

ESRP Storage Program
EMC Celerra NS40 (1350 User) iSCSI Storage Solution for
Microsoft Exchange Server 2007

Tested with: ESRP – Storage Version 2.0
Tested Date: 05/7/07

EMC believes the information in this publication is accurate as of its publication date. The information is subject to change without notice.

THE INFORMATION IN THIS PUBLICATION IS PROVIDED "AS IS." EMC CORPORATION MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WITH RESPECT TO THE INFORMATION IN THIS PUBLICATION, AND SPECIFICALLY DISCLAIMS IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Use, copying, and distribution of any EMC software described in this publication requires an applicable software license.

EMC², EMC, EMC ControlCenter, AlphaStor, ApplicationXtender, Avamar, Captiva, Catalog Solution, Celerra, Centera, CentraStar, CLARAlert, CLARiiON, ClientPak, CodeLink, Connectrix, Co-StandbyServer, Dantz, Direct Matrix Architecture, DiskXtender, DiskXtender 2000, Documentum, EmailXaminer, EmailXtender, EmailXtract, eRoom, FLARE, HighRoad, InputAccel, Invista, Max Retriever, Navisphere, NetWorker, nLayers, OpenScale, Powerlink, PowerPath, Rainfinity, RepliStor, ResourcePak, Retrospect, Smarts, SnapshotServer, SnapView/IP, SRDF, Symmetrix, TimeFinder, VisualSAN, VSAM-Assist, WebXtender, where information lives, Xtender, and Xtender Solutions are registered trademarks and EMC Developers Program, EMC OnCourse, EMC Proven, EMC Snap, EMC Storage Administrator, Acartus, Access Logix, ArchiveXtender, Authentic Problems, Automated Resource Manager, AutoStart, AutoSwap, AVALONidm, C-Clip, Celerra Replicator, CLARevent, Codebook Correlation Technology, Common Information Model, CopyCross, CopyPoint, DatabaseXtender, Direct Matrix, EDM, E-Lab, Enginuity, FarPoint, Global File Virtualization, Graphic Visualization, InfoMover, Infoscapes, MediaStor, MirrorView, NetWin, OnAlert, PowerSnap, RepliCare, SafeLine, SAN Advisor, SAN Copy, SAN Manager, SDMS, SnapImage, SnapSure, SnapView, StorageScope, SupportMate, SymmAPI, SymmEnabler, Symmetrix DMX, UltraPoint, UltraScale, Viewlets, and VisualSRM are trademarks of EMC Corporation.

All other trademarks used herein are the property of their respective owners.

Copyright © 1998-2007 EMC Corporation. All rights reserved.

Printed 6/1/2007

H2848

Table of Contents

Overview	4
Disclaimer	4
Features.....	4
Solution Description.....	5
Targeted Customer Profile	7
Tested Deployment.....	7
Simulated Exchange Configuration	7
Primary Storage Hardware	7
Primary Storage Software	8
Primary Storage Disk Configuration (Mailbox Store Disks).....	8
Primary Storage Disk Configuration (Transactional Log Disks)	9
Streaming Backup	9
Disk Configuration (Streaming Backup to disk).....	9
Best Practices.....	9
Core Storage/Replication.....	9
Backup strategy	10
Test Result Summary	10
Reliability	11
Primary Storage Performance Results	11
Individual Server Metrics	11
Streaming Backup Performance.....	12
Database Read-only Performance	12
Log Read-only Performance	12
Backup to Disk Performance	12
Conclusion	12
Contact Information	13
Appendix A: Stress Testing	14
Stress Test Result Report.....	14
Database Checksum Results	16
Appendix B: Performance Testing.....	19
Performance Test Result Report	19
Database Checksum Results	21
Appendix C: Streaming Backup Testing.....	24
Streaming backup Test Result Report.....	24
Appendix D: Soft Recovery Testing.....	26
SoftRecovery Test Result Report	26
SoftRecovery Performance Test Result Report	28
SoftRecovery Database Checksum Results.....	30
Appendix E: Maximum Solution IOPS Testing	33
Maximum Performance Test Result Report	33

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.mspx>

Disclaimer

This document has been produced independently of Microsoft Corporation. Microsoft Corporation expressly disclaims responsibility for, and makes no warranty, express or implied, with respect to, the accuracy of the contents of this document.

The information contained in this document represents the current view of EMC on the issues discussed as of the date of publication. Due to changing market conditions, it should not be interpreted to be a commitment on the part of EMC, and EMC cannot guarantee the accuracy of any information presented after the date of publication.

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 Fiber 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 1350 Exchange 2007 users. Each of the 1350 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 1350, 0.5 IOPS Exchange users. Each storage group in Exchange 2007 is recommended to have only one database. The 1350 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.

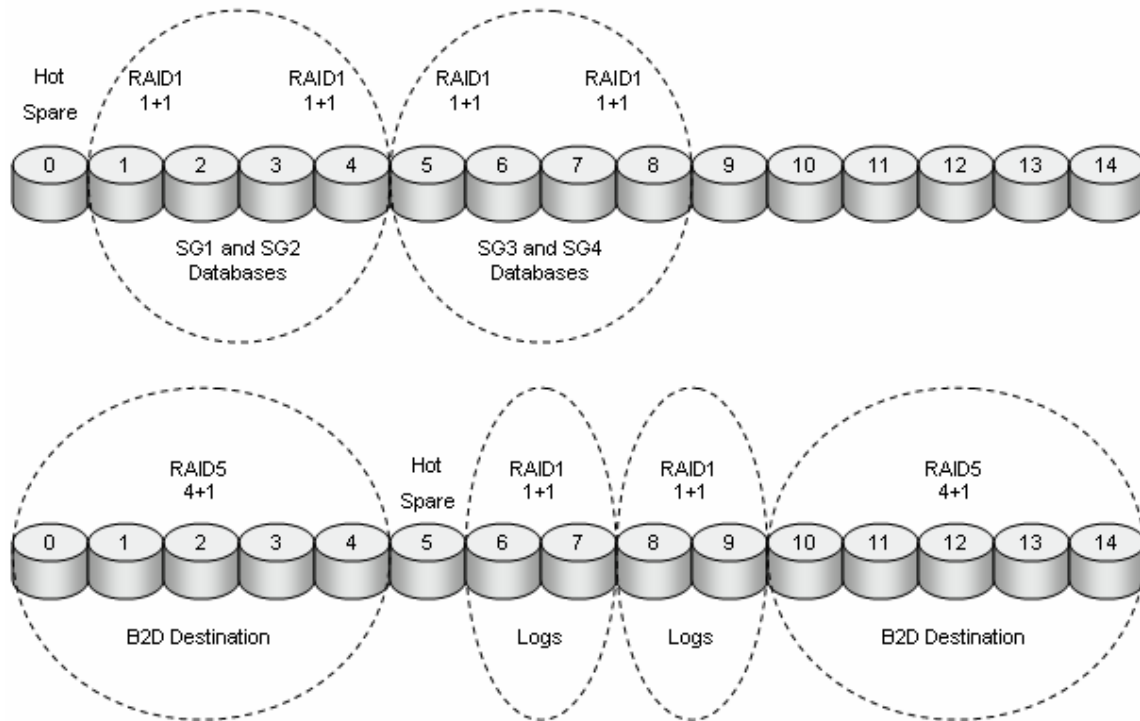


Figure 1 - Building Block 1 and 2

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 scalable 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 1350 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 — 3 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	1350
Number of hosts	1
Number of mailboxes/host	1350
Number of storage groups/host	4
Number of mailbox stores/storage group	1
Number of mailboxes/mailbox store	337
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*1Gb 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 – 60 AC
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	4Gbps 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 – 60 AC
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 uses.

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.

Database I/O	
Average Database Disk Transfers/sec	743.285
Average Database Disk Reads/sec	378.656
Average Database Disk Writes/sec	364.629
Average Database Disk Read Latency (ms)	14.25
Average Database Disk Write Latency (ms)	3
Transaction Log I/O	
Average Log Disk Writes/sec	222.167
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	8.64
MB read/sec total	34.56
File size/sec taken	388123.08/44972

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)	0.886
---	-------

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)	379.02645
Time taken to backup each storage group	3:07:23
Average MB backed up/sec	34.562
Average MB backed up/sec per storage group	8.6406

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 1350 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:

United States: (800) 782-4362 (SVC-4EMC)
Canada: (800) 543-4782 (543-4SVC)
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

Overall Test Result	Pass
Machine Name	C2D77C1
Test Description	
Test Start Time	5/2/2007 8:21:42 PM
Test End Time	5/3/2007 10:00:37 PM
Jetstress Version	08.01.0075.000
Ese Version	08.01.0013.000
Operating System	Microsoft Windows Server 2003 Service Pack 1 (5.2.3790.65536)
Performance Log	C:\Jetstress\8disk\4t\stress_rr\Stress_2007_5_2_21_53_43.blg C:\Jetstress\8disk\4t\stress_rr\DBChecksum_2007_5_3_22_0_37.blg

Database Sizing and Throughput

Achieved I/O per Second	698.656
Capacity Percentage	100%
Throughput Percentage	100%
Initial database size	406984916992
Final database size	477472817152
Database files (count)	4

Jetstress System Parameters

Thread count	4 (per-storage group)
Log buffers	9000
Minimum database cache	128.0 MB
Maximum database cache	1024.0 MB
Insert operations	25%
Delete operations	10%
Replace operations	50%

Read operations	15%
Lazy commits	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:)	0.015	0.003	92.286	82.558	(n/a)
Database (H:)	0.015	0.003	92.805	82.525	(n/a)
Database (I:)	0.015	0.003	92.023	81.927	(n/a)
Database (J:)	0.015	0.003	92.386	82.145	(n/a)
Log (K:)	0.000	0.002	0.000	47.854	11498.184
Log (L:)	0.000	0.002	0.000	47.995	11472.497
Log (M:)	0.000	0.002	0.000	47.892	11442.177
Log (N:)	0.000	0.002	0.000	47.881	11451.180

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.110	0.359	4.008
Available MBytes	14352.355	14271.000	15393.000
Free System Page Table Entries	16759181.000	16759181.000	16759181.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	51658588.160	51597312.000	51789824.000
Pool Paged Bytes	129193034.240	42741760.000	244248576.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 5/2/2007 8:21:42 PM

```
-- Jetstress testing begins ...
5/2/2007 8:21:42 PM -- Prepare testing begins ...
5/2/2007 8:21:42 PM -- Duplicating 4 databases:
5/2/2007 9:53:42 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).
5/2/2007 9:53:42 PM -- Attaching databases ...
5/2/2007 9:53:42 PM -- Prepare testing ends.
5/2/2007 9:53:42 PM -- Dispatching transactions begins ...
5/2/2007 9:53:42 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)
5/2/2007 9:53:42 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)
5/2/2007 9:53:43 PM -- Database read latency thresholds: (average: 0.02 seconds/read,
maximum: 0.1 seconds/read).
5/2/2007 9:53:43 PM -- Log write latency thresholds: (average: 0.01 seconds/write,
maximum: 0.1 seconds/write).
5/2/2007 9:53:44 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%,
```

Reads 15%, Lazy Commits 80%.
5/2/2007 9:53:44 PM -- Performance logging begins (interval: 15000 ms).
5/2/2007 9:53:44 PM -- Attaining prerequisites:
5/2/2007 10:00:32 PM -- \Database(JetstressWin)\Database Cache Size, Last: 968294400.0 (lower bound: 966367600.0, upper bound: none)
5/3/2007 10:00:33 PM -- Performance logging ends.
5/3/2007 10:00:33 PM -- JetInterop batch transaction stats: 429240, 429878, 429582, and 429405.
5/3/2007 10:00:33 PM -- Dispatching transactions ends.
5/3/2007 10:00:33 PM -- Shutting down databases ...
5/3/2007 10:00:37 PM -- Instance2476.1 (complete), Instance2476.2 (complete), Instance2476.3 (complete), and Instance2476.4 (complete)
5/3/2007 10:00:37 PM -- Performance logging begins (interval: 15000 ms).
5/3/2007 10:00:37 PM -- Verifying database checksums ...
5/3/2007 11:45:35 PM -- G: (100% processed), H: (100% processed), I: (100% processed), and J: (100% processed)
5/3/2007 11:45:36 PM -- Performance logging ends.
5/3/2007 11:45:36 PM --
[C:\Jetstress\8disk\4t\stress_rr\DBChecksum_2007_5_3_22_0_37.blg](#) has 419 samples.
5/3/2007 11:45:39 PM --
[C:\Jetstress\8disk\4t\stress_rr\DBChecksum_2007_5_3_22_0_37.html](#) is saved.
5/3/2007 11:45:39 PM -- Verifying log checksums ...
5/3/2007 11:45:45 PM -- K:\ (21 logs passed), L:\ (22 logs passed), M:\ (22 logs passed), and N:\ (22 logs passed)
5/3/2007 11:45:45 PM -- [C:\Jetstress\8disk\4t\stress_rr\Stress_2007_5_2_21_53_43.blg](#) has 5787 samples.
5/3/2007 11:45:45 PM -- Creating test report ...
5/3/2007 11:46:26 PM -- Volume G: has 0.0148 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume H: has 0.0155 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume I: has 0.0150 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume J: has 0.0149 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume K: has 0.0023 for Avg. Disk sec/Write.
5/3/2007 11:46:26 PM -- Volume K: has 0.0000 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume L: has 0.0023 for Avg. Disk sec/Write.
5/3/2007 11:46:26 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume M: has 0.0023 for Avg. Disk sec/Write.
5/3/2007 11:46:26 PM -- Volume M: has 0.0000 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Volume N: has 0.0023 for Avg. Disk sec/Write.
5/3/2007 11:46:26 PM -- Volume N: has 0.0000 for Avg. Disk sec/Read.
5/3/2007 11:46:26 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/3/2007 11:46:26 PM -- 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
G:\Jetstress1.edb	14580338	0	0	0	3316 MBytes / 6072 seconds
H:\Jetstress1.edb	14569842	0	0	0	3234 MBytes / 6130 seconds
I:\Jetstress1.edb	14573938	0	0	0	3266 MBytes / 6297 seconds

J:\Jetstress1.edb	14561138	0	0	0	3166 MBytes / 6297 seconds
(Sum)	58285256	0	0	0	697 MBytes / 24797 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
G:	0.125	0.001	290.356	0.004
H:	0.133	0.001	289.958	0.004
I:	0.146	0.001	289.591	0.002
J:	0.143	0.001	288.364	0.002

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	7.999	4.607	11.378
Available MBytes	15056.504	15043.000	15182.000
Free System Page Table Entries	16759179.200	16759160.000	16759181.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	60618268.105	60010496.000	62025728.000
Pool Paged Bytes	245157712.038	245088256.000	246169600.000

Test Log 5/2/2007 8:21:42 PM

```
-- Jetstress testing begins ...
5/2/2007 8:21:42 PM -- Prepare testing begins ...
5/2/2007 8:21:42 PM -- Duplicating 4 databases:
5/2/2007 9:53:42 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).
5/2/2007 9:53:42 PM -- Attaching databases ...
5/2/2007 9:53:42 PM -- Prepare testing ends.
5/2/2007 9:53:42 PM -- Dispatching transactions begins ...
5/2/2007 9:53:42 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)
5/2/2007 9:53:42 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)
5/2/2007 9:53:43 PM -- Database read latency thresholds: (average: 0.02 seconds/read,
maximum: 0.1 seconds/read).
5/2/2007 9:53:43 PM -- Log write latency thresholds: (average: 0.01 seconds/write,
maximum: 0.1 seconds/write).
5/2/2007 9:53:44 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%,
Reads 15%, Lazy Commits 80%.
5/2/2007 9:53:44 PM -- Performance logging begins (interval: 15000 ms).
5/2/2007 9:53:44 PM -- Attaining prerequisites:
5/2/2007 10:00:32 PM -- \Database(JetstressWin)\Database Cache Size, Last: 968294400.0
(lower bound: 966367600.0, upper bound: none)
5/3/2007 10:00:33 PM -- Performance logging ends.
5/3/2007 10:00:33 PM -- JetInterop batch transaction stats: 429240, 429878, 429582, and
429405.
5/3/2007 10:00:33 PM -- Dispatching transactions ends.
5/3/2007 10:00:33 PM -- Shutting down databases ...
5/3/2007 10:00:37 PM -- Instance2476.1 (complete), Instance2476.2 (complete),
```

Instance2476.3 (complete), and Instance2476.4 (complete)
5/3/2007 10:00:37 PM -- Performance logging begins (interval: 15000 ms).
5/3/2007 10:00:37 PM -- Verifying database checksums ...
5/3/2007 11:45:35 PM -- G: (100% processed), H: (100% processed), I: (100% processed),
and J: (100% processed)
5/3/2007 11:45:36 PM -- Performance logging ends.
5/3/2007 11:45:36 PM --
C:\Jetstress\8disk\4t\stress_rr\DBChecksum_2007_5_3_22_0_37.blg has 419 samples.

Appendix B: Performance Testing

Performance Test Result Report

Test Summary

Overall Test Result	Pass
Machine Name	C2D77C1
Test Description	
Test Start Time	4/29/2007 10:34:57 AM
Test End Time	4/29/2007 2:13:56 PM
Jetstress Version	08.01.0075.000
Ese Version	08.01.0013.000
Operating System	Microsoft Windows Server 2003 Service Pack 1 (5.2.3790.65536)
Performance Log	C:\Jetstress\8disk\4t\perf_rr\Performance_2007_4_29_12_7_2.blg C:\Jetstress\8disk\4t\perf_rr\DBChecksum_2007_4_29_14_13_56.blg

Database Sizing and Throughput

Achieved I/O per Second	743.285
Capacity Percentage	100%
Throughput Percentage	100%
Initial database size	406984916992
Final database size	414276714496
Database files (count)	4

Jetstress System Parameters

Thread count	4 (per-storage group)
Log buffers	9000
Minimum database cache	128.0 MB
Maximum database cache	1024.0 MB
Insert operations	25%
Delete operations	10%
Replace operations	50%

Read operations	15%
Lazy commits	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	0.003	94.216	91.033	(n/a)
Database (H:)	0.015	0.003	94.553	90.874	(n/a)
Database (I:)	0.014	0.003	93.941	90.210	(n/a)
Database (J:)	0.014	0.003	95.946	92.512	(n/a)
Log (K:)	0.000	0.002	0.000	55.208	11745.622
Log (L:)	0.000	0.002	0.000	55.202	11762.902
Log (M:)	0.000	0.002	0.000	55.706	11574.845
Log (N:)	0.000	0.002	0.000	56.051	11730.898

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.242	0.935	3.513
Available MBytes	14336.669	14147.000	15137.000
Free System Page Table Entries	16759321.000	16759321.000	16759321.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	54674894.517	54464512.000	55095296.000
Pool Paged Bytes	42657755.645	42520576.000	43802624.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/29/2007 10:34:57 AM

Jetstress testing begins ...
4/29/2007 10:34:57 AM -- Prepare testing begins ...
4/29/2007 10:34:57 AM -- Duplicating 4 databases:
4/29/2007 12:07:01 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).
4/29/2007 12:07:01 PM -- Attaching databases ...
4/29/2007 12:07:01 PM -- Prepare testing ends.
4/29/2007 12:07:01 PM -- Dispatching transactions begins ...
4/29/2007 12:07:01 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)
4/29/2007 12:07:01 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)
4/29/2007 12:07:02 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
4/29/2007 12:07:02 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
4/29/2007 12:07:03 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces

50%, Reads 15%, Lazy Commits 80%.
 4/29/2007 12:07:03 PM -- Performance logging begins (interval: 15000 ms).
 4/29/2007 12:07:03 PM -- Attaining prerequisites:
 4/29/2007 12:13:51 PM -- \Database(JetstressWin)\Database Cache Size, Last: 967352300.0
 (lower bound: 966367600.0, upper bound: none)4/29/2007 2:13:53 PM -- Performance
 logging ends.
 4/29/2007 2:13:53 PM -- JetInterop batch transaction stats: 43524, 43299, 43501, and
 43637.
 4/29/2007 2:13:53 PM -- Dispatching transactions ends.
 4/29/2007 2:13:53 PM -- Shutting down databases ...
 4/29/2007 2:13:56 PM -- Instance2924.1 (complete), Instance2924.2 (complete),
 Instance2924.3 (complete), and Instance2924.4 (complete)
 4/29/2007 2:13:56 PM -- Performance logging begins (interval: 15000 ms).
 4/29/2007 2:13:56 PM -- Verifying database checksums ...
 4/29/2007 3:43:35 PM -- G: (100% processed), H: (100% processed), I: (100% processed),
 and J: (100% processed)
 4/29/2007 3:43:36 PM -- Performance logging ends.
 4/29/2007 3:43:36 PM --
[C:\Jetstress\8disk\4t\perf_rr\DBChecksum_2007_4_29_14_13_56.blg](#) has 358 samples.
 4/29/2007 3:43:39 PM --
[C:\Jetstress\8disk\4t\perf_rr\DBChecksum_2007_4_29_14_13_56.html](#) is saved.
 4/29/2007 3:43:39 PM -- Verifying log checksums ...
 4/29/2007 3:43:45 PM -- K:\ (22 logs passed), L:\ (21 logs passed), M:\ (22 logs passed),
 and N:\ (22 logs passed)
 4/29/2007 3:43:45 PM -- [C:\Jetstress\8disk\4t\perf_rr\Performance_2007_4_29_12_7_2.blg](#)
 has 507 samples.
 4/29/2007 3:43:45 PM -- Creating test report ...
 4/29/2007 3:43:47 PM -- Volume G: has 0.0141 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume H: has 0.0152 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume I: has 0.0145 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume J: has 0.0145 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume K: has 0.0023 for Avg. Disk sec/Write.
 4/29/2007 3:43:47 PM -- Volume K: has 0.0000 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume L: has 0.0023 for Avg. Disk sec/Write.
 4/29/2007 3:43:47 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume M: has 0.0023 for Avg. Disk sec/Write.
 4/29/2007 3:43:47 PM -- Volume M: has 0.0000 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Volume N: has 0.0023 for Avg. Disk sec/Write.
 4/29/2007 3:43:47 PM -- Volume N: has 0.0000 for Avg. Disk sec/Read.
 4/29/2007 3:43:47 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/29/2007 3:43:47 PM -- 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
G:\Jetstress1.edb	12641890	0	0	0	460 MBytes / 5143 seconds
H:\Jetstress1.edb	12642914	0	0	0	468 MBytes / 5219 seconds
I:\Jetstress1.edb	12640866	0	0	0	452 MBytes / 5377 seconds

J:\Jetstress1.edb	12645218	0	0	0	486 MBytes / 5378 seconds
(Sum)	50570888	0	0	0	1869 MBytes / 21119 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
G:	0.122	0.001	294.711	0.003
H:	0.131	0.001	294.471	0.004
I:	0.145	0.000	293.831	0.000
J:	0.141	0.001	293.171	0.001

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	7.344	3.695	10.440
Available MBytes	15175.358	15160.000	15300.000
Free System Page Table Entries	16759319.827	16759300.000	16759321.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	59588974.123	59187200.000	59670528.000
Pool Paged Bytes	42645744.268	42569728.000	43626496.000

Test Log 4/29/2007 10:34:57 AM

Jetstress testing begins ...

4/29/2007 10:34:57 AM -- Prepare testing begins ...

4/29/2007 10:34:57 AM -- Duplicating 4 databases:

4/29/2007 12:07:01 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).

4/29/2007 12:07:01 PM -- Attaching databases ...

4/29/2007 12:07:01 PM -- Prepare testing ends.

4/29/2007 12:07:01 PM -- Dispatching transactions begins ...

4/29/2007 12:07:01 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

4/29/2007 12:07:01 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

4/29/2007 12:07:02 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

4/29/2007 12:07:02 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

4/29/2007 12:07:03 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.

4/29/2007 12:07:03 PM -- Performance logging begins (interval: 15000 ms).

4/29/2007 12:07:03 PM -- Attaining prerequisites:

4/29/2007 12:13:51 PM -- \Database(JetstressWin)\Database Cache Size, Last: 967352300.0 (lower bound: 966367600.0, upper bound: none)

4/29/2007 2:13:53 PM -- Performance logging ends.

4/29/2007 2:13:53 PM -- JetInterop batch transaction stats: 43524, 43299, 43501, and 43637.

4/29/2007 2:13:53 PM -- Dispatching transactions ends.

4/29/2007 2:13:53 PM -- Shutting down databases ...

4/29/2007 2:13:56 PM -- Instance2924.1 (complete), Instance2924.2 (complete),

Instance2924.3 (complete), and Instance2924.4 (complete)
4/29/2007 2:13:56 PM -- Performance logging begins (interval: 15000 ms).
4/29/2007 2:13:56 PM -- Verifying database checksums ...
4/29/2007 3:43:35 PM -- G: (100% processed), H: (100% processed), I: (100% processed),
and J: (100% processed)
4/29/2007 3:43:36 PM -- Performance logging ends.
4/29/2007 3:43:36 PM C:\Jetstress\8disk\4t\perf_rr\DBChecksum_2007_4_29_14_13_56.blg
has 358 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
Instance3060.1	97030.77	02:58:44	9.05
Instance3060.2	97030.77	03:03:39	8.81
Instance3060.3	97030.77	03:13:36	8.35
Instance3060.4	97030.77	03:13:33	8.35

Jetstress System Parameters

Thread count	4 (per-storage group)
Log buffers	9000
Minimum database cache	128.0 MB
Maximum database cache	1024.0 MB
Insert operations	25%
Delete operations	10%
Replace operations	50%
Read operations	15%
Lazy commits	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:)	0.007	0	67.270	0.007	(n/a)
Database (H:)	0.007	0.000	67.294	0.007	(n/a)
Database (I:)	0.008	0	67.261	0.003	(n/a)
Database (J:)	0.008	0	67.263	0.003	(n/a)
Log (K:)	0.000	0	0.000	0.006	70.305
Log (L:)	0.000	0	0.000	0.007	83.799
Log (M:)	0.000	0	0.000	0.002	20.615
Log (N:)	0.000	0	0.000	0.002	20.379

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	48.505	11.039	84.026
Available MBytes	14792.511	14507.000	15263.000
Free System Page Table Entries	16759320.619	16759176.000	16759321.000
Transition Pages RePurposed/sec	8327.175	0.000	16296.322
Pool Nonpaged Bytes	61550592.000	52523008.000	69292032.000
Pool Paged Bytes	543229943.926	47214592.000	839098368.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/29/2007 5:33:39 AM

Jetstress testing begins ...

4/29/2007 5:33:39 AM -- Prepare testing begins ...

4/29/2007 5:33:39 AM -- Duplicating 4 databases:

4/29/2007 7:05:53 AM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).

4/29/2007 7:05:53 AM -- Attaching databases ...

4/29/2007 7:05:53 AM -- Prepare testing ends.

4/29/2007 7:05:54 AM -- Performance logging begins (interval: 15000 ms).

4/29/2007 7:05:54 AM -- Streaming backup databases ...

4/29/2007 10:19:32 AM -- Performance logging ends.

4/29/2007 10:19:32 AM -- Instance3060.1 (100% processed), Instance3060.2 (100% processed), Instance3060.3 (100% processed), and Instance3060.4 (100% processed)

4/29/2007 10:19:32 AM --

C:\Jetstress\8disk\4t\b2d_rr\StreamingBackup_2007_4_29_7_5_53.blg has 761 samples.

4/29/2007 10:19:32 AM -- Creating test report ...

Appendix D: Soft Recovery Testing

SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2356.1	541	464.4881088
Instance2356.2	507	454.2383712
Instance2356.3	510	453.4883904
Instance2356.4	500	451.238448

Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (G:)	0.126	0.051	215.940	4.704	(n/a)
Database (H:)	0.103	0.043	201.766	4.497	(n/a)
Database (I:)	0.114	0.045	205.325	4.529	(n/a)
Database (J:)	0.110	0.043	205.554	4.440	(n/a)
Log (K:)	0.010	0.051	38.577	1.987	4067.329
Log (L:)	0.011	0.041	36.222	1.927	3969.910
Log (M:)	0.010	0.043	36.436	1.933	4088.263
Log (N:)	0.010	0.046	35.722	1.883	3937.671

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	4.304	2.146	8.201
Available MBytes	14526.948	14339.000	15395.000
Free System Page Table Entries	16758301.000	16758301.000	16758301.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	60928105.931	60354560.000	61890560.000
Pool Paged Bytes	45716886.069	45563904.000	46108672.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 5/21/2007 2:15:09 PM

Jetstress testing begins ...
5/21/2007 2:15:09 PM -- Prepare testing begins ...
5/21/2007 2:15:09 PM -- Duplicating 4 databases:
5/21/2007 4:34:21 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).
5/21/2007 4:34:22 PM -- Attaching databases ...
5/21/2007 4:34:22 PM -- Prepare testing ends.
5/21/2007 4:34:22 PM -- Dispatching transactions begins ...
5/21/2007 4:34:22 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)
5/21/2007 4:34:22 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)
5/21/2007 4:34:22 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
5/21/2007 4:34:22 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
5/21/2007 4:34:23 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.
5/21/2007 4:34:23 PM -- Performance logging begins (interval: 15000 ms).
5/21/2007 4:34:23 PM -- Generating log files ...
5/21/2007 5:02:31 PM -- K:\ (108.4% generated), L:\ (101.4% generated), M:\ (102.0% generated), and N:\ (100.2% generated)
5/21/2007 5:02:32 PM -- Performance logging ends.
5/21/2007 5:02:32 PM -- JetInterop batch transaction stats: 10134, 9910, 9987, and 9741.
5/21/2007 5:02:32 PM -- Dispatching transactions ends.
5/21/2007 5:02:32 PM -- Shutting down databases ...
5/21/2007 5:02:35 PM -- Instance2356.1 (complete), Instance2356.2 (complete), Instance2356.3 (complete), and Instance2356.4 (complete)
5/21/2007 5:02:36 PM -- Performance logging begins (interval: 15000 ms).
5/21/2007 5:02:36 PM -- Verifying database checksums ...
5/21/2007 6:25:41 PM -- G: (100% processed), H: (100% processed), I: (100% processed), and J: (100% processed)
5/21/2007 6:25:42 PM -- Performance logging ends.
5/21/2007 6:25:42 PM --
C:\Jetstress\8disk\4t\soft_rr\DBChecksum_2007_5_21_17_2_35.blg has 332 samples.
5/21/2007 6:25:45 PM --
C:\Jetstress\8disk\4t\soft_rr\DBChecksum_2007_5_21_17_2_35.html is saved.
5/21/2007 6:25:45 PM -- Verifying log checksums ...
5/21/2007 6:26:10 PM -- K:\ (100 logs passed), L:\ (100 logs passed), M:\ (100 logs passed), and N:\ (100 logs passed)
5/21/2007 6:26:10 PM --
C:\Jetstress\8disk\4t\soft_rr\Performance_2007_5_21_16_34_22.blg has 112 samples.
5/21/2007 6:26:10 PM -- Creating test report ...
5/21/2007 6:26:11 PM -- Volume G: has 0.0139 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume H: has 0.0143 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume I: has 0.0141 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume J: has 0.0144 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume K: has 0.0022 for Avg. Disk sec/Write.
5/21/2007 6:26:11 PM -- Volume K: has 0.0019 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume L: has 0.0023 for Avg. Disk sec/Write.
5/21/2007 6:26:11 PM -- Volume L: has 0.0019 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume M: has 0.0023 for Avg. Disk sec/Write.
5/21/2007 6:26:11 PM -- Volume M: has 0.0017 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Volume N: has 0.0022 for Avg. Disk sec/Write.
5/21/2007 6:26:11 PM -- Volume N: has 0.0021 for Avg. Disk sec/Read.
5/21/2007 6:26:11 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/21/2007 6:26:11 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/21/2007 6:26:11 PM --
C:\Jetstress\8disk\4t\soft_rr\Performance_2007_5_21_16_34_22.html is saved.
5/21/2007 6:26:12 PM -- Performance logging begins (interval: 2000 ms).

5/21/2007 6:26:12 PM -- Recovering databases ...
 5/21/2007 6:33:58 PM -- Performance logging ends.
 5/21/2007 6:33:58 PM -- Instance2356.1 (464.4881088), Instance2356.2 (454.2383712),
 Instance2356.3 (453.4883904), and Instance2356.4 (451.238448)
 5/21/2007 6:33:58 PM --
C:\Jetstress\8disk\4t\soft_rr\SoftRecovery_2007_5_21_18_26_11.blg has 232 samples.
 5/21/2007 6:33:58 PM -- Creating test report...

SoftRecovery Performance Test Result Report

Test Summary

Overall Test Result	Pass
Machine Name	C2D77C1
Test Description	
Test Start Time	5/21/2007 2:15:09 PM
Test End Time	5/21/2007 5:02:35 PM
Jetstress Version	08.01.0075.000
Ese Version	08.01.0013.000
Operating System	Microsoft Windows Server 2003 Service Pack 1 (5.2.3790.65536)
Performance Log	C:\Jetstress\8disk\4t\soft_rr\Performance_2007_5_21_16_34_22.blg C:\Jetstress\8disk\4t\soft_rr\DBChecksum_2007_5_21_17_2_35.blg

Database Sizing and Throughput

Achieved I/O per Second	730.495
Capacity Percentage	100%
Throughput Percentage	100%
Initial database size	406993305600
Final database size	408685707264
Database files (count)	4

Jetstress System Parameters

Thread count	4 (per-storage group)
Log buffers	9000
Minimum database cache	128.0 MB
Maximum database cache	1024.0 MB
Insert operations	25%

Delete operations	10%
Replace operations	50%
Read operations	15%
Lazy commits	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	97.033	94.056	(n/a)
Database (H:)	0.014	0.004	91.729	87.261	(n/a)
Database (I:)	0.014	0.004	93.371	87.908	(n/a)
Database (J:)	0.014	0.004	92.576	86.560	(n/a)
Log (K:)	0.002	0.002	0.077	59.612	11978.877
Log (L:)	0.002	0.002	0.075	57.367	11585.651
Log (M:)	0.002	0.002	0.075	57.717	11555.405
Log (N:)	0.002	0.002	0.074	56.670	11629.203

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.793	1.456	4.425
Available MBytes	14413.080	14174.000	15163.000
Free System Page Table Entries	16758301.000	16758301.000	16758301.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	57148233.143	57139200.000	57176064.000
Pool Paged Bytes	46216411.429	45973504.000	47063040.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 5/21/2007 2:15:09 PM

Jetstress testing begins ...

5/21/2007 2:15:09 PM -- Prepare testing begins ...

5/21/2007 2:15:09 PM -- Duplicating 4 databases:

5/21/2007 4:34:21 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).

5/21/2007 4:34:22 PM -- Attaching databases ...

5/21/2007 4:34:22 PM -- Prepare testing ends.

5/21/2007 4:34:22 PM -- Dispatching transactions begins ...

5/21/2007 4:34:22 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

5/21/2007 4:34:22 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

5/21/2007 4:34:22 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

5/21/2007 4:34:22 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

5/21/2007 4:34:23 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.

5/21/2007 4:34:23 PM -- Performance logging begins (interval: 15000 ms).

5/21/2007 4:34:23 PM -- Generating log files ...

5/21/2007 5:02:31 PM -- K:\ (108.4% generated), L:\ (101.4% generated), M:\ (102.0% generated), and N:\ (100.2% generated)

5/21/2007 5:02:32 PM -- Performance logging ends.

5/21/2007 5:02:32 PM -- JetInterop batch transaction stats: 10134, 9910, 9987, and 9741.

5/21/2007 5:02:32 PM -- Dispatching transactions ends.

5/21/2007 5:02:32 PM -- Shutting down databases ...

5/21/2007 5:02:35 PM -- Instance2356.1 (complete), Instance2356.2 (complete), Instance2356.3 (complete), and Instance2356.4 (complete)

5/21/2007 5:02:36 PM -- Performance logging begins (interval: 15000 ms).

5/21/2007 5:02:36 PM -- Verifying database checksums ...

5/21/2007 6:25:41 PM -- G: (100% processed), H: (100% processed), I: (100% processed), and J: (100% processed)

5/21/2007 6:25:42 PM -- Performance logging ends.

5/21/2007 6:25:42 PM -- C:\Jetstress\8disk\4t\soft_rr\DBChecksum_2007_5_21_17_2_35.blg has 332 samples.

5/21/2007 6:25:45 PM -- C:\Jetstress\8disk\4t\soft_rr\DBChecksum_2007_5_21_17_2_35.html is saved.

5/21/2007 6:25:45 PM -- Verifying log checksums ...

5/21/2007 6:26:10 PM -- K:\ (100 logs passed), L:\ (100 logs passed), M:\ (100 logs passed), and N:\ (100 logs passed)

5/21/2007 6:26:10 PM -- C:\Jetstress\8disk\4t\soft_rr\Performance_2007_5_21_16_34_22.blg has 112 samples.

5/21/2007 6:26:10 PM -- Creating test report ...

5/21/2007 6:26:11 PM -- Volume G: has 0.0139 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume H: has 0.0143 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume I: has 0.0141 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume J: has 0.0144 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume K: has 0.0022 for Avg. Disk sec/Write.

5/21/2007 6:26:11 PM -- Volume K: has 0.0019 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume L: has 0.0023 for Avg. Disk sec/Write.

5/21/2007 6:26:11 PM -- Volume L: has 0.0019 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume M: has 0.0023 for Avg. Disk sec/Write.

5/21/2007 6:26:11 PM -- Volume M: has 0.0017 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Volume N: has 0.0022 for Avg. Disk sec/Write.

5/21/2007 6:26:11 PM -- Volume N: has 0.0021 for Avg. Disk sec/Read.

5/21/2007 6:26:11 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

5/21/2007 6:26:11 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
G:\Jetstress1.edb	12475746	0	0	0	3258 MBytes / 4850 seconds
H:\Jetstress1.edb	12471650	0	0	0	3226 MBytes / 4984 seconds
I:\Jetstress1.edb	12471394	0	0	0	3224 MBytes / 4881 seconds

J:\Jetstress1.edb	12469602	0	0	0	3210 MBytes / 4985 seconds
(Sum)	49888392	0	0	0	633 MBytes / 19701 seconds

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
G:	0.119	0.002	313.808	0.004
H:	0.131	0.000	313.364	0.001
I:	0.130	0.001	313.159	0.003
J:	0.133	0.001	312.167	0.002

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	8.802	5.076	12.368
Available MBytes	15185.738	15172.000	15312.000
Free System Page Table Entries	16758300.699	16758281.000	16758301.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	63978014.843	63512576.000	64720896.000
Pool Paged Bytes	45828934.940	44802048.000	46911488.000

Test Log 5/21/2007 2:15:09 PM

Jetstress testing begins ...
5/21/2007 2:15:09 PM -- Prepare testing begins ...
5/21/2007 2:15:09 PM -- Duplicating 4 databases:
5/21/2007 4:34:21 PM -- 100.0% of 379.0 GB complete (379.0 GB duplicated).
5/21/2007 4:34:22 PM -- Attaching databases ...
5/21/2007 4:34:22 PM -- Prepare testing ends.
5/21/2007 4:34:22 PM -- Dispatching transactions begins ...
5/21/2007 4:34:22 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)
5/21/2007 4:34:22 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)
5/21/2007 4:34:22 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).
5/21/2007 4:34:22 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).
5/21/2007 4:34:23 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.
5/21/2007 4:34:23 PM -- Performance logging begins (interval: 15000 ms).
5/21/2007 4:34:23 PM -- Generating log files ...
5/21/2007 5:02:31 PM -- K:\ (108.4% generated), L:\ (101.4% generated), M:\ (102.0% generated), and N:\ (100.2% generated)
5/21/2007 5:02:32 PM -- Performance logging ends.

5/21/2007 5:02:32 PM -- JetInterop batch transaction stats: 10134, 9910, 9987, and 9741.
5/21/2007 5:02:32 PM -- Dispatching transactions ends.
5/21/2007 5:02:32 PM -- Shutting down databases ...
5/21/2007 5:02:35 PM -- Instance2356.1 (complete), Instance2356.2 (complete),
Instance2356.3 (complete), and Instance2356.4 (complete)
5/21/2007 5:02:36 PM -- Performance logging begins (interval: 15000 ms).
5/21/2007 5:02:36 PM -- Verifying database checksums ...
5/21/2007 6:25:41 PM -- G: (100% processed), H: (100% processed), I: (100% processed),
and J: (100% processed)
5/21/2007 6:25:42 PM -- Performance logging ends.
5/21/2007 6:25:42 PM -- [C:\Jetstress\8disk\4t\soft_rr\DBCchecksum_2007_5_21_17_2_35.blg](#)
has 332 samples.

Appendix E: Maximum Solution IOPS Testing

The building block described under is the EMC recommended configuration for a 1350 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 4 to 9 without modifying any of the other components. The achieved IOPS increased from 743.285 to 1142.18 – a 54% 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

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

Database Sizing and Throughput

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

Jetstress System Parameters

Thread count	9 (per-storage group)
Log buffers	9000
Minimum database cache	128.0 MB
Maximum database cache	1024.0 MB
Insert operations	25%
Delete operations	10%
Replace operations	50%
Read operations	15%
Lazy commits	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 has 362 samples.

5/2/2007 7:37:54 PM -- 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 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.