ESRP Storage Program

EMC Celerra NS40 (1000 User) Storage Solution for Microsoft Exchange Server 2003

Tested with: ESRP – Storage Version 1.2
Tested Date: 03/23/07

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Overview

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

> * The *ESRP* – Storage program was developed by Microsoft Corporation to provide a common storage testing framework for vendors to provide information on its storage solutions for Microsoft Exchange Server software. For more details on the *Microsoft ESRP – Storage* program, please refer: http://www.microsoft.com/technet/prodtechnol/exchange/2003/esrp.mspx.

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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. In addition, 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 2003 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.

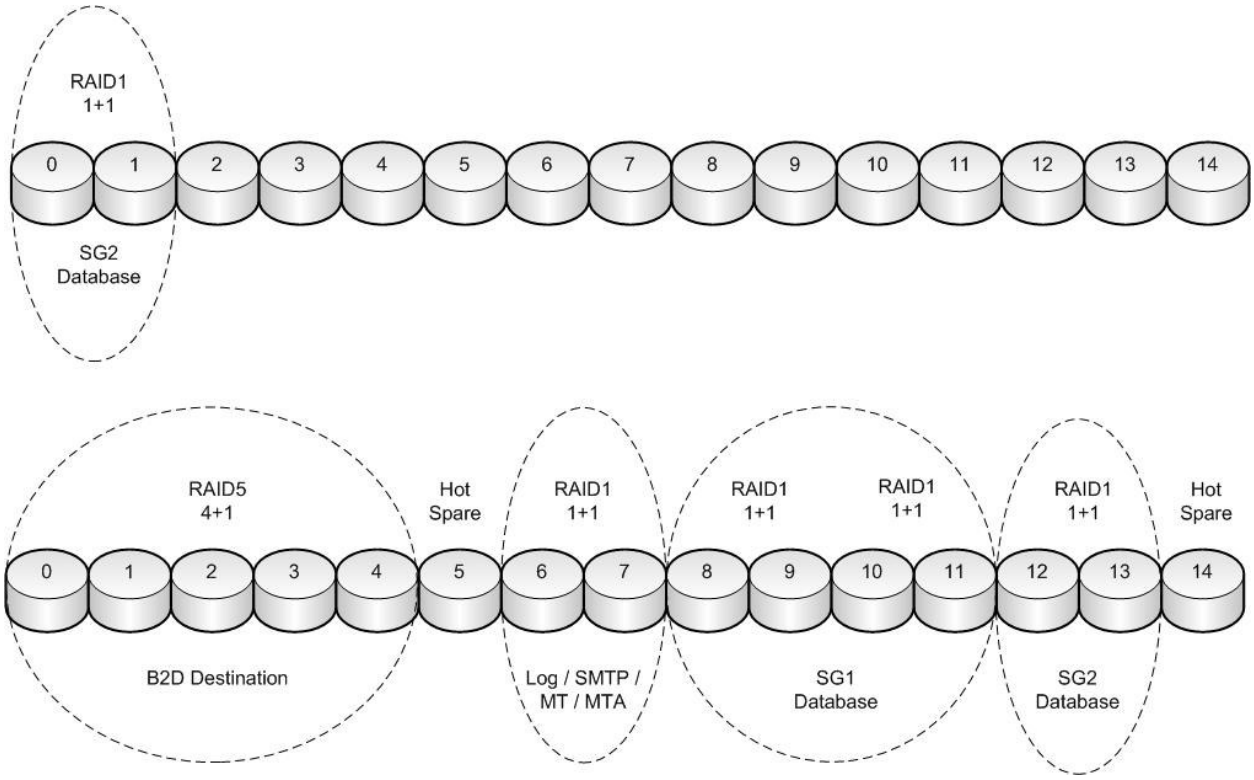
The performance results and best practices discussed in this document provides proven guidelines for configuring the Celerra NS40 for high-performance Exchange environments. For this solution, an integrated Celerra NS40 storage system was used and configured for 1000 Exchange 2003 users. Each of the 1000 users had a profile of 1 IOPS and a 250MB 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 the number of disk spindles required to support 1000 Exchange users assuming an Exchange IO profile of 1 IOPS per Exchange user. The testing in this document proves that a ten spindle building block (eight spindles for the database and two spindles for the log) meets and exceeds the Microsoft Exchange Server recommended metrics for reliability, scalability, and performance.

Our testing determined that ten 15K FC spindles can easily satisfy the I/O workload of 1000, 1.0 IOPS Exchange users. The 1000 users will belong

to two Exchange storage groups. The Exchange database for each storage group will reside on four spindles in two 1+1 RAID 1 groups. The logs will be stored in a file system created on a single 1+1 RAID 1 groups. The diagram of the disk layout is shown below.



The *building block* is scalable. This allows an organization to simply take this *building block* and scale by a factor until the desired number of Microsoft Exchange Servers users (that is, Microsoft MAPI Outlook users) is met.

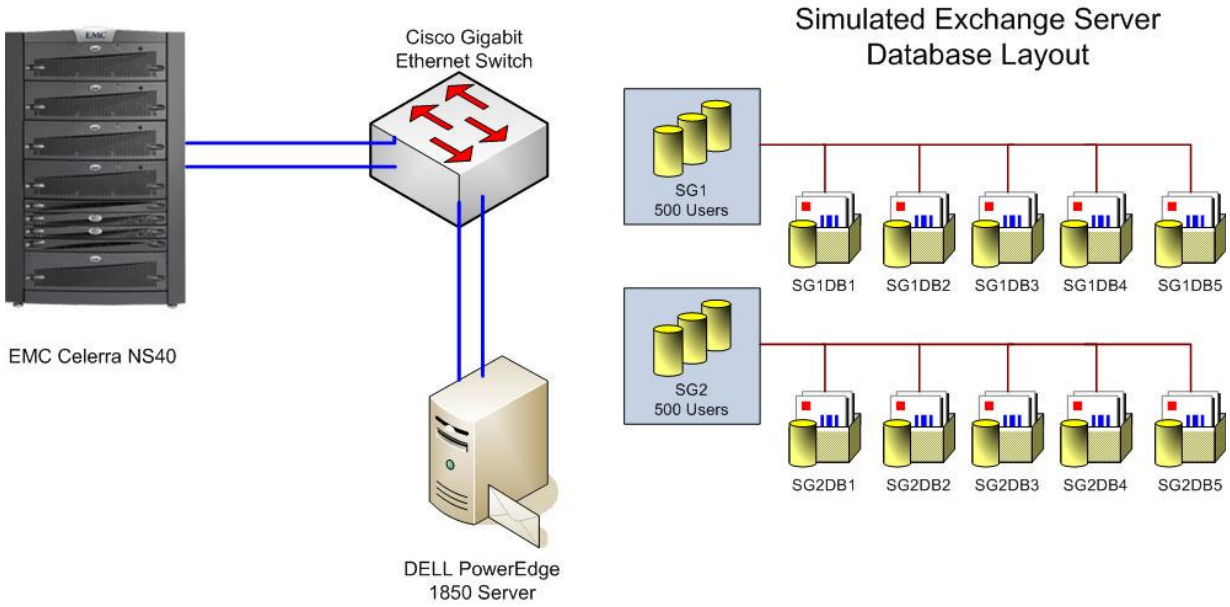
For this particular building block to grow from 1000 to 2000 Exchange users, 10 additional disk spindles require to be added to the Celerra. The new set of 2000 users will have two new Exchange storage groups and the Exchange database for that storage group will be placed on the newly added disk spindles. The logs will also be stored in a new file system created on two new Log spindles.

If configured properly, this layout will exceed the Microsoft Exchange Server recommendations for healthy performance from both disk and end-user perspective.

The following table describes the characteristics of each building block.

Number of Users	1000
Number of Exchange Servers	1
IOPS per User	1.0
Mailbox Size	250 MB
Number of disks required for Logs and Database	10
Disk Type	146 GB 15K FC
RAID Type	1
Number of Storage Groups per Server headroom	2

The diagram below shows the EMC Celerra NS40 ESRP Test environment.



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 to consider are:

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

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

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

Targeted Customer Profile

This solution is intended for medium-to-large Enterprise Exchange customers. This configuration is designed to support 1000 Exchange users with the following assumptions:

- 1 Exchange server
- 0.84 IOPS per user
- 250 MB mailbox
- Two Exchange storage groups per Exchange server
- Five databases per storage group

Tested Deployment

The following tables summarize the testing environment.

Simulated Exchange Configuration

Number of Exchange mailboxes simulated	1000
Number of hosts	1
Number of mailboxes/host	1000
Number of storage groups/host	2
Number of mailbox stores/storage group	5
Number of mailboxes/mailbox store	100
Number of mailbox store LUNs/storage group	2 Database LUNs and 2 Log file LUNs
Simulated profile: I/O's per second per mailbox	1.0 (includes 20% overhead over targeted customer profile)
Database LUN size	472 GB
Log LUN size	47.2 GB
Backup LUN size/storage group	468 GB
Total database size for performance testing	244.36 GB
% Storage capacity used by Exchange database	51.77%

Hardware

Storage type (SAN, DAS, iSCSI, NAS)	iSCSI
Storage model and OS/firmware revision	EMC Celerra NS40 DART 5.5.24.2
Storage cache	4 GB
Number of storage controllers	2
Number of storage ports	2
Maximum bandwidth of storage connectivity to host	2 * 1Gbps Ethernet
Switch type/model/firmware revision	Cisco Catalyst Switch 6509 (IOS Version 12.2)
HBA model and firmware	Microsoft iSCSI Software Initiator 2.03 Intel® PRO/1000 MT Adapter
Number of HBA's/host	2
Host server type	Dell 1850 Four - Intel Xeon 3.00 GHz CPU 4GB RAM
Total number of disks tested in solution	10
Maximum number of spindles that can be hosted in the storage	240

Software

HBA driver	Microsoft iSCSI Software Initiator 2.03 Intel® PRO/1000 MT Adapter
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	MC/S (weighted path)
Host OS	Windows 2003 Enterprise Server SP1
ESE.dll file version	6.5.7638.2
Replication solution name/version	N/A

Disk Configuration (Mailbox Store Disks)

Disk type, speed, and firmware revision	SCSI Fiber Channel – 15K – R450
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)	N/A
Number of slices per LUN or number of disks per LUN	N/A
Raid level	RAID1 at the storage system
Total formatted capacity	472 GB (236 GB * 2)
Storage capacity utilization	40.41%
Database capacity utilization	20.92%

Disk Configuration (Transactional Log Disks)

Disk type, speed, and firmware revision	SCSI Fiber Channel – 15K – R450
Raw capacity per disk (GB)	146 GB
Number of spindles in test	2
Total raw storage capacity (GB)	292 GB
Disk slice size (GB)	N/A
Number of disks per LUN	2
Raid level	RAID 1 at the storage system
Total formatted capacity	47.2 GB

Streaming Backup

Disk type, speed, and firmware revision	SCSI Fiber Channel – 15K – R450
Raw capacity per disk (GB)	146 GB
Number of spindles in test	5
Total raw storage capacity (GB)	730 GB
Disk slice size (GB)	N/A
Number of disks per LUN	5
Raid level	RAID 5 at the storage system
Total formatted capacity	468 GB

Replication

N/A

Best Practices

Microsoft Exchange Server is a disk-intensive application. It is characterized by very bursty (mostly 4 KB random access) read/write operations to the database files, with sequential (mostly 512 byte) write operations to the transaction logs. It is this random, bursty workload, with periods of high peaks, that makes designing a well-performing storage solution with Microsoft Exchange Server a challenge. Every corporate environment has unique user and storage requirements. Hence, storage designs cannot be based simply on generalizations.

Based on the ESRP testing, EMC recommends the following to improve the storage performance with Microsoft Exchange Server. For Microsoft Exchange Server best practices on storage design, please visit: http://www.microsoft.com/technet/prodtechnol/exchange/2003/library/optimizestorage.mspx

Core Storage

- Use DISKPART (in Windows 2003 SP1) to align all Microsoft Exchange Server related disks. Use a value of 64 to align the NTFS partitions at a 64 KB boundary.
- 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.
- Place the Microsoft Exchange Server logs and databases on separate physical disks and in different RAID groups.
- 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.
- Set TcpAckFrequency = 1 per http://support.microsoft.com/kb/328890 to improve iSCSI performance.

  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 Exchange 2003 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 FATA 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. FATA drives operate at a lower rotational speed and will provide much lower throughput than Fiber Channel drives. FATA 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: N/A
- 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.

Performance

The goal of these tests is to characterize the performance of the underlying storage subsystem. These tests run for a period of two hours and exercise the storage with a typical Exchange workload (as defined in the Customer Profile section). The data below is a sample taken from the attached host and is the average of all logical disks over the two hour test duration.

Average of the database disks read latency (ms)	14.35
Average of the database disks write latency (ms)	3
Average of the log disks write latency (ms)	1.4
Average database disk read IO per sec	718.74

Average database disk write IO per sec	347.27
Average log disk write IO per sec	85.56
Max database page fault stalls per sec	0

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

Also, refer Appendix D – 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	44.95 MB/sec
MB read/sec total	89.9 MB/sec
File size/sec taken	251577 MB/ 2799 sec

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 100 log files played in a single storage group. Each log file is 5 MB in size.

Average time to play one log file (sec)	7.64 sec
Average log disks read bytes/sec	1361969.5

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)	122.84 GB
Time taken to backup each storage group	01:58:44.89
Average MB backed up/sec per storage group	17.65

In this particular scenario, two storage groups were used. Thus, the aggregate average backup bandwidth is 17.65.18 MB/sec * 2 storage groups ~ 35 MB/sec.

For Backup Streaming results, refer Streaming Backup to Disk Results section in the Appendix C.

Conclusion

The Celerra NS40 produced impressive performance results when tested in conjunction with Exchange 2003. The results clearly show that a Celerra NS40 can satisfy the performance requirements of 1000 Heavy Exchange users with ten physical disk spindles (eight 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/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 – Performance Test Results

Performance Statistics

Planned disk subsystem profile:

Total test database size	Production data size	Total number of databases	Expected I/O	Achieved I/O
244.36 GB (based on the attached database)	(n/a)	10 (2 storage(s) * 5 database(s))	1000.00 (1000 mailboxes of 1.00 IOPS)	1066.02

JetStress test parameter summary:

Instance	threadCount	logBufferSize	opInsert	opReplace	opDelete	lazyCommit
1	5	9000	17	70	5	90
2	5	9000	17	70	5	90

Disk subsystem performance summary:

Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Data (F:)	0.014	0.003	359.36	173.60	(n/a)
Data (E:)	0.014	0.003	359.38	173.67	(n/a)
Log (K:)	0.001	0.001	0.211	42.73	6562.31
Log (L:)	0.001	0.001	0.211	42.83	6561.56

Processor/memory performance summary:

Counter	Average	Minimum	Maximum
% Processor Time	2.690	0.985	20.71
Available MBytes	2773.04	2692.00	3640.00
Free System Page Table Entries	41289.08	41289.00	41329.00
Pages/Sec	39.98	0.000	16268.90
Pool Nonpaged Bytes	38956619.89	38174720.00	39383040.00
Pool Paged Bytes	37337297.50	37023744.00	38379520.00
Database Page Fault Stalls/sec	0.000	0.000	0.000

Performance log C:\Program Files\Jetstress\Performance_2007_4_13_0-42-23.blg is saved.

4/13/2007 12:42:17 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 12:42:17 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 12:42:17 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 12:42:23 AM -- Loading performance counters...
4/13/2007 12:42:23 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 12:42:23 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 12:42:23 AM -- Start Jetstress test...
4/13/2007 12:42:24 AM -- Starting Performance test run...
4/13/2007 12:42:25 AM -- Performance logging started.
4/13/2007 12:42:25 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_2007_4_13_0-42-23.blg.
4/13/2007 2:42:12 AM -- Adding new data to the performance log file...
4/13/2007 2:42:27 AM -- Performance logging stopped.
4/13/2007 2:42:27 AM -- Stopping Jetstress...
4/13/2007 2:42:45 AM -- Creating test report ...
4/13/2007 2:42:47 AM -- Volume F: has 0.0143 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume E: has 0.0144 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 2:42:47 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 2:42:47 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 2:42:47 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

Data Checksum Statistics

The following table shows a quick overview of checksum statistics:

Database	Pages seen	Bad checksums	Correctable checksums	Wrong page numbers	MB read/sec (File size/Seconds taken)
E:Jetstress.edb	6425858	0	0	0	40.4 MB/sec (25101 MB/622 seconds)
E:Jetstress1.edb	6424578	0	0	0	43.0 MB/sec (25096 MB/583 seconds)
E:Jetstress2.edb	6426114	0	0	0	44.0 MB/sec (25102 MB/570 seconds)
E:Jetstress3.edb	6425602	0	0	0	44.6 MB/sec (25100 MB/563 seconds)

E:Jetstress4.edb	6425602	0	0	0	45.3 MB/sec (25100 MB/553 seconds)
F:Jetstress.edb	6426370	0	0	0	40.4 MB/sec (25103 MB/621 seconds)
F:Jetstress1.edb	6425858	0	0	0	43.1 MB/sec (25101 MB/581 seconds)
F:Jetstress2.edb	6425346	0	0	0	44.2 MB/sec (25099 MB/567 seconds)
F:Jetstress3.edb	6426370	0	0	0	44.6 MB/sec (25103 MB/562 seconds)
F:Jetstress4.edb	6424578	0	0	0	45.2 MB/sec (25096 MB/555 seconds)
(sum)	64256276	0	0	0	86.8 MB/sec (251001 MB/2891 seconds)

The following table shows a quick overview of database and log performance counter sample data:

Storage Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Total Seconds
E:	1.549	0.000	644.96	0.000	622.11
E:	1.317	0.000	665.70	0.000	583.84
E:	1.130	0.000	678.18	0.000	570.13
E:	1.030	0.000	686.67	0.000	563.25
E:	0.968	0.000	694.03	0.000	553.76
F:	2.041	0.042	645.54	0.003	621.48
F:	1.543	0.022	667.19	0.002	581.92
F:	1.280	0.015	680.04	0.001	567.82
F:	1.153	0.011	688.28	0.001	562.81
F:	1.067	0.009	694.94	0.001	555.73

The following table shows a quick overview of processor and memory performance counter sample data:

Counter	Average	Minimum	Maximum
% Processor Time	8.851	0.000	20.77
Available MBytes	3604.99	3600.00	3639.00
Free System Page Table Entries	41288.14	41272.00	41289.00

Pages/Sec	0.230	0.000	102.02
Pool Nonpaged Bytes	41314870.00	40914940.00	41795580.00
Pool Paged Bytes	37637800.00	37093380.00	38182910.00

Performance log C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_2-42-47.blg is saved.

4/13/2007 12:42:17 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 12:42:17 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 12:42:17 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 12:42:23 AM -- Loading performance counters...
4/13/2007 12:42:23 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 12:42:23 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 12:42:23 AM -- Start Jetstress test...
4/13/2007 12:42:24 AM -- Starting Performance test run...
4/13/2007 12:42:25 AM -- Performance logging started.
4/13/2007 12:42:25 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_2007_4_13_0-42-23.blg.
4/13/2007 2:42:12 AM -- Adding new data to the performance log file...
4/13/2007 2:42:27 AM -- Performance logging stopped.
4/13/2007 2:42:27 AM -- Stopping Jetstress...
4/13/2007 2:42:45 AM -- Creating test report ...
4/13/2007 2:42:47 AM -- Volume F: has 0.0143 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume E: has 0.0144 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 2:42:47 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 2:42:47 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 2:42:47 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 2:42:47 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/13/2007 2:42:48 AM -- Performance logging started.
4/13/2007 2:42:48 AM -- Performance data will be saved to C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_2-42-47.blg.
4/13/2007 2:42:48 AM -- Checksum validation may take a while depending on the file sizes.
4/13/2007 3:31:01 AM -- Database checksum in progress:
Storage Group #1 (100%), and Storage Group #2 (100%).
4/13/2007 3:31:01 AM -- Performance logging stopped.
4/13/2007 3:31:01 AM -- Checksum is completed, please open C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_2-42-47.html for checksum result.

Appendix B – Stress Test Results

Stress Statistics

Planned disk subsystem profile:

Total test database size	Production data size	Total number of databases	Expected I/O	Achieved I/O
244.14 GB (75% of production data)	244.14 GB (1000 mailboxes of 250 MB)	10 (2 storage(s) * 5 database(s))	1000.00 (1000 mailboxes of 1.00 IOPS)	1054.98

JetStress test parameter summary:

Instance	threadCount	logBufferSize	opInsert	opReplace	opDelete	lazyCommit
1	5	9000	17	70	5	90
2	5	9000	17	70	5	90

Disk subsystem performance summary:

Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Data (F:)	0.014	0.003	353.05	174.40	(n/a)
Data (E:)	0.014	0.003	353.11	174.42	(n/a)
Log (K:)	0.002	0.001	0.204	42.22	6505.68
Log (L:)	0.002	0.001	0.203	42.12	6524.77

Processor/memory performance summary:

Counter	Average	Minimum	Maximum
% Processor Time	2.598	1.815	23.30
Available MBytes	2575.11	2503.00	3428.00
Free System Page Table Entries	40241.00	40241.00	40241.00
Pages/Sec	13.20	3.267	4087.44
Pool Nonpaged Bytes	49742071.64	37167104.00	50585600.00
Pool Paged Bytes	115142186.34	42823680.00	119443456.00
Database Page Fault Stalls/sec	0.000	0.000	0.000

Performance log C:\Program Files\Jetstress\Stress_2007_4_16_16-14-14.blg is saved.

4/16/2007 9:59:08 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/16/2007 9:59:08 AM -- Validating input parameters, it may take a few minutes...
4/16/2007 11:28:02 AM -- Inserting records: 9810778 records have been inserted. Database creation process has completed 100%.
4/16/2007 11:28:02 AM -- Database creation has completed and the test database file size is 24940 MB (with an approximate 66% overhead).
4/16/2007 4:14:13 PM -- Duplicating 10 databases: 24.36 GB of 24.36 GB is duplicated (100.00% complete).
4/16/2007 4:14:13 PM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/16/2007 4:14:14 PM -- Loading performance counters...
4/16/2007 4:14:14 PM -- Instance544.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/16/2007 4:14:14 PM -- Instance544.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/16/2007 4:14:14 PM -- Start Jetstress test...
4/16/2007 4:14:16 PM -- Starting Stress test run...
4/16/2007 4:14:16 PM -- Performance logging started.
4/16/2007 4:14:16 PM -- Performance data will be saved to C:\Program Files\Jetstress\Stress_2007_4_16_16-14-14.blg.
4/17/2007 4:13:20 PM -- Adding new data to the performance log file...
4/17/2007 4:14:19 PM -- Performance logging stopped.
4/17/2007 4:14:19 PM -- Stopping Jetstress...
4/17/2007 4:14:38 PM -- Creating test report ...
4/17/2007 4:14:46 PM -- Volume F: has 0.0143 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume E: has 0.0143 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/17/2007 4:14:46 PM -- Volume K: has 0.0019 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/17/2007 4:14:46 PM -- Volume L: has 0.0019 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Test has 0 Max Database Page Fault Stalls/sec.
4/17/2007 4:14:46 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

Checksum Statistics

The following table shows a quick overview of checksum statistics:

Database	Pages seen	Bad checksums	Correctable checksums	Wrong page numbers	MB read/sec (File size/Seconds taken)
E:Jetstress.edb	6630402	0	0	0	39.6 MB/sec (25900 MB/653 seconds)
E:Jetstress1.edb	6630658	0	0	0	46.6 MB/sec (25901 MB/556 seconds)
E:Jetstress2.edb	6632706	0	0	0	45.1 MB/sec (25909 MB/574 seconds)
E:Jetstress3.edb	6629378	0	0	0	45.1 MB/sec (25896 MB/573 seconds)
E:Jetstress4.edb	6630402	0	0	0	43.9 MB/sec (25900 MB/590 seconds)
F:Jetstress.edb	6630914	0	0	0	39.7 MB/sec (25902 MB/652 seconds)
F:Jetstress1.edb	6632450	0	0	0	46.3 MB/sec (25908 MB/560 seconds)
F:Jetstress2.edb	6629378	0	0	0	45.1 MB/sec (25896 MB/574 seconds)
F:Jetstress3.edb	6630914	0	0	0	45.3 MB/sec (25902 MB/571 seconds)
F:Jetstress4.edb	6633218	0	0	0	43.9 MB/sec (25911 MB/590 seconds)
(sum)	66310420	0	0	0	87.8 MB/sec (259025 MB/2949 seconds)

The following table shows a quick overview of database and log performance counter sample data:

Storage Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Total Seconds
E:	1.755	0.000	633.50	0.000	654.04
E:	1.264	0.000	684.87	0.000	556.23
E:	1.085	0.000	696.57	0.000	574.89
E:	0.993	0.000	702.92	0.000	573.61
E:	0.940	0.002	702.77	0.003	590.50
F:	1.796	0.040	634.90	0.005	652.74

F:	1.286	0.022	683.63	0.002	560.15
F:	1.095	0.015	695.76	0.002	574.50
F:	1.000	0.011	702.80	0.001	571.79
F:	0.946	0.011	702.80	0.004	590.17

The following table shows a quick overview of processor and memory performance counter sample data:

Counter	Average	Minimum	Maximum
% Processor Time	10.40	0.000	38.28
Available MBytes	3417.15	3369.00	3440.00
Free System Page Table Entries	40240.14	40219.00	40241.00
Pages/Sec	0.034	0.000	49.23
Pool Nonpaged Bytes	52304280.00	52051970.00	52682750.00
Pool Paged Bytes	118594900.00	118038500.00	119836700.00

Performance log C:\Program Files\Jetstress\DatabaseChecksum_2007_4_17_16-14-46.blg is saved.

4/16/2007 9:59:08 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/16/2007 9:59:08 AM -- Validating input parameters, it may take a few minutes...
4/16/2007 11:28:02 AM -- Inserting records: 9810778 records have been inserted. Database creation process has completed 100%.
4/16/2007 11:28:02 AM -- Database creation has completed and the test database file size is 24940 MB (with an approximate 66% overhead).
4/16/2007 4:14:13 PM -- Duplicating 10 databases: 24.36 GB of 24.36 GB is duplicated (100.00% complete).
4/16/2007 4:14:13 PM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/16/2007 4:14:14 PM -- Loading performance counters...
4/16/2007 4:14:14 PM -- Instance544.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/16/2007 4:14:14 PM -- Instance544.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/16/2007 4:14:14 PM -- Start Jetstress test...
4/16/2007 4:14:16 PM -- Starting Stress test run...
4/16/2007 4:14:16 PM -- Performance logging started.
4/16/2007 4:14:16 PM -- Performance data will be saved to C:\Program Files\Jetstress\Stress_2007_4_16_16-14-14.blg.

4/17/2007 4:13:20 PM -- Adding new data to the performance log file...
4/17/2007 4:14:19 PM -- Performance logging stopped.
4/17/2007 4:14:19 PM -- Stopping Jetstress...
4/17/2007 4:14:38 PM -- Creating test report ...
4/17/2007 4:14:46 PM -- Volume F: has 0.0143 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume E: has 0.0143 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/17/2007 4:14:46 PM -- Volume K: has 0.0019 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/17/2007 4:14:46 PM -- Volume L: has 0.0019 for Avg. Disk sec/Read.
4/17/2007 4:14:46 PM -- Test has 0 Max Database Page Fault Stalls/sec.
4/17/2007 4:14:46 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/17/2007 4:14:47 PM -- Performance logging started.
4/17/2007 4:14:47 PM -- Performance data will be saved to C:\Program Files\Jetstress\DatabaseChecksum_2007_4_17_16-14-46.blg.
4/17/2007 4:14:47 PM -- Checksum validation may take a while depending on the file sizes.
4/17/2007 5:03:56 PM -- Database checksum in progress:
Storage Group #1 (100%), and Storage Group #2 (100%).
4/17/2007 5:03:56 PM -- Performance logging stopped.
4/17/2007 5:03:56 PM -- Checksum is completed, please open C:\Program Files\Jetstress\DatabaseChecksum_2007_4_17_16-14-46.html for checksum result.

Appendix C – Streaming Backup to Disk Results

Performance Log Generation Statistics

Planned disk subsystem profile:

Total test database size	Production data size	Total number of databases	Expected I/O	Achieved I/O
245.29 GB (based on the attached database)	(n/a)	10 (2 storage(s) * 5 database(s))	1000.00 (1000 mailboxes of 1.00 IOPS)	1075.05

JetStress test parameter summary:

Instance	threadCount	logBufferSize	opInsert	opReplace	opDelete	lazyCommit
1	5	9000	17	70	5	90
2	5	9000	17	70	5	90

Disk subsystem performance summary:

Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Data (F:)	0.014	0.003	364.97	172.67	(n/a)
Data (E:)	0.014	0.003	364.10	173.31	(n/a)
Log (K:)	0.001	0.001	0.214	44.68	6459.04
Log (L:)	0.001	0.001	0.214	44.25	6465.89

Processor/memory performance summary:

Counter	Average	Minimum	Maximum
% Processor Time	2.620	1.463	3.955
Available MBytes	2723.90	2689.00	3536.00
Free System Page Table Entries	40209.00	40209.00	40209.00
Pages/Sec	5.164	0.000	13.47
Pool Nonpaged Bytes	42885521.57	42475520.00	43319296.00
Pool Paged Bytes	42171484.36	40009728.00	43556864.00
Database Page Fault Stalls/sec	0.000	0.000	0.000

Performance log C:\Program Files\Jetstress\Performance_LogGeneration_2007_4_13_7-38-1.blg is saved.

4/13/2007 7:26:57 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 7:26:58 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 7:26:58 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 7:38:01 AM -- Loading performance counters...
4/13/2007 7:38:01 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Start Jetstress test...
4/13/2007 7:38:03 AM -- Starting StreamingBackup test run...
4/13/2007 7:38:04 AM -- Performance logging started.
4/13/2007 7:38:04 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_LogGeneration_2007_4_13_7-38-1.blg.
4/13/2007 8:42:06 AM -- Adding new data to the performance log file...
4/13/2007 8:42:19 AM -- Performance logging stopped.
4/13/2007 8:42:19 AM -- Stopping Jetstress...
4/13/2007 8:42:37 AM -- Creating test report ...
4/13/2007 8:42:39 AM -- Volume F: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume E: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 8:42:39 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

Backup Database Read Only Statistics

The following table shows a quick overview of checksum statistics:

Database	Pages seen	Bad checksums	Correctable checksums	Wrong page numbers	MB read/sec (File size/Seconds taken)
E:Jetstress.edb	6440962	0	0	0	45.8 MB/sec (25160 MB/549 seconds)
E:Jetstress1.edb	6439426	0	0	0	44.3 MB/sec (25154 MB/568 seconds)
E:Jetstress2.edb	6440962	0	0	0	44.2 MB/sec (25160 MB/569 seconds)
E:Jetstress3.edb	6440706	0	0	0	44.7 MB/sec (25159 MB/563 seconds)
E:Jetstress4.edb	6440450	0	0	0	45.6 MB/sec (25158 MB/551 seconds)
F:Jetstress.edb	6440450	0	0	0	45.9 MB/sec (25158 MB/548 seconds)
F:Jetstress1.edb	6440450	0	0	0	44.4 MB/sec (25158 MB/566 seconds)
F:Jetstress2.edb	6439938	0	0	0	44.4 MB/sec (25156 MB/567 seconds)
F:Jetstress3.edb	6441218	0	0	0	44.7 MB/sec (25161 MB/563 seconds)
F:Jetstress4.edb	6439170	0	0	0	45.5 MB/sec (25153 MB/553 seconds)
(sum)	64403732	0	0	0	89.9 MB/sec (251577 MB/2799 seconds)

The following table shows a quick overview of database and log performance counter sample data:

Storage Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Total Seconds
E:	0.698	0.000	731.75	0.000	549.17
E:	0.712	0.000	719.66	0.000	568.11
E:	0.716	0.000	715.37	0.000	569.31
E:	0.717	0.002	715.36	0.003	563.37
E:	0.714	0.002	718.04	0.002	551.74
F:	0.697	0.014	732.99	0.020	548.23

F:	0.710	0.007	721.27	0.010	566.61
F:	0.715	0.005	717.30	0.006	567.20
F:	0.715	0.006	716.88	0.008	563.06
F:	0.713	0.005	718.84	0.007	553.43

The following table shows a quick overview of processor and memory performance counter sample data:

Counter	Average	Minimum	Maximum
% Processor Time	9.51	0.000	31.54
Available MBytes	3559.58	3450.00	3619.00
Free System Page Table Entries	40208.16	40209.00	40209.00
Pages/Sec	27.08	0.000	20500.41
Pool Nonpaged Bytes	43101500.00	42893310.00	43978750.00
Pool Paged Bytes	43278730.00	42020860.00	45993980.00

Performance log C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_9-8-7.blg is saved.

4/13/2007 7:26:57 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 7:26:58 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 7:26:58 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 7:38:01 AM -- Loading performance counters...
4/13/2007 7:38:01 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Start Jetstress test...
4/13/2007 7:38:03 AM -- Starting StreamingBackup test run...
4/13/2007 7:38:04 AM -- Performance logging started.
4/13/2007 7:38:04 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_LogGeneration_2007_4_13_7-38-1.blg.
4/13/2007 8:42:06 AM -- Adding new data to the performance log file...
4/13/2007 8:42:19 AM -- Performance logging stopped.
4/13/2007 8:42:19 AM -- Stopping Jetstress...
4/13/2007 8:42:37 AM -- Creating test report ...
4/13/2007 8:42:39 AM -- Volume F: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume E: has 0.0141 for Avg. Disk sec/Read.

4/13/2007 8:42:39 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 8:42:39 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/13/2007 8:42:39 AM -- Soft recovery may take a while depending on the number of log files.
4/13/2007 8:42:40 AM -- Performance logging started.
4/13/2007 8:42:40 AM -- Performance data will be saved to C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.blg.
4/13/2007 9:08:05 AM -- Adding new data to the performance log file...
4/13/2007 9:08:07 AM -- Performance logging stopped.
4/13/2007 9:08:07 AM -- Soft recovery is completed, please open C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.html for soft recovery result.
4/13/2007 9:08:08 AM -- Performance logging started.
4/13/2007 9:08:08 AM -- Performance data will be saved to C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_9-8-7.blg.
4/13/2007 9:08:08 AM -- Checksum validation may take a while depending on the file sizes.
4/13/2007 9:54:50 AM -- Database checksum in progress:
Storage Group #1 (100%), and Storage Group #2 (100%).
4/13/2007 9:54:50 AM -- Performance logging stopped.
4/13/2007 9:54:50 AM -- Checksum is completed, please open C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_9-8-7.html for checksum result.

Backup to Disk Statistics

This test is to verify the storage configuration for a streaming backup operation.

This table reports the performance metrics of streaming backup for each storage group backed up.

Storage Group	Storage Group Size (MB)	Backup Time (hh:mm:ss.msec)	Average MB Backed Per Second
1	125791.04	01:58:49.01	17.64
2	125786.04	01:58:40.77	17.66

This table reports the performance metrics of streaming backup for each database backed up.

Storage Group	Database Name	Database Size (MB)
1	E:Jetstress.edb	25160.01
	E:Jetstress1.edb	25154.01
	E:Jetstress2.edb	25160.01
	E:Jetstress3.edb	25159.01
	E:Jetstress4.edb	25158.01
2	F:Jetstress.edb	25158.01
	F:Jetstress1.edb	25158.01
	F:Jetstress2.edb	25156.01
	F:Jetstress3.edb	25161.01
	F:Jetstress4.edb	25153.01

Planned disk subsystem profile:

Total test database size	Production data size	Total number of databases	Expected I/O	Achieved I/O
245.29 GB (based on the attached database)	(n/a)	10 (2 storage(s) * 5 database(s))	1000.00 (1000 mailboxes of 1.00 IOPS)	563.74

JetStress test parameter summary:

Instance	threadCount	logBufferSize	opInsert	opReplace	opDelete	lazyCommit
1	5	9000	17	70	5	90
2	5	9000	17	70	5	90

Disk subsystem performance summary:

Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Data (F:)	0.008	0.000	281.79	0.032	(n/a)
Data (E:)	0.008	0.000	281.88	0.031	(n/a)
Log (K:)	0.000	0.000	0.013	0.114	41.98
Log (L:)	0.000	0.000	0.013	0.119	50.07

Processor/memory performance summary:

Counter	Average	Minimum	Maximum
% Processor Time	5.127	3.909	6.513
Available MBytes	2643.85	2637.00	3572.00
Free System Page Table Entries	40129.00	40129.00	40129.00
Pages/Sec	0.260	0.000	48.67
Pool Nonpaged Bytes	43946371.23	43368448.00	44113920.00
Pool Paged Bytes	45608650.22	44285952.00	47755264.00
Database Page Fault Stalls/sec	0.000	0.000	0.000

Performance log C:\Program Files\Jetstress\Backup_To_Disk_2007_4_13_9-56-13.blg is saved.

4/13/2007 7:26:57 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 7:26:58 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 7:26:58 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 7:38:01 AM -- Loading performance counters...
4/13/2007 7:38:01 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Start Jetstress test...
4/13/2007 7:38:03 AM -- Starting StreamingBackup test run...
4/13/2007 7:38:04 AM -- Performance logging started.
4/13/2007 7:38:04 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_LogGeneration_2007_4_13_7-38-1.blg.

4/13/2007 8:42:06 AM -- Adding new data to the performance log file...
4/13/2007 8:42:19 AM -- Performance logging stopped.
4/13/2007 8:42:19 AM -- Stopping Jetstress...
4/13/2007 8:42:37 AM -- Creating test report ...
4/13/2007 8:42:39 AM -- Volume F: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume E: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 8:42:39 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/13/2007 8:42:39 AM -- Soft recovery may take a while depending on the number of log files.
4/13/2007 8:42:40 AM -- Performance logging started.
4/13/2007 8:42:40 AM -- Performance data will be saved to C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.blg.
4/13/2007 9:08:05 AM -- Adding new data to the performance log file...
4/13/2007 9:08:07 AM -- Performance logging stopped.
4/13/2007 9:08:07 AM -- Soft recovery is completed, please open C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.html for soft recovery result.
4/13/2007 9:08:08 AM -- Performance logging started.
4/13/2007 9:08:08 AM -- Performance data will be saved to C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_9-8-7.blg.
4/13/2007 9:08:08 AM -- Checksum validation may take a while depending on the file sizes.
4/13/2007 9:54:50 AM -- Database checksum in progress:
Storage Group #1 (100%), and Storage Group #2 (100%).
4/13/2007 9:54:50 AM -- Performance logging stopped.
4/13/2007 9:54:50 AM -- Checksum is completed, please open C:\Program Files\Jetstress\DatabaseChecksum_2007_4_13_9-8-7.html for checksum result.
4/13/2007 9:54:52 AM -- Performance logging started.
4/13/2007 9:54:52 AM -- Performance data will be saved to C:\Program Files\Jetstress\LogChecksum_2007_4_13_9-54-50.blg.
4/13/2007 9:54:52 AM -- Checksum validation may take a while depending on the file sizes.
4/13/2007 9:56:13 AM -- Log checksum in progress:
(100 files(s) passed), and (100 files(s) passed).
4/13/2007 9:56:13 AM -- Performance logging stopped.
4/13/2007 9:56:13 AM -- Storage Groups being Backed up... The Backup Time may take hours depending on the size of the Storage Group.
4/13/2007 10:21:52 AM -- Performance logging started.
4/13/2007 10:21:52 AM -- Performance data will be saved to C:\Program Files\Jetstress\Backup_To_Disk_2007_4_13_9-56-13.blg.
4/13/2007 10:21:52 AM -- Loading performance counters...
4/13/2007 12:20:52 PM -- Adding new data to the performance log file...
4/13/2007 12:20:56 PM -- Backup Complete!
4/13/2007 12:20:58 PM -- Performance logging stopped.
4/13/2007 12:20:58 PM -- Creating test report ...

Soft Recovery Statistics

The following table shows a quick overview of log replay statistics for 100 log files per storage group:

Storage Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Disk Read Bytes/sec	Total Seconds
Log (K:)	0.000	0.016	21.96	0.156	1429600.00	725.66
Log (L:)	0.000	0.029	19.88	0.237	1294339.00	801.41

The following table shows a quick overview of processor and memory performance counter sample data:

Counter	Average	Minimum	Maximum
% Processor Time	2.488	0.000	24.60
Available MBytes	2759.73	2660.00	3564.00
Free System Page Table Entries	40208.55	40209.00	40209.00
Pages/Sec	2.360	0.000	404.85
Pool Nonpaged Bytes	42832880.00	42651650.00	43048960.00
Pool Paged Bytes	43578660.00	42582020.00	44834820.00

Performance log C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.blg is saved.

4/13/2007 7:26:57 AM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

4/13/2007 7:26:58 AM -- Validating input parameters, it may take a few minutes...
4/13/2007 7:26:58 AM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
4/13/2007 7:38:01 AM -- Loading performance counters...
4/13/2007 7:38:01 AM -- Instance2592.1: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Instance2592.2: IO parameters are thread (5), insert (17), replace (70), delete (5), and lazy commit (90)
4/13/2007 7:38:01 AM -- Start Jetstress test...
4/13/2007 7:38:03 AM -- Starting StreamingBackup test run...
4/13/2007 7:38:04 AM -- Performance logging started.
4/13/2007 7:38:04 AM -- Performance data will be saved to C:\Program Files\Jetstress\Performance_LogGeneration_2007_4_13_7-38-1.blg.
4/13/2007 8:42:06 AM -- Adding new data to the performance log file...
4/13/2007 8:42:19 AM -- Performance logging stopped.
4/13/2007 8:42:19 AM -- Stopping Jetstress...

4/13/2007 8:42:37 AM -- Creating test report ...
4/13/2007 8:42:39 AM -- Volume F: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume E: has 0.0141 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume K: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume K: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Volume L: has 0.0014 for Avg. Disk sec/Write.
4/13/2007 8:42:39 AM -- Volume L: has 0.0007 for Avg. Disk sec/Read.
4/13/2007 8:42:39 AM -- Test has 0 Max Database Page Fault Stalls/sec.
4/13/2007 8:42:39 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/13/2007 8:42:39 AM -- Soft recovery may take a while depending on the number of log files.
4/13/2007 8:42:40 AM -- Performance logging started.
4/13/2007 8:42:40 AM -- Performance data will be saved to C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.blg.
4/13/2007 9:08:05 AM -- Adding new data to the performance log file...
4/13/2007 9:08:07 AM -- Performance logging stopped.
4/13/2007 9:08:07 AM -- Soft recovery is completed, please open C:\Program Files\Jetstress\SoftRecovery_2007_4_13_8-42-39.html for soft recovery result

Appendix D – Performance Test Results (Maximum IOPS)

Tuning for Maximum IO Throughput

The *building block* described under is the EMC recommended configuration for a 1000 Exchange user workload at 1.0 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 5 to 8 without modifying any of the other components. The achieved IOPS increased from 1069.21 to 1286.12 – a 17% 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*.

Performance Statistics

Planned disk subsystem profile:

Total test database size	Production data size	Total number of databases	Expected I/O	Achieved I/O
247.31 GB (based on the attached database)	(n/a)	10 (2 storage(s) * 5 database(s))	1000.00 (1000 mailboxes of 1.00 IOPS)	1286.12

JetStress test parameter summary:

Instance	threadCount	logBufferSize	opInsert	opReplace	opDelete	lazyCommit
1	8	9000	17	70	5	90
2	8	9000	17	70	5	90

Disk subsystem performance summary:

Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Data (F:)	0.019	0.003	432.52	210.74	(n/a)
Data (E:)	0.019	0.004	432.17	210.70	(n/a)

Log (K:)	0.001	0.001	0.253	50.06	6767.68
Log (L:)	0.001	0.001	0.250	50.34	6718.32

Processor/memory performance summary:

Counter	Average	Minimum	Maximum
% Processor Time	3.122	1.928	5.277
Available MBytes	2640.78	2625.00	3425.00
Free System Page Table Entries	40186.33	40186.00	40226.00
Pages/Sec	6.169	0.000	20.87
Pool Nonpaged Bytes	37225653.71	36839424.00	37634048.00
Pool Paged Bytes	37178425.72	36773888.00	38920192.00
Database Page Fault Stalls/sec	0.000	0.000	0.000

Performance log B:\FinalRun_MCS_weighted_path\1000_max_10\Performance_2007_2_8_22-0-31.blg is saved.

2/8/2007 10:00:24 PM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

2/8/2007 10:00:24 PM -- Validating input parameters, it may take a few minutes...
2/8/2007 10:00:24 PM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
2/8/2007 10:00:31 PM -- Loading performance counters...
2/8/2007 10:00:31 PM -- Instance3496.1: IO parameters are thread (8), insert (17), replace (70), delete (5), and lazy commit (90)
2/8/2007 10:00:31 PM -- Instance3496.2: IO parameters are thread (8), insert (17), replace (70), delete (5), and lazy commit (90)
2/8/2007 10:00:31 PM -- Start Jetstress test...
2/8/2007 10:00:33 PM -- Starting Performance test run...
2/8/2007 10:00:33 PM -- Performance logging started.
2/8/2007 10:00:33 PM -- Performance data will be saved to B:\FinalRun_MCS_weighted_path\1000_max_10\Performance_2007_2_8_22-0-31.blg.
2/9/2007 12:00:19 AM -- Adding new data to the performance log file...
2/9/2007 12:00:33 AM -- Performance logging stopped.
2/9/2007 12:00:33 AM -- Stopping Jetstress...
2/9/2007 12:00:54 AM -- Creating test report ...
2/9/2007 12:00:57 AM -- Volume F: has 0.0187 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Volume E: has 0.0188 for Avg. Disk sec/Read.

2/9/2007 12:00:57 AM -- Volume K: has 0.0015 for Avg. Disk sec/Write.
2/9/2007 12:00:57 AM -- Volume K: has 0.0010 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Volume L: has 0.0015 for Avg. Disk sec/Write.
2/9/2007 12:00:57 AM -- Volume L: has 0.0010 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Test has 0 Max Database Page Fault Stalls/sec.
2/9/2007 12:00:57 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

Checksum Statistics

The following table shows a quick overview of checksum statistics:

Database	Pages seen	Bad checksums	Correctable checksums	Wrong page numbers	MB read/sec (File size/Seconds taken)
E:Jetstress.edb	6507266	0	0	0	39.9 MB/sec (25419 MB/636 seconds)
E:Jetstress1.edb	6507266	0	0	0	44.9 MB/sec (25419 MB/565 seconds)
E:Jetstress2.edb	6505986	0	0	0	45.6 MB/sec (25414 MB/557 seconds)
E:Jetstress3.edb	6505218	0	0	0	44.6 MB/sec (25411 MB/569 seconds)
E:Jetstress4.edb	6505986	0	0	0	44.6 MB/sec (25414 MB/569 seconds)
F:Jetstress.edb	6507266	0	0	0	39.9 MB/sec (25419 MB/636 seconds)
F:Jetstress1.edb	6507522	0	0	0	45.0 MB/sec (25420 MB/565 seconds)
F:Jetstress2.edb	6507266	0	0	0	45.6 MB/sec (25419 MB/557 seconds)
F:Jetstress3.edb	6505986	0	0	0	44.6 MB/sec (25414 MB/569 seconds)
F:Jetstress4.edb	6505986	0	0	0	44.6 MB/sec (25414 MB/569 seconds)
(sum)	65065748	0	0	0	87.7 MB/sec (254163 MB/2899 seconds)

The following table shows a quick overview of database and log performance counter sample data:

Storage Volume	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Total Seconds
E:	1.648	0.057	638.69	0.006	636.63

E:	1.206	0.030	676.74	0.003	565.65
E:	1.047	0.020	693.29	0.002	557.90
E:	0.970	0.015	698.27	0.002	569.85
E:	0.921	0.012	701.33	0.001	569.98
F:	1.748	0.072	638.67	0.011	636.85
F:	1.259	0.038	676.92	0.006	565.34
F:	1.097	0.026	693.48	0.004	557.82
F:	0.993	0.020	698.41	0.003	569.93
F:	0.934	0.016	701.50	0.002	569.71

The following table shows a quick overview of processor and memory performance counter sample data:

Counter	Average	Minimum	Maximum
% Processor Time	9.500	0.000	23.85
Available MBytes	3552.61	3471.00	3563.00
Free System Page Table Entries	40184.59	40186.00	40186.00
Pages/Sec	0.619	0.000	864.00
Pool Nonpaged Bytes	37823600.00	37724160.00	37928960.00
Pool Paged Bytes	38112110.00	36352000.00	39411710.00

Performance log B:\FinalRun_MCS_weighted_path\1000_max_10\DatabaseChecksum_2007_2_9_0-0-57.blg is saved.

2/8/2007 10:00:24 PM -- Environment validation results:

Detected JetstressUI version: 6.5.7830.0
Detected operating system: Microsoft Windows Server 2003 (5.2.3790.0) Service Pack 1
Detected ESE.dll version: 6.5.7638.2
Detected ESEPERF.dll version: 6.5.7638.1

2/8/2007 10:00:24 PM -- Validating input parameters, it may take a few minutes...
2/8/2007 10:00:24 PM -- Attaching databases ... (it may take a few minutes if the databases are in dirty shutdown state)
2/8/2007 10:00:31 PM -- Loading performance counters...
2/8/2007 10:00:31 PM -- Instance3496.1: IO parameters are thread (8), insert (17), replace (70), delete (5), and lazy commit (90)
2/8/2007 10:00:31 PM -- Instance3496.2: IO parameters are thread (8), insert (17), replace (70), delete (5), and lazy commit (90)
2/8/2007 10:00:31 PM -- Start Jetstress test...
2/8/2007 10:00:33 PM -- Starting Performance test run...
2/8/2007 10:00:33 PM -- Performance logging started.

2/8/2007 10:00:33 PM -- Performance data will be saved to
B:\FinalRun_MCS_weighted_path\1000_max_10\Performance_2007_2_8_22-0-31.blg.
2/9/2007 12:00:19 AM -- Adding new data to the performance log file...
2/9/2007 12:00:33 AM -- Performance logging stopped.
2/9/2007 12:00:33 AM -- Stopping Jetstress...
2/9/2007 12:00:54 AM -- Creating test report ...
2/9/2007 12:00:57 AM -- Volume F: has 0.0187 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Volume E: has 0.0188 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Volume K: has 0.0015 for Avg. Disk sec/Write.
2/9/2007 12:00:57 AM -- Volume K: has 0.0010 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Volume L: has 0.0015 for Avg. Disk sec/Write.
2/9/2007 12:00:57 AM -- Volume L: has 0.0010 for Avg. Disk sec/Read.
2/9/2007 12:00:57 AM -- Test has 0 Max Database Page Fault Stalls/sec.
2/9/2007 12:00:57 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
2/9/2007 12:00:57 AM -- Performance logging started.
2/9/2007 12:00:57 AM -- Performance data will be saved to
B:\FinalRun_MCS_weighted_path\1000_max_10\DatabaseChecksum_2007_2_9_0-0-57.blg.
2/9/2007 12:00:57 AM -- Checksum validation may take a while depending on the file sizes.
2/9/2007 12:49:17 AM -- Database checksum in progress:
Storage Group #1 (100%), and Storage Group #2 (100%).
2/9/2007 12:49:17 AM -- Performance logging stopped.
2/9/2007 12:49:17 AM -- Checksum is completed, please open
B:\FinalRun_MCS_weighted_path\1000_max_10\DatabaseChecksum_2007_2_9_0-0-57.html
for checksum result.