, the building block is defined as six disk spindles. The testing in this document proves that two six spindle building blocks (eight spindles for the databases and four spindles for the logs) meets and exceeds the Microsoft Exchange Server recommended metrics for reliability, scalability, and performance.

Our testing determined that twelve 15K FC spindles can easily satisfy the I/O workload of 1100, 0.5 IOPS Exchange users. Each storage group in Exchange 2007 is recommended to have only one database. The 1100 users were distributed among four Exchange storage groups. 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 diagram of the disk layout is shown in Figure 1.



**Figure 1 - Building Block 1 and 2**

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

All these factors are beyond the scope of ESRP-Storage. Therefore, 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, please refer to Performance Issues available at <http://technet.microsoft.com/en-us/library/bb397229.aspx>

Another tool to consider is Microsoft Operations Manager. The Exchange Server 2007 Management Pack for Microsoft Operations Manager includes rules and scripts to monitor and report on performance, availability, and reliability of all Exchange 2007 server roles including Mailbox, Client Access, Hub Transport, Edge Transport and Unified Messaging. Monitoring Exchange 2007 with Microsoft Operations Manager 2005 SP1, available at

<http://technet.microsoft.com/en-us/library/de353bdc-f872-4cf6-b36b-12d4a773e974.aspx>

## Targeted Customer Profile

This solution is intended for businesses hosting 1100 Exchange mailboxes. The configuration used for testing is as below:

- Number of mailbox servers presented to the storage array — 1
- User IO profile for testing — 0.42 (0.5 IOPS tested)
- User mailbox size for testing — 250 MB
- Backup strategy for testing — Streaming Backup to Disk
- Time for Restore — 2.5 hours per SG, Tested 100 GB database per SG

## Tested Deployment

The following tables summarize the testing environment:

### Simulated Exchange Configuration

Number of Exchange mailboxes simulated	1100
Number of hosts	1
Number of mailboxes/host	1100
Number of storage groups/host	4
Number of mailbox stores/storage group	1
Number of mailboxes/mailbox store	275
Number of mailbox store LUNs/storage group	1
Simulated profile: I/O's per second per mailbox (IOPS, include 20% headroom)	0.5
Database LUN size	118 GB
Log LUN size	11.8 GB
Backup LUN size/storage group	165 GB
Total database size for performance testing	379 GB
% Storage capacity used by Exchange database**	82%

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

### Primary Storage Hardware

Storage Connectivity (Fibre Channel, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	EMC Celerra NS40 DART 5.5.27.5
Storage cache	4 GB
Number of storage controllers	2
Number of storage ports	2 Tested – 8 possible
Maximum bandwidth of storage connectivity to host	4*1 Gb per SP
Switch type/model/firmware revision	Dell 5324 Version 2.21 Build No. 3.04

HBA model and firmware	Intel(R) PRO/1000 MT Dual Port Server Adapter
Number of HBA's/host	2
Host server type	Dell PowerEdge 2950 2: Dual Core [01]: EM64T Family 6 Model 15 Stepping 6 GenuineIntel ~2328 Mhz [02]: EM64T Family 6 Model 15 Stepping 6 GenuineIntel ~2328 Mhz [03]: EM64T Family 6 Model 15 Stepping 6 GenuineIntel ~2328 Mhz [04]: EM64T Family 6 Model 15 Stepping 6 GenuineIntel ~2328 Mhz
Total number of disks tested in solution	22
Maximum number of spindles that can be hosted in the storage	240

### Primary Storage Software

HBA driver	Microsoft iSCSI Software Initiator 2.04 Intel® PRO/1000 PT Dual Port Server Adapter
HBA QueueTarget Setting	Not Applicable
HBA QueueDepth Setting	Not Applicable
Multi-Pathing	Multiple Connections per Session (MC/S)
Host OS	Microsoft® Windows® Server 2003, Enterprise Edition *64 SP1 5.2.3790 Service Pack 1 Build 3790
ESE.dll file version	08.01.0075.000
Replication solution name/version	Not Applicable

### Primary Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed and firmware revision	4 Gbps FC SCSI 15,000 RPM – 60AC
Raw capacity per disk (GB)	146 GB
Number of physical disks in test	8
total raw storage capacity (GB)	1168 GB
Disk slice size (GB)	Not Applicable
Number of slices per LUN or number of disks per LUN	Not Applicable
Number of Luns Per Raid Group	2
LUN Size in GB	118.4
Raid level	Raid 1_0
Total formatted capacity	474 GB
Storage capacity utilization	41%
Database capacity utilization	34%

### Primary Storage Disk Configuration (Transactional Log Disks)

Disk type, speed and firmware revision	4 Gbps FC SCSI 15,000 RPM – 60AC
Raw capacity per disk (GB)	146 GB
Number of spindles in test	4
total raw storage capacity (GB)	292 GB
Disk slice size (GB)	Not Applicable

Number of slices per LUN or number of disks per LUN	Not Applicable
Number of Luns per Raid Group	2
LUN Size in GB	11.8
Raid level	Raid 1_0
Total formatted capacity	23.6 GB

## **Streaming Backup**

### **Disk Configuration (Streaming Backup to disk)**

Disk type, speed and firmware revision	4 Gbps FC SCSI 15,000 RPM – 60AC
Raw capacity per disk (GB)	146 GB
Number of spindles in test	10
Total raw storage capacity (GB)	1460 GB
Disk slice size (GB)	Not Applicable
Number of slices per LUN or number of disks per LUN	Not Applicable
Number of Luns per Raid Group	1
Raid level	Raid 5
Total formatted capacity	907 GB

## **Best Practices**

Microsoft Exchange server is a disk-intensive application. Based on the testing run using the ESRP framework, EMC would recommend the Exchange 2007 best practices to improve the storage performance.

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

## **Core Storage/Replication**

1. Use DISKPART (in Windows 2003x64 SP1) to align all Microsoft Exchange Server related disks. Use a value of 64 to align the NTFS partitions at a 64 KB boundary.
2. Isolate the Microsoft Exchange Server database workload from other workloads. This ensures the highest level of performance for Microsoft Exchange Server and simplifies troubleshooting in the event of a disk related Microsoft Exchange performance problem.
3. Set TcpAckFrequency = 1 per <http://support.microsoft.com/kb/328890> to improve iSCSI performance.
4. Size and configure the environment based on disk spindle performance. Storage capacity should be a secondary issue. In other words, size for performance and then capacity.
5. Place the Microsoft Exchange Server logs and databases on separate physical disks and in different RAID groups.

See the following Microsoft documentation for storage based replication best practices and support criteria:

Deployment Guidelines for Data Replication  
<http://www.microsoft.com/technet/prodtechnol/exchange/guides/E2k3DataRepl/bedf62a9-dff7-49a8-bd27-b2f1c46d5651.mspx>

Multi-site data replication support for Exchange  
<http://support.microsoft.com/?kbid=895847>

**Note:** In the event a performance problem cannot be resolved using common performance analysis, EMC Corporation strongly recommends that a case be opened with EMC Customer Service so that the appropriate Customer Support resource may be engaged.

## **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 in order to meet 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 work in conjunction with Volume Shadow Copy services (VSS) as proven techniques, having undergone vigorous testing.

In this solution, the tested method for backup was a one stage disk-to-disk backup. With this configuration, several best practice considerations must be understood in order to achieve optimal performance.

1. Disk-to-disk backup LUNs should be configured in separate disk groups. Workload isolation will optimize performance of the streaming backups and minimize the impact on the production workload.
2. Higher capacity Fiber Channel or ATA drives should be utilized if the environment requires additional backup copies of the data on the primary disks. FATA drives should not be utilized to host production Exchange traffic without careful consideration of the performance impact. ATA drives operate at a lower rotational speed and will provide much lower throughput than Fiber Channel drives. ATA drives are also designed for an 8\*5 duty cycle and are not meant to operate 24\*7. Over-utilization will result in a shorter mean time between failures (MTBF) when compared to Fiber Channel drives which are rated for 24\*7 use.

## **Test Result Summary**

This section provides a high level summary of the test data from ESRP as well as links to the detailed reports located in Appendix: Test Reports, which are generated by the ESRP testing framework.

## **Reliability**

The goal of these tests is to determine the reliability of the underlying storage subsystem. These tests run for a period of 24 hours and ensure that the storage can handle extreme IO workloads for significant periods of time. After a test run, both the logs and databases are verified to ensure that there is no data corruption.

The reliability test on the Celerra NS40 provided the following results:

- Errors reported in the system and application event logs: None
- Errors reported for database and log checksum: None

- Error during back-to-disk test: None
- Error in database checksum on the remote storage database: N/A

The Jetstress performance results (24-hour performance test) can be found under the [Reliability Test](#) section in Appendix B.

## Primary Storage Performance Results

The Primary Storage performance testing is designed to exercise the storage with maximum sustainable Exchange type of IO for two hours. The test is to show how long it takes for the storage to respond to an IO under load. The data below is the sum of all the logical disk I/O's, and average of all the logical disks I/O latency in the 2 hours test duration. Each server is listed separately and the aggregate numbers across all servers is listed as well.

## Individual Server Metrics

The sum of I/O's across Storage Groups and the average latency across all Storage Groups on a per server basis.

<b>Database I/O</b>	
Average Database Disk Transfers/sec	623.409
Average Database Disk Reads/sec	316.306
Average Database Disk Writes/sec	307.103
Average Database Disk Read Latency (ms)	13
Average Database Disk Write Latency (ms)	3
<b>Transaction Log I/O</b>	
Average Log Disk Writes/sec	194.845
Average Log Disk Write Latency (ms)	2

The Jetstress performance results (two hour performance test) can be found under the [Performance Test](#) section in Appendix A.

Also, refer to [Appendix E](#) – Performance Test Results (Maximum IOPS) to find results that characterize the maximum performance of the disk layout.

## Streaming Backup Performance

The goal of these tests is to characterize the streaming backup performance of the underlying storage subsystem. ESRP requires two types of tests. The first test characterizes the read performance of the storage by performing a checksum of the logs and databases. The second test characterizes the end-to-end backup-to-disk performance of the storage.

## Database Read-only Performance

This test characterizes the read performance of the database. The following table shows the average rate for a single database file.

MB read/sec per storage group	10.245
MB read/sec total	40.98
File size/sec taken	387947.08/37889

## Log Read-only Performance

This test characterizes the rate at which log files can be played back against the database. The following table shows the average rate for 500 log files played in a single storage group. Each log file is 1 MB in size.

Average time to play one log file (sec)	0.89
---	------

## Backup to Disk Performance

This test characterizes the end-to-end backup-to-disk performance of the storage. This test will backup all the database files to disk. The following table shows an average rate at which each storage group can be backed up:

Total database size per storage group (GB)	378.8546
Time taken to backup each storage group	2:37:52
Average MB backed up/sec	40.983
Average MB backed up/sec per storage group	10.246

## Conclusion

The Celerra NS40 produced impressive performance results when tested in conjunction with Exchange 2007. The results clearly show that a Celerra NS40 can satisfy the performance requirements of 1100 Heavy Exchange users with six physical disk spindles (four spindles for database and two spindles for log). This is defined as the basic Celerra Exchange building block. This building block approach simplifies the sizing of the solution and allows predictable scaling.

This document is developed by EMC, and reviewed by the Microsoft Exchange Product team. The test results and data presented in this document are based on the tests in the ESRP test framework. Customers should not use this data directly for pre-deployment verification. It is still necessary to validate the storage design for a specific environment. A careful analysis of each environment must be performed in order to understand the specific requirement of the architecture and to adapt a solution that best fits those needs. The results in this document prove that the Celerra NS40 can support a high-performance Microsoft Exchange Server configuration.

The ESRP program is not designed to be a benchmarking program as the tests are not designed to produce maximum throughput for a given solution. Rather, the tests focus on producing recommendations from vendors for running Microsoft Exchange. Essentially, the data presented in this document should not be used for comparisons amongst different 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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Worldwide: (508) 497-7901

For additional information on EMC Products and Services available to customers and partners, please refer to:

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

## Appendix A: Stress Testing

### ***Stress Test Result Report***

Test Summary

<b>Overall Test Result</b>	<b>Pass</b>
<b>Machine Name</b>	C2D77C1
<b>Test Description</b>	
<b>Test Start Time</b>	5/7/2007 2:36:00 PM
<b>Test End Time</b>	5/8/2007 4:28:22 PM
<b>Jetstress Version</b>	08.01.0075.000
<b>Ese Version</b>	08.01.0013.000
<b>Operating System</b>	Microsoft Windows Server 2003 Service Pack 1 (5.2.3790.65536)
<b>Performance Log</b>	<a href="#">C:\Jetstress\8disk\3t\stress_rr\Stress_2007_5_7_16_19_5.blg</a> <a href="#">C:\Jetstress\8disk\3t\stress_rr\DBChecksum_2007_5_8_16_28_22.blg</a>

Database Sizing and Throughput

<b>Achieved I/O per Second</b>	550.522
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial database size</b>	406984916992
<b>Final database size</b>	462880833536
<b>Database files (count)</b>	4

Jetstress System Parameters

<b>Thread count</b>	3 (per-storage group)
<b>Log buffers</b>	9000
<b>Minimum database cache</b>	128.0 MB
<b>Maximum database cache</b>	1024.0 MB
<b>Insert operations</b>	25%
<b>Delete operations</b>	10%
<b>Replace operations</b>	50%
<b>Read operations</b>	15%
<b>Lazy commits</b>	80%

## Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (G:)	0.014	0.004	72.317	65.638	(n/a)
Database (H:)	0.014	0.004	72.076	65.359	(n/a)
Database (I:)	0.014	0.003	72.330	65.090	(n/a)
Database (J:)	0.014	0.004	72.507	65.205	(n/a)
Log (K:)	0.000	0.003	0.000	38.755	11271.676
Log (L:)	0.000	0.003	0.000	38.826	11260.400
Log (M:)	0.000	0.003	0.000	38.725	11234.806
Log (N:)	0.000	0.003	0.000	38.655	11254.895

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.565	0.518	2.810
Available MBytes	14427.105	14417.000	14436.000
Free System Page Table Entries	16758901.000	16758901.000	16758901.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	52581125.973	52568064.000	52609024.000
Pool Paged Bytes	41444293.973	41324544.000	42082304.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/7/2007 2:36:00 PM -- Jetstress testing begins ...  
 5/7/2007 2:36:00 PM -- Prepare testing begins ...  
 5/7/2007 2:36:00 PM -- Duplicating 4 databases:  
 5/7/2007 4:19:04 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).  
 5/7/2007 4:19:04 PM -- Attaching databases ...  
 5/7/2007 4:19:04 PM -- Prepare testing ends.  
 5/7/2007 4:19:04 PM -- Dispatching transactions begins ...  
 5/7/2007 4:19:04 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 5/7/2007 4:19:04 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 5/7/2007 4:19:05 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).  
 5/7/2007 4:19:05 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).  
 5/7/2007 4:19:06 PM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
 5/7/2007 4:19:06 PM -- Performance logging begins (interval: 15000 ms).  
 5/7/2007 4:19:06 PM -- Attaining prerequisites:  
 5/7/2007 4:28:17 PM -- \Database(JetstressWin)\Database Cache Size, Last: 966631400.0

(lower bound: 966367600.0, upper bound: none)  
5/8/2007 4:28:18 PM -- Performance logging ends.  
5/8/2007 4:28:18 PM -- JetInterop batch transaction stats: 339620, 339835, 339395, and 338978.  
5/8/2007 4:28:18 PM -- Dispatching transactions ends.  
5/8/2007 4:28:18 PM -- Shutting down databases ...  
5/8/2007 4:28:22 PM -- Instance132.1 (complete), Instance132.2 (complete), Instance132.3 (complete), and Instance132.4 (complete)  
5/8/2007 4:28:23 PM -- Performance logging begins (interval: 15000 ms).  
5/8/2007 4:28:23 PM -- Verifying database checksums ...  
5/8/2007 5:58:28 PM -- G: (100% processed), H: (100% processed), I: (100% processed), and J: (100% processed)  
5/8/2007 5:58:29 PM -- Performance logging ends.  
5/8/2007 5:58:29 PM --  
[C:\Jetstress\8disk\3t\stress\\_rr\DBChecksum\\_2007\\_5\\_8\\_16\\_28\\_22.blg](C:\Jetstress\8disk\3t\stress_rr\DBChecksum_2007_5_8_16_28_22.blg) has 360 samples.  
5/8/2007 5:58:32 PM --  
[C:\Jetstress\8disk\3t\stress\\_rr\DBChecksum\\_2007\\_5\\_8\\_16\\_28\\_22.html](C:\Jetstress\8disk\3t\stress_rr\DBChecksum_2007_5_8_16_28_22.html) is saved.  
5/8/2007 5:58:32 PM -- Verifying log checksums ...  
5/8/2007 5:58:38 PM -- K:\ (22 logs passed), L:\ (21 logs passed), M:\ (22 logs passed), and N:\ (22 logs passed)  
5/8/2007 5:58:38 PM -- [C:\Jetstress\8disk\3t\stress\\_rr\Stress\\_2007\\_5\\_7\\_16\\_19\\_5.blg](C:\Jetstress\8disk\3t\stress_rr\Stress_2007_5_7_16_19_5.blg) has 5796 samples.  
5/8/2007 5:58:38 PM -- Creating test report ...  
5/8/2007 5:59:18 PM -- Volume G: has 0.0137 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume H: has 0.0144 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume I: has 0.0140 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume J: has 0.0140 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume K: has 0.0028 for Avg. Disk sec/Write.  
5/8/2007 5:59:18 PM -- Volume K: has 0.0000 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume L: has 0.0028 for Avg. Disk sec/Write.  
5/8/2007 5:59:18 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume M: has 0.0028 for Avg. Disk sec/Write.  
5/8/2007 5:59:18 PM -- Volume M: has 0.0000 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Volume N: has 0.0028 for Avg. Disk sec/Write.  
5/8/2007 5:59:18 PM -- Volume N: has 0.0000 for Avg. Disk sec/Read.  
5/8/2007 5:59:18 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
5/8/2007 5:59:18 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

## Appendix B: Performance Testing

### Performance Test Result Report

Test Summary

<b>Overall Test Result</b>	Pass
<b>Machine Name</b>	RTPSOL396
<b>Test Description</b>	
<b>Test Start Time</b>	5/2/2007 6:32:21 AM
<b>Test End Time</b>	5/2/2007 8:40:49 AM
<b>Jetstress Version</b>	08.01.0075.000
<b>Ese Version</b>	08.00.0685.024
<b>Operating System</b>	Microsoft Windows Server 2003 R2 Service Pack 1 (5.2.3790.65536)
<b>Performance Log</b>	<a href="#">C:\Program Files\Exchange Jetstress\Performance_2007_5_2_6_32_23.blg</a> <a href="#">C:\Program Files\Exchange Jetstress\DBChecksum_2007_5_2_8_40_49.blg</a>

Database Sizing and Throughput

<b>Achieved I/O per Second</b>	623.409
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial database size</b>	406842310656
<b>Final database size</b>	412989063168
<b>Database files (count)</b>	4

Jetstress System Parameters

<b>Thread count</b>	3 (per-storage group)
<b>Log buffers</b>	9000
<b>Minimum database cache</b>	128.0 MB
<b>Maximum database cache</b>	1024.0 MB
<b>Insert operations</b>	25%
<b>Delete operations</b>	10%
<b>Replace operations</b>	50%
<b>Read operations</b>	15%
<b>Lazy commits</b>	80%

## 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	0.003	80.177	77.369	(n/a)
Database (F:)	0.013	0.003	79.274	77.192	(n/a)
Database (G:)	0.013	0.003	78.552	75.836	(n/a)
Database (H:)	0.013	0.003	78.303	76.706	(n/a)
Log (K:)	0.002	0.002	2.011	49.296	11058.442
Log (L:)	0.002	0.002	2.017	48.818	11232.411
Log (M:)	0.002	0.002	1.987	48.114	11258.535
Log (N:)	0.002	0.002	2.010	48.617	11260.817

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.036	0.728	6.561
Available MBytes	30062.895	29926.000	30862.000
Free System Page Table Entries	16754536.000	16754536.000	16754536.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	73703248.000	73162752.000	74170368.000
Pool Paged Bytes	158803768.000	156889088.000	160669696.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/2/2007 3:43:53 AM -- Prepare testing begins ...  
 5/2/2007 3:43:53 AM -- Creating E:\Jetstress1.edb.  
 5/2/2007 3:43:53 AM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)  
 5/2/2007 3:43:53 AM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)  
 5/2/2007 4:12:19 AM -- 60.0% of 94.7 GB complete (3462911 records inserted).  
 5/2/2007 4:37:43 AM -- 100.0% of 94.7 GB complete (5552148 records inserted).  
 5/2/2007 4:37:45 AM -- Duplicating 4 databases:  
 5/2/2007 6:29:01 AM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
 5/2/2007 6:29:05 AM -- Attaching databases ...  
 5/2/2007 6:29:05 AM -- Prepare testing ends.  
 5/2/2007 6:32:21 AM -- Jetstress testing begins ...  
 5/2/2007 6:32:21 AM -- Prepare testing begins ...  
 5/2/2007 6:32:22 AM -- Attaching databases ...  
 5/2/2007 6:32:22 AM -- Prepare testing ends.  
 5/2/2007 6:32:22 AM -- Dispatching transactions begins ...  
 5/2/2007 6:32:22 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 5/2/2007 6:32:22 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 5/2/2007 6:32:23 AM -- Database read latency thresholds: (average: 0.02 seconds/read,

maximum: 0.05 seconds/read).  
 5/2/2007 6:32:23 AM -- Log write latency thresholds: (average: 0.01 seconds/write,  
 maximum: 0.05 seconds/write).  
 5/2/2007 6:32:45 AM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces 50%,  
 Reads 15%, Lazy Commits 80%.  
 5/2/2007 6:32:45 AM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 6:32:45 AM -- Attaining prerequisites:  
 5/2/2007 6:40:45 AM -- \Database(JetstressWin)\Database Cache Size, Last: 966893600.0  
 (lower bound: 966367600.0, upper bound: none)  
 5/2/2007 8:40:47 AM -- Performance logging ends.  
 5/2/2007 8:40:47 AM -- JetInterop batch transaction stats: 37222, 37019, 36619, and 37061.  
 5/2/2007 8:40:47 AM -- Dispatching transactions ends.  
 5/2/2007 8:40:47 AM -- Shutting down databases ...  
 5/2/2007 8:40:49 AM -- Instance2760.1 (complete), Instance2760.2 (complete),  
 Instance2760.3 (complete), and Instance2760.4 (complete)  
 5/2/2007 8:40:50 AM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 8:40:50 AM -- Verifying database checksums ...  
 5/2/2007 9:36:59 AM -- E: (100% processed), F: (100% processed), G: (100% processed),  
 and H: (100% processed)  
 5/2/2007 9:37:00 AM -- Performance logging ends.  
 5/2/2007 9:37:00 AM -- [C:\Program Files\Exchange  
 Jetstress\DBChecksum\\_2007\\_5\\_2\\_8\\_40\\_49.blg](#) has 224 samples.  
 5/2/2007 9:37:03 AM -- [C:\Program Files\Exchange  
 Jetstress\DBChecksum\\_2007\\_5\\_2\\_8\\_40\\_49.html](#) is saved.  
 5/2/2007 9:37:03 AM -- Verifying log checksums ...  
 5/2/2007 9:37:08 AM -- K:\ (22 logs passed), L:\ (22 logs passed), M:\ (22 logs passed), and  
 N:\ (22 logs passed)  
 5/2/2007 9:37:08 AM -- [C:\Program Files\Exchange  
 Jetstress\Performance\\_2007\\_5\\_2\\_6\\_32\\_23.blg](#) has 512 samples.  
 5/2/2007 9:37:08 AM -- Creating test report ...  
 5/2/2007 9:37:11 AM -- Volume E: has 0.0132 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume F: has 0.0133 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume G: has 0.0131 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume H: has 0.0131 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume K: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 9:37:11 AM -- Volume K: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume L: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 9:37:11 AM -- Volume L: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume M: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 9:37:11 AM -- Volume M: has 0.0022 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Volume N: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 9:37:11 AM -- Volume N: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 9:37:11 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 5/2/2007 9:37:11 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

## Database Checksum Results

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
E:\Jetstress1.edb	12600674	0	0	0	138 MBytes / 3358 seconds
F:\Jetstress1.edb	12605026	0	0	0	172 MBytes / 3368 seconds

G:\Jetstress1.edb	12601442	0	0	0	144 MBytes / 3287 seconds
H:\Jetstress1.edb	12606562	0	0	0	184 MBytes / 3289 seconds
(Sum)	50413704	0	0	0	641 MBytes / 13304 seconds

#### Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
E:	0.139	0.061	470.894	0.007
F:	0.138	0.015	466.958	0.007
G:	0.121	0.021	470.908	0.007
H:	0.117	0.002	471.125	0.006

#### Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	24.475	2.264	30.520
Available MBytes	30876.460	30861.000	31058.000
Free System Page Table Entries	16754396.000	16754396.000	16754396.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	89403264.000	87609344.000	89796608.000
Pool Paged Bytes	158281380.571	157331456.000	160530432.000

#### Test Log

5/2/2007 3:43:53 AM -- Prepare testing begins ...  
 5/2/2007 3:43:53 AM -- Creating E:\Jetstress1.edb.  
 5/2/2007 3:43:53 AM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)  
 5/2/2007 3:43:53 AM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)  
 5/2/2007 4:12:19 AM -- 60.0% of 94.7 GB complete (3462911 records inserted).  
 5/2/2007 4:37:43 AM -- 100.0% of 94.7 GB complete (5552148 records inserted).  
 5/2/2007 4:37:45 AM -- Duplicating 4 databases:  
 5/2/2007 6:29:01 AM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
 5/2/2007 6:29:05 AM -- Attaching databases ...  
 5/2/2007 6:29:05 AM -- Prepare testing ends.  
 5/2/2007 6:32:21 AM -- Jetstress testing begins ...  
 5/2/2007 6:32:21 AM -- Prepare testing begins ...  
 5/2/2007 6:32:22 AM -- Attaching databases ...  
 5/2/2007 6:32:22 AM -- Prepare testing ends.  
 5/2/2007 6:32:22 AM -- Dispatching transactions begins ...  
 5/2/2007 6:32:22 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 5/2/2007 6:32:22 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 5/2/2007 6:32:23 AM -- Database read latency thresholds: (average: 0.02 seconds/read,  
 maximum: 0.05 seconds/read).  
 5/2/2007 6:32:23 AM -- Log write latency thresholds: (average: 0.01 seconds/write,  
 maximum: 0.05 seconds/write).  
 5/2/2007 6:32:45 AM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces 50%,

Reads 15%, Lazy Commits 80%.  
5/2/2007 6:32:45 AM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 6:32:45 AM -- Attaining prerequisites:  
5/2/2007 6:40:45 AM -- \Database(JetstressWin)\Database Cache Size, Last: 966893600.0  
(lower bound: 966367600.0, upper bound: none)  
5/2/2007 8:40:47 AM -- Performance logging ends.  
5/2/2007 8:40:47 AM -- JetInterop batch transaction stats: 37222, 37019, 36619, and 37061.  
5/2/2007 8:40:47 AM -- Dispatching transactions ends.  
5/2/2007 8:40:47 AM -- Shutting down databases ...  
5/2/2007 8:40:49 AM -- Instance2760.1 (complete), Instance2760.2 (complete),  
Instance2760.3 (complete), and Instance2760.4 (complete)  
5/2/2007 8:40:50 AM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 8:40:50 AM -- Verifying database checksums ...  
5/2/2007 9:36:59 AM -- E: (100% processed), F: (100% processed), G: (100% processed),  
and H: (100% processed)  
5/2/2007 9:37:00 AM -- Performance logging ends.  
5/2/2007 9:37:00 AM -- [C:\Program Files\Exchange  
Jetstress\DBChecksum\\_2007\\_5\\_2\\_8\\_40\\_49.blg](#) has 224 samples.

## Appendix C: Streaming Backup Testing

### ***Streaming backup Test Result Report***

Streaming Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance436.1	96986.77	02:40:42	10.06
Instance436.2	96986.77	02:42:58	9.92
Instance436.3	96986.77	02:34:01	10.49
Instance436.4	96986.77	02:33:48	10.51

Jetstress System Parameters

<b>Thread count</b>	3 (per-storage group)
<b>Log buffers</b>	9000
<b>Minimum database cache</b>	128.0 MB
<b>Maximum database cache</b>	1024.0 MB
<b>Insert operations</b>	25%
<b>Delete operations</b>	10%
<b>Replace operations</b>	50%
<b>Read operations</b>	15%
<b>Lazy commits</b>	80%

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	80.188	0.010	(n/a)
Database (F:)	0.007	0	80.196	0.004	(n/a)
Database (G:)	0.006	0.000	80.191	0.009	(n/a)
Database (H:)	0.006	0	80.190	0.009	(n/a)
Log (K:)	0	0	0.001	0.009	106.577
Log (L:)	0.000	0	0.000	0.003	30.792
Log (M:)	0	0	0.001	0.009	106.922
Log (N:)	0	0	0.001	0.008	103.822

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	59.286	22.196	86.700
Available MBytes	30916.947	30518.000	31318.000
Free System Page Table Entries	16754462.841	16754410.000	16755050.000
Transition Pages RePurposed/sec	9496.025	0.000	22834.880
Pool Nonpaged Bytes	83448868.973	70385664.000	90370048.000
Pool Paged Bytes	602385049.520	126857216.000	1060642816.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/3/2007 8:00:35 AM -- Jetstress testing begins ...  
 5/3/2007 8:00:35 AM -- Prepare testing begins ...  
 5/3/2007 8:00:35 AM -- Creating E:\Jetstress1.edb.  
 5/3/2007 8:00:35 AM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)  
 5/3/2007 8:00:35 AM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)  
 5/3/2007 8:24:37 AM -- 60.0% of 94.7 GB complete (3462888 records inserted).  
 5/3/2007 8:46:11 AM -- 100.0% of 94.7 GB complete (5551929 records inserted).  
 5/3/2007 8:46:13 AM -- Duplicating 4 databases:  
 5/3/2007 10:17:02 AM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
 5/3/2007 10:17:02 AM -- Attaching databases ...  
 5/3/2007 10:17:02 AM -- Prepare testing ends.  
 5/3/2007 10:17:04 AM -- Performance logging begins (interval: 15000 ms).  
 5/3/2007 10:17:04 AM -- Streaming backup databases ...  
 5/3/2007 1:00:05 PM -- Performance logging ends.  
 5/3/2007 1:00:05 PM -- Instance436.1 (100% processed), Instance436.2 (100% processed),  
 Instance436.3 (100% processed), and Instance436.4 (100% processed)  
 5/3/2007 1:00:06 PM -- C:\Program Files\Exchange  
 Jetstress\StreamingBackup\_2007\_5\_3\_10\_17\_2.blg has 637 samples.  
 5/3/2007 1:00:07 PM -- Creating test report ...

## Appendix D: Soft Recovery Testing

### SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance3044.1	503	457.0839756
Instance3044.2	500	455.5839564
Instance3044.3	522	451.333902
Instance3044.4	512	449.0838732

### Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (E:)	0.132	0.052	198.631	4.454	(n/a)
Database (F:)	0.119	0.043	204.424	4.507	(n/a)
Database (G:)	0.111	0.044	204.719	4.698	(n/a)
Database (H:)	0.109	0.045	198.631	4.606	(n/a)
Log (K:)	0.010	0.053	36.505	1.936	4042.318
Log (L:)	0.010	0.048	36.353	1.956	4016.008
Log (M:)	0.010	0.049	37.961	2.062	4066.704
Log (N:)	0.010	0.053	37.159	1.991	4162.532

### Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	6.972	2.345	11.720
Available MBytes	30577.395	30275.000	31326.000
Free System Page Table Entries	16754700.000	16754700.000	16754700.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	76691348.211	75587584.000	79360000.000
Pool Paged Bytes	72727426.246	64913408.000	265961472.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

### Test Log

5/2/2007 11:01:41 AM -- Prepare testing begins ...  
 5/2/2007 11:01:42 AM -- Duplicating 4 databases:  
 5/2/2007 11:01:55 AM -- 0.3% of 378.9 GB complete (1.2 GB duplicated).  
 5/2/2007 11:01:55 AM -- Prepare testing ends.  
 5/2/2007 11:03:02 AM -- Prepare testing begins ...  
 5/2/2007 11:03:02 AM -- Duplicating 4 databases:  
 5/2/2007 12:16:53 PM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
 5/2/2007 12:16:54 PM -- Attaching databases ...  
 5/2/2007 12:16:54 PM -- Prepare testing ends.  
 5/2/2007 10:15:26 PM -- Jetstress testing begins ...  
 5/2/2007 10:15:26 PM -- Prepare testing begins ...  
 5/2/2007 10:15:28 PM -- Attaching databases ...  
 5/2/2007 10:15:28 PM -- Prepare testing ends.  
 5/2/2007 10:15:28 PM -- Dispatching transactions begins ...  
 5/2/2007 10:15:28 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 5/2/2007 10:15:28 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 5/2/2007 10:15:29 PM -- Database read latency thresholds: (average: 0.02 seconds/read,  
 maximum: 0.05 seconds/read).  
 5/2/2007 10:15:29 PM -- Log write latency thresholds: (average: 0.01 seconds/write,  
 maximum: 0.05 seconds/write).  
 5/2/2007 10:15:33 PM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces  
 50%, Reads 15%, Lazy Commits 80%.  
 5/2/2007 10:15:33 PM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 10:15:33 PM -- Generating log files ...  
 5/2/2007 10:47:58 PM -- K:\ (100.8% generated), L:\ (100.2% generated), M:\ (104.4%  
 generated), and N:\ (102.6% generated)  
 5/2/2007 10:47:59 PM -- Performance logging ends.  
 5/2/2007 10:47:59 PM -- JetInterop batch transaction stats: 9831, 9950, 9946, and 9875.  
 5/2/2007 10:47:59 PM -- Dispatching transactions ends.  
 5/2/2007 10:47:59 PM -- Shutting down databases ...  
 5/2/2007 10:48:03 PM -- Instance3044.1 (complete), Instance3044.2 (complete),  
 Instance3044.3 (complete), and Instance3044.4 (complete)  
 5/2/2007 10:48:04 PM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 10:48:04 PM -- Verifying database checksums ...  
 5/2/2007 11:40:19 PM -- E: (100% processed), F: (100% processed), G: (100% processed),  
 and H: (100% processed)  
 5/2/2007 11:40:19 PM -- E:\Jetstress1.edb has 1 bad checksum page(s).  
 5/2/2007 11:40:19 PM -- F:\Jetstress1.edb has 1 bad checksum page(s).  
 5/2/2007 11:40:19 PM -- G:\Jetstress1.edb has 1 bad checksum page(s).  
 5/2/2007 11:40:19 PM -- H:\Jetstress1.edb has 1 bad checksum page(s).  
 5/2/2007 11:40:20 PM -- Performance logging ends.  
 5/2/2007 11:40:20 PM -- [C:\Program Files\Exchange  
 Jetstress\DBChecksum\\_2007\\_5\\_2\\_22\\_48\\_3.blg](C:\Program Files\Exchange Jetstress\DBChecksum_2007_5_2_22_48_3.blg) has 209 samples.  
 5/2/2007 11:40:23 PM -- [C:\Program Files\Exchange  
 Jetstress\DBChecksum\\_2007\\_5\\_2\\_22\\_48\\_3.html](C:\Program Files\Exchange Jetstress\DBChecksum_2007_5_2_22_48_3.html) is saved.  
 5/2/2007 11:40:23 PM -- Verifying log checksums ...  
 5/2/2007 11:40:48 PM -- K:\ (100 logs passed), L:\ (100 logs passed), M:\ (100 logs passed),  
 and N:\ (100 logs passed)  
 5/2/2007 11:40:48 PM -- [C:\Program Files\Exchange  
 Jetstress\Performance\\_2007\\_5\\_2\\_22\\_15\\_29.blg](C:\Program Files\Exchange Jetstress\Performance_2007_5_2_22_15_29.blg) has 129 samples.  
 5/2/2007 11:40:48 PM -- Creating test report ...  
 5/2/2007 11:40:49 PM -- Volume E: has 0.0128 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume F: has 0.0126 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume G: has 0.0125 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume H: has 0.0125 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume K: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume K: has 0.0020 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume L: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume L: has 0.0021 for Avg. Disk sec/Read.

5/2/2007 11:40:49 PM -- Volume M: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume M: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume N: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume N: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 5/2/2007 11:40:49 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
 5/2/2007 11:40:49 PM -- [C:\Program Files\Exchange Jetstress\Performance\\_2007\\_5\\_2\\_22\\_15\\_29.html](C:\Program Files\Exchange Jetstress\Performance_2007_5_2_22_15_29.html) is saved.  
 5/2/2007 11:40:50 PM -- Performance logging begins (interval: 2000 ms).  
 5/2/2007 11:40:50 PM -- Recovering databases ...  
 5/2/2007 11:48:28 PM -- Performance logging ends.  
 5/2/2007 11:48:28 PM -- Instance3044.1 (457.0839756), Instance3044.2 (455.5839564), Instance3044.3 (451.333902), and Instance3044.4 (449.0838732)  
 5/2/2007 11:48:28 PM -- [C:\Program Files\Exchange Jetstress\SoftRecovery\\_2007\\_5\\_2\\_23\\_40\\_49.blg](C:\Program Files\Exchange Jetstress\SoftRecovery_2007_5_2_23_40_49.blg) has 228 samples.  
 5/2/2007 11:48:28 PM -- Creating test report ...

## SoftRecovery Performance Test Result Report

### Test Summary

<b>Overall Test Result</b>	<b>Pass</b>
<b>Machine Name</b>	RTPSOL396
<b>Test Description</b>	
<b>Test Start Time</b>	5/2/2007 10:15:26 PM
<b>Test End Time</b>	5/2/2007 10:48:03 PM
<b>Jetstress Version</b>	08.01.0075.000
<b>Ese Version</b>	08.00.0685.024
<b>Operating System</b>	Microsoft Windows Server 2003 R2 Service Pack 1 (5.2.3790.65536)
<b>Performance Log</b>	<a href="C:\Program Files\Exchange Jetstress\Performance_2007_5_2_22_15_29.blg">C:\Program Files\Exchange Jetstress\Performance_2007_5_2_22_15_29.blg</a> <a href="C:\Program Files\Exchange Jetstress\DBChecksum_2007_5_2_22_48_3.blg">C:\Program Files\Exchange Jetstress\DBChecksum_2007_5_2_22_48_3.blg</a>

### Database Sizing and Throughput

<b>Achieved I/O per Second</b>	622.218
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial database size</b>	406842310656
<b>Final database size</b>	408530518016
<b>Database files (count)</b>	4

## Jetstress System Parameters

<b>Thread count</b>	3 (per-storage group)
<b>Log buffers</b>	9000
<b>Minimum database cache</b>	128.0 MB
<b>Maximum database cache</b>	1024.0 MB
<b>Insert operations</b>	25%
<b>Delete operations</b>	10%
<b>Replace operations</b>	50%
<b>Read operations</b>	15%
<b>Lazy commits</b>	80%

## 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	0.003	78.317	75.960	(n/a)
Database (F:)	0.013	0.003	80.881	75.294	(n/a)
Database (G:)	0.013	0.002	80.001	77.729	(n/a)
Database (H:)	0.013	0.003	77.950	76.086	(n/a)
Log (K:)	0.002	0.002	2.166	51.123	11302.423
Log (L:)	0.002	0.002	2.175	51.506	11093.162
Log (M:)	0.002	0.002	2.249	52.133	11448.298
Log (N:)	0.002	0.002	2.204	51.721	11281.240

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.484	1.694	5.861
Available MBytes	30266.380	29905.000	30903.000
Free System Page Table Entries	16754980.000	16754980.000	16754980.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	68088824.062	66670592.000	69582848.000
Pool Paged Bytes	68311055.876	62431232.000	73695232.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/2/2007 11:01:41 AM -- Prepare testing begins ...  
5/2/2007 11:01:42 AM -- Duplicating 4 databases:  
5/2/2007 11:01:55 AM -- 0.3% of 378.9 GB complete (1.2 GB duplicated).  
5/2/2007 11:01:55 AM -- Prepare testing ends.  
5/2/2007 11:03:02 AM -- Prepare testing begins ...  
5/2/2007 11:03:02 AM -- Duplicating 4 databases:  
5/2/2007 12:16:53 PM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
5/2/2007 12:16:54 PM -- Attaching databases ...  
5/2/2007 12:16:54 PM -- Prepare testing ends.  
5/2/2007 10:15:26 PM -- Jetstress testing begins ...  
5/2/2007 10:15:26 PM -- Prepare testing begins ...  
5/2/2007 10:15:28 PM -- Attaching databases ...  
5/2/2007 10:15:28 PM -- Prepare testing ends.  
5/2/2007 10:15:28 PM -- Dispatching transactions begins ...  
5/2/2007 10:15:28 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
5/2/2007 10:15:28 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
5/2/2007 10:15:29 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).  
5/2/2007 10:15:29 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).  
5/2/2007 10:15:33 PM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
5/2/2007 10:15:33 PM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 10:15:33 PM -- Generating log files ...  
5/2/2007 10:47:58 PM -- K:\ (100.8% generated), L:\ (100.2% generated), M:\ (104.4% generated), and N:\ (102.6% generated)  
5/2/2007 10:47:59 PM -- Performance logging ends.  
5/2/2007 10:47:59 PM -- JetInterop batch transaction stats: 9831, 9950, 9946, and 9875.  
5/2/2007 10:47:59 PM -- Dispatching transactions ends.  
5/2/2007 10:47:59 PM -- Shutting down databases ...  
5/2/2007 10:48:03 PM -- Instance3044.1 (complete), Instance3044.2 (complete), Instance3044.3 (complete), and Instance3044.4 (complete)  
5/2/2007 10:48:04 PM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 10:48:04 PM -- Verifying database checksums ...  
5/2/2007 11:40:19 PM -- E: (100% processed), F: (100% processed), G: (100% processed), and H: (100% processed)  
5/2/2007 11:40:19 PM -- E:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- F:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- G:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- H:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:20 PM -- Performance logging ends.  
5/2/2007 11:40:20 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum 2007 5 2 22 48 3.blg](#) has 209 samples.  
5/2/2007 11:40:23 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum 2007 5 2 22 48 3.html](#) is saved.  
5/2/2007 11:40:23 PM -- Verifying log checksums ...  
5/2/2007 11:40:48 PM -- K:\ (100 logs passed), L:\ (100 logs passed), M:\ (100 logs passed), and N:\ (100 logs passed)  
5/2/2007 11:40:48 PM -- [C:\Program Files\Exchange Jetstress\Performance 2007 5 2 22 15 29.blg](#) has 129 samples.  
5/2/2007 11:40:48 PM -- Creating test report ...  
5/2/2007 11:40:49 PM -- Volume E: has 0.0128 for Avg. Disk sec/Read.  
5/2/2007 11:40:49 PM -- Volume F: has 0.0126 for Avg. Disk sec/Read.  
5/2/2007 11:40:49 PM -- Volume G: has 0.0125 for Avg. Disk sec/Read.  
5/2/2007 11:40:49 PM -- Volume H: has 0.0125 for Avg. Disk sec/Read.  
5/2/2007 11:40:49 PM -- Volume K: has 0.0022 for Avg. Disk sec/Write.

5/2/2007 11:40:49 PM -- Volume K: has 0.0020 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume L: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume L: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume M: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume M: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Volume N: has 0.0022 for Avg. Disk sec/Write.  
 5/2/2007 11:40:49 PM -- Volume N: has 0.0021 for Avg. Disk sec/Read.  
 5/2/2007 11:40:49 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 5/2/2007 11:40:49 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

## SoftRecovery Database Checksum Results

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
E:\Jetstress1.edb	12466786	1	0	0	3188 MBytes / 3120 seconds
F:\Jetstress1.edb	12464738	1	0	0	3172 MBytes / 3135 seconds
G:\Jetstress1.edb	12469090	1	0	0	3206 MBytes / 3112 seconds
H:\Jetstress1.edb	12468834	1	0	0	3204 MBytes / 3112 seconds
(Sum)	49869448	4	0	0	485 MBytes / 12480 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
E:	0.143	0.044	499.568	0.005
F:	0.129	0.030	499.234	0.004
G:	0.121	0.021	499.580	0.004
H:	0.122	0.045	499.649	0.004

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	24.980	4.480	33.100
Available MBytes	31120.608	31107.000	31311.000
Free System Page Table Entries	16754700.335	16754700.000	16754770.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	85695747.675	83943424.000	86540288.000
Pool Paged Bytes	73699857.148	73261056.000	78028800.000

## Test Log

5/2/2007 11:01:41 AM -- Prepare testing begins ...  
5/2/2007 11:01:42 AM -- Duplicating 4 databases:  
5/2/2007 11:01:55 AM -- 0.3% of 378.9 GB complete (1.2 GB duplicated).  
5/2/2007 11:01:55 AM -- Prepare testing ends.  
5/2/2007 11:03:02 AM -- Prepare testing begins ...  
5/2/2007 11:03:02 AM -- Duplicating 4 databases:  
5/2/2007 12:16:53 PM -- 100.0% of 378.9 GB complete (378.9 GB duplicated).  
5/2/2007 12:16:54 PM -- Attaching databases ...  
5/2/2007 12:16:54 PM -- Prepare testing ends.  
5/2/2007 10:15:26 PM -- Jetstress testing begins ...  
5/2/2007 10:15:26 PM -- Prepare testing begins ...  
5/2/2007 10:15:28 PM -- Attaching databases ...  
5/2/2007 10:15:28 PM -- Prepare testing ends.  
5/2/2007 10:15:28 PM -- Dispatching transactions begins ...  
5/2/2007 10:15:28 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
5/2/2007 10:15:28 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
5/2/2007 10:15:29 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).  
5/2/2007 10:15:29 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).  
5/2/2007 10:15:33 PM -- Operation mix: Sessions 3, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
5/2/2007 10:15:33 PM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 10:15:33 PM -- Generating log files ...  
5/2/2007 10:47:58 PM -- K:\ (100.8% generated), L:\ (100.2% generated), M:\ (104.4% generated), and N:\ (102.6% generated)  
5/2/2007 10:47:59 PM -- Performance logging ends.  
5/2/2007 10:47:59 PM -- JetInterop batch transaction stats: 9831, 9950, 9946, and 9875.  
5/2/2007 10:47:59 PM -- Dispatching transactions ends.  
5/2/2007 10:47:59 PM -- Shutting down databases ...  
5/2/2007 10:48:03 PM -- Instance3044.1 (complete), Instance3044.2 (complete), Instance3044.3 (complete), and Instance3044.4 (complete)  
5/2/2007 10:48:04 PM -- Performance logging begins (interval: 15000 ms).  
5/2/2007 10:48:04 PM -- Verifying database checksums ...  
5/2/2007 11:40:19 PM -- E: (100% processed), F: (100% processed), G: (100% processed), and H: (100% processed)  
5/2/2007 11:40:19 PM -- E:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- F:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- G:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:19 PM -- H:\Jetstress1.edb has 1 bad checksum page(s).  
5/2/2007 11:40:20 PM -- Performance logging ends.  
5/2/2007 11:40:20 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum\\_2007\\_5\\_2\\_22\\_48\\_3.blg](#) has 209 samples.

## Appendix E: Maximum Solution IOPS Testing

The building block described under is the EMC recommended configuration for an 1100 Exchange user workload at 0.5 IOPS per user. The result shown in Appendix A 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 IO 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 proving 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 3 to 9 without modifying any of the other components. The achieved IOPS increased from 623.409 to 1142.18 – a 83% increase, while still providing latency results that satisfied the ESRP criteria. 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 Result Report**

#### Test Summary

<b>Overall Test Result</b>	<b>Pass</b>
<b>Machine Name</b>	C2D77C1
<b>Test Description</b>	
<b>Test Start Time</b>	5/2/2007 2:31:03 PM
<b>Test End Time</b>	5/2/2007 6:07:09 PM
<b>Jetstress Version</b>	08.01.0075.000
<b>Ese Version</b>	08.01.0013.000
<b>Operating System</b>	Microsoft Windows Server 2003 Service Pack 1 (5.2.3790.65536)
<b>Performance Log</b>	<a href="#">C:\Jetstress\8disk\10t\perf_rr\Performance_2007_5_2_16_3_6.blg</a> <a href="#">C:\Jetstress\8disk\10t\perf_rr\DBChecksum_2007_5_2_18_7_9.blg</a>

## Database Sizing and Throughput

<b>Achieved I/O per Second</b>	1142.18
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial database size</b>	406984916992
<b>Final database size</b>	417852358656
<b>Database files (count)</b>	4

## Jetstress System Parameters

<b>Thread count</b>	9 (per-storage group)
<b>Log buffers</b>	9000
<b>Minimum database cache</b>	128.0 MB
<b>Maximum database cache</b>	1024.0 MB
<b>Insert operations</b>	25%
<b>Delete operations</b>	10%
<b>Replace operations</b>	50%
<b>Read operations</b>	15%
<b>Lazy commits</b>	80%

## Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (G:)	0.018	0.004	146.696	137.483	(n/a)
Database (H:)	0.020	0.004	148.365	138.769	(n/a)
Database (I:)	0.019	0.004	148.512	136.536	(n/a)
Database (J:)	0.019	0.004	148.650	137.169	(n/a)
Log (K:)	0.000	0.002	0.000	77.116	12897.766
Log (L:)	0.000	0.002	0.000	78.039	12874.291
Log (M:)	0.000	0.002	0.000	77.092	12718.771
Log (N:)	0	0.002	0.000	77.779	12705.015

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.606	2.263	6.011
Available MBytes	14329.826	14256.000	15207.000

Free System Page Table Entries	16759721.848	16759721.000	16759791.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	47757630.578	47386624.000	48058368.000
Pool Paged Bytes	42640824.630	42557440.000	43511808.000
Database Page Fault Stalls/sec	0.001	0.000	0.266

## Test Log

5/2/2007 2:31:03 PM -- Jetstress testing begins ...  
 5/2/2007 2:31:03 PM -- Prepare testing begins ...  
 5/2/2007 2:31:03 PM -- Duplicating 4 databases:  
 5/2/2007 4:03:05 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).  
 5/2/2007 4:03:05 PM -- Attaching databases ...  
 5/2/2007 4:03:05 PM -- Prepare testing ends.  
 5/2/2007 4:03:05 PM -- Dispatching transactions begins ...  
 5/2/2007 4:03:05 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 5/2/2007 4:03:05 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 5/2/2007 4:03:06 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).  
 5/2/2007 4:03:06 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).  
 5/2/2007 4:03:07 PM -- Operation mix: Sessions 9, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
 5/2/2007 4:03:07 PM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 4:03:07 PM -- Attaining prerequisites:  
 5/2/2007 4:07:02 PM -- \Database(JetstressWin)\Database Cache Size, Last: 968278000.0 (lower bound: 966367600.0, upper bound: none)  
 5/2/2007 6:07:03 PM -- Performance logging ends.  
 5/2/2007 6:07:03 PM -- JetInterop batch transaction stats: 64901, 65215, 65147, and 65262.  
 5/2/2007 6:07:04 PM -- Dispatching transactions ends.  
 5/2/2007 6:07:04 PM -- Shutting down databases ...  
 5/2/2007 6:07:09 PM -- Instance2012.1 (complete), Instance2012.2 (complete), Instance2012.3 (complete), and Instance2012.4 (complete)  
 5/2/2007 6:07:10 PM -- Performance logging begins (interval: 15000 ms).  
 5/2/2007 6:07:10 PM -- Verifying database checksums ...  
 5/2/2007 7:37:49 PM -- G: (100% processed), H: (100% processed), I: (100% processed), and J: (100% processed)  
 5/2/2007 7:37:50 PM -- Performance logging ends.  
 5/2/2007 7:37:50 PM -- [C:\Jetstress\8disk\10t\perf\\_rr\DBChecksum\\_2007\\_5\\_2\\_18\\_7\\_9.blg](C:\Jetstress\8disk\10t\perf_rr\DBChecksum_2007_5_2_18_7_9.blg) has 362 samples.  
 5/2/2007 7:37:54 PM -- [C:\Jetstress\8disk\10t\perf\\_rr\DBChecksum\\_2007\\_5\\_2\\_18\\_7\\_9.html](C:\Jetstress\8disk\10t\perf_rr\DBChecksum_2007_5_2_18_7_9.html) is saved.  
 5/2/2007 7:37:54 PM -- Verifying log checksums ...  
 5/2/2007 7:38:00 PM -- K:\ (21 logs passed), L:\ (21 logs passed), M:\ (22 logs passed), and N:\ (22 logs passed)  
 5/2/2007 7:38:00 PM -- [C:\Jetstress\8disk\10t\perf\\_rr\Performance\\_2007\\_5\\_2\\_16\\_3\\_6.blg](C:\Jetstress\8disk\10t\perf_rr\Performance_2007_5_2_16_3_6.blg) has 495 samples.  
 5/2/2007 7:38:00 PM -- Creating test report ...  
 5/2/2007 7:38:02 PM -- Volume G: has 0.0180 for Avg. Disk sec/Read.  
 5/2/2007 7:38:02 PM -- Volume H: has 0.0200 for Avg. Disk sec/Read.  
 5/2/2007 7:38:02 PM -- Volume I: has 0.0187 for Avg. Disk sec/Read.  
 5/2/2007 7:38:02 PM -- Volume J: has 0.0187 for Avg. Disk sec/Read.  
 5/2/2007 7:38:02 PM -- Volume K: has 0.0023 for Avg. Disk sec/Write.  
 5/2/2007 7:38:02 PM -- Volume K: has 0.0000 for Avg. Disk sec/Read.  
 5/2/2007 7:38:02 PM -- Volume L: has 0.0023 for Avg. Disk sec/Write.  
 5/2/2007 7:38:02 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.

5/2/2007 7:38:02 PM -- Volume M: has 0.0023 for Avg. Disk sec/Write.  
5/2/2007 7:38:02 PM -- Volume M: has 0.0000 for Avg. Disk sec/Read.  
5/2/2007 7:38:02 PM -- Volume N: has 0.0023 for Avg. Disk sec/Write.  
5/2/2007 7:38:02 PM -- Volume N: has 0.0000 for Avg. Disk sec/Read.  
5/2/2007 7:38:02 PM -- Test has 0.266233454844433 Maximum Database Page Fault Stalls/sec.  
5/2/2007 7:38:02 PM -- Test has 2 Database Page Fault Stalls/sec samples higher than 0.