

PowerEdge 2900 III  
1000 Mailbox Cluster Continuous  
Replication  
Microsoft Exchange 2007 Storage Solution



**Tested with: ESRP – Storage Version 2.0**  
**Tested Date: Feb 07, 2008**

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## Overview

This document provides information on Dell PowerEdge 2900 III 1000 Mailbox Cluster Continuous Replication storage solution for Microsoft Exchange Server 2007, based on *Microsoft Exchange Solution Reviewed Program (ESRP) – Storage program\**. 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 click <http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.msp>

## Disclaimer

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## Features

This white paper describes a tested and validated storage solution. It includes two Dell PowerEdge™ 2900 III servers (Active and Passive nodes) for a 1000 mailbox Exchange Server 2007 environment with Cluster Continuous Replication (CCR). CCR is a high availability clustering mechanism based on the Microsoft Cluster Services (MSCS) Majority Node Set (MNS) model. It requires an active and a passive Exchange Mailbox server node, each of which maintain their copy of the mailbox databases. Mail clients access the primary (active) server, and database changes to it are copied to the secondary (passive) server in the form of log records. The copied log records are played on the secondary server to keep the secondary database copies consistent with the primary.

The secondary site is configured to be identical to the primary. The primary and secondary storage do not share storage array controllers or disks.

The tested user profile was 0.5 IOPS per user (0.42 IOPS per user with 20% headroom) with a 500 MB mailbox size.

Dell PowerEdge 2900 III provides SAS based internal storage with RAID

- Capable of housing up to ten 3.5-inch SAS disk drives
- Host based RAID options with Dell PERC 6/i

The PowerEdge 2900 III Cluster Continuous Replication solution presented in this paper utilizes a total of 10 disks per cluster node - 6 disks for Exchange information stores, 2 for transaction logs, and 2 additional drives are used for operating system and application files.

## Solution Description

The Dell™ PowerEdge 2900 III server is the building block for this solution and is capable of meeting the high performance requirements of messaging deployments. For more information see [Dell PowerEdge 2900 III](#).

Dell PERC 6/i RAID controller is used in the PowerEdge 2900 III hosting the Exchange server. The presented solution is for up to 1000 mailboxes.

The tested user profile was 0.5 IOPS per user (0.42 IOPS per user with 20% headroom) with a 500 MB mailbox size.

Microsoft Exchange Server System:

<b>Server</b>	Dell PowerEdge 2900 III
<b>CPU</b>	2 Intel® Xeon® CPU; 5160@3.00GHz
<b>Memory</b>	8 GB DDR2 ECC
<b>NIC</b>	Broadcom NeXtreme II
<b>RAID Controller</b>	PERC 6i (FW Version 1.11.52-0349)
<b>Internal Disks</b>	10 Seagate 300 GB 15K RPM SAS (ST3300655SS)

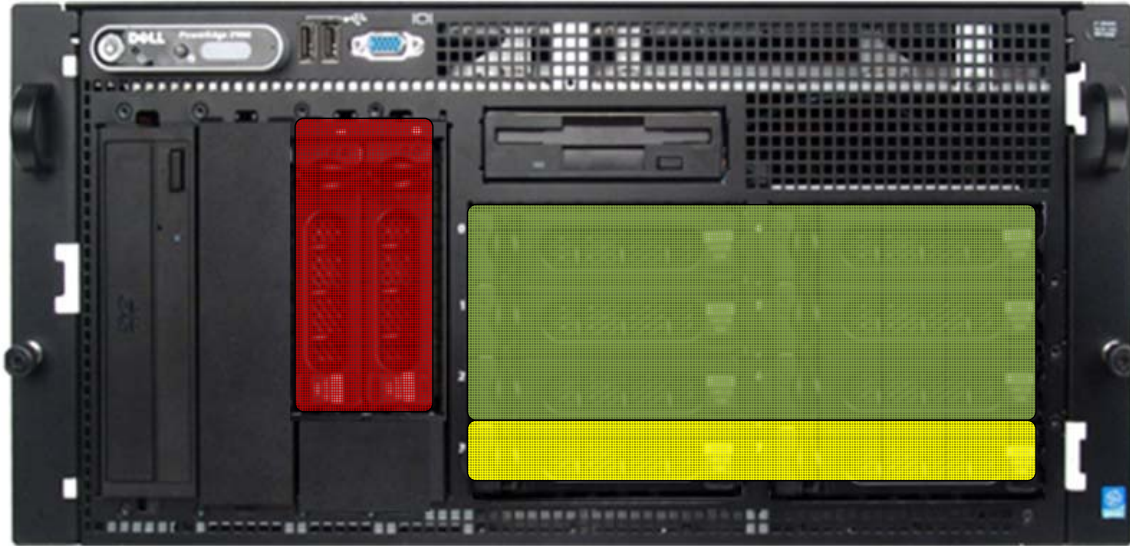
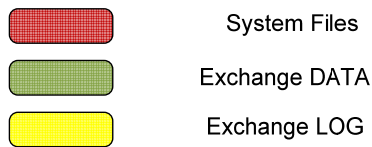


Figure 2: Dell PowerEdge 2900 III System Disk Layout



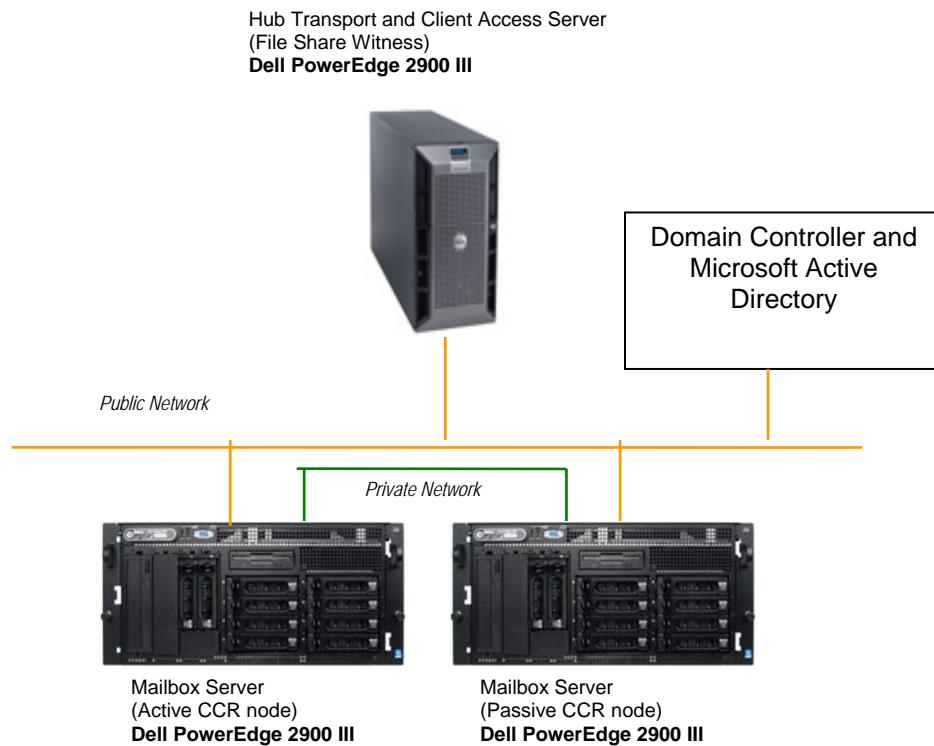
Storage System:

<b>Storage System</b>	Dell PowerEdge 2900 III internal storage with RAID
<b>Disks</b>	10 Seagate 300GB 15K RPM SAS (ST33006555SS/Rev S512) Drives
<b>RAID Controller</b>	PERC 6/i (FW Version V.1.11.52.0349)

Storage Configuration:

The storage configuration was as follows:

- 6-disk RAID 10 volume was created for Mailbox storage.
- 2-disk RAID 1 volume was created for the transaction logs.
- 2-disk RAID 1 volume was created for Operating System and application files



**Figure 3 Test Setup**

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 scale up Exchange solution.

Other factors which affect 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 for 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 Microsoft's Troubleshooting Microsoft Exchange Server Performance, available at <http://go.microsoft.com/fwlink/?LinkId=23454>.

## ***Targeted Customer Profile***

The configuration used for testing was as follows:

- Number of mailboxes : 1000
- Number of hosts attached to the storage system: 1
- User IO profile: 0.42 I/O Operations per second with 20% headroom (Tested 0.5 IOPS)
- 500 MB mailbox quota per mailbox

## ***Tested Deployment***

The following tables summarize the testing environment:

### **Simulated Exchange Configuration:**

<b>Number of Exchange mailboxes simulated</b>	1000
<b>Number of hosts</b>	1
<b>Number of mailboxes/host</b>	1000
<b>Number of storage groups/host</b>	4
<b>Number of mailbox stores/storage group</b>	1
<b>Number of mailboxes/mailbox store</b>	250
<b>Number of mailbox store LUNs/storage group</b>	4 Storage Groups per LUN
<b>Simulated profile: I/O's per second per mailbox (IOPS, include 20% headroom)</b>	0.42 IOPS/user (Tested 0.5)
<b>Database LUN size</b>	836 GB
<b>Log LUN size</b>	278 GB
<b>Total database size for performance testing</b>	489 GB
<b>% storage capacity used by Exchange database**</b>	489/ 836= 59%

\*\*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 (Fiber Channel, SAS, SATA, iSCSI)	SAS
Storage model and OS/firmware revision	PowerEdge 2900 III Internal RAID Firmware 1.11.52-0349 <a href="http://www.windowsservercatalog.com/item.aspx?idItem=1021cd1c-83a3-bce8-54d4-e22276c2c38e">http://www.windowsservercatalog.com/item.aspx?idItem=1021cd1c-83a3-bce8-54d4-e22276c2c38e</a>
Storage cache	512 MB
Number of storage controllers	1
Number of storage ports	1
Maximum bandwidth of storage connectivity to host	3 Gbit
Switch type/model/firmware revision	N/A
HBA model and firmware	Dell PERC 6/i Controller Firmware 1.11.52-0349
Number of HBA's/host	1
Host server type	Dell PowerEdge 2900 III 2 Intel® Xeon® CPU; 5160@3.00GHz
Total number of disks tested in solution	10
Maximum number of spindles can be hosted in the storage	10

### Primary Storage Software:

HBA driver	Dell PERC 6/i 2.14.0.64
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	No
Host OS	Windows Server 2003 Enterprise X64 Edition SP2
ESE.dll file version	8.0.685.24
Replication solution name/version	Cluster Continuous Replication (CCR)

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

Disk type, speed and firmware revision	Seagate SAS 15K (ST33006555ss/Rev S512) 300 GB Drives
Raw capacity per disk (GB)	300 GB
Number of physical disks in test	6
Total raw storage capacity (GB)	1800
Number of disks per LUN	6
Raid level	RAID 10
Total formatted capacity	836 GB
Storage capacity utilization	836 GB/ 1800 GB = 46%
Database capacity utilization	489 GB / 1800 GB= 27%

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

Disk type, speed and firmware revision	Seagate SAS 15K (ST33006555ss/Rev S512) 300 GB Drives
Raw capacity per disk (GB)	300 GB
Number of Spindles in test	2
total raw storage capacity (GB)	600 GB
Number of disks per LUN	2
Raid level	RAID 1
Total formatted capacity	278 GB

### *Replication Configuration*

Replication mechanism	Cluster Continuous Replication
Number of links	2
Simulated link distance	LAN
Link type	IP
Link bandwidth	Gigabit Ethernet (1 Gbps)

### Replicated Storage Hardware:

Storage Connectivity (Fiber Channel, SAS, SATA, iSCSI)	SAS
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<b>Storage model and OS/firmware revision</b>	PowerEdge 2900 III Internal RAID Firmware 1.11.52-0349 <a href="http://www.windowservercatalog.com/item.aspx?idItem=1021cd1c-83a3-bce8-54d4-e22276c2c38e">http://www.windowservercatalog.com/item.aspx?idItem=1021cd1c-83a3-bce8-54d4-e22276c2c38e</a>
<b>Storage cache</b>	512 MB
<b>Number of storage controllers</b>	1
<b>Number of storage ports</b>	1
<b>Maximum bandwidth of storage connectivity to host</b>	3 Gbit
<b>Switch type/model/firmware revision</b>	N/A
<b>HBA model and firmware</b>	Dell PERC 6/i Controller Firmware 1.11.52-0349
<b>Number of HBA's/host</b>	1
<b>Host server type</b>	Dell PowerEdge 2900 III 2 Intel®Xeon®CPU;5160@3.00GHz
<b>Total number of disks tested in solution</b>	10
<b>Maximum number of spindles can be hosted in the storage</b>	10

#### Replicated Storage Software:

<b>HBA driver</b>	Dell PERC 6/i 2.14.0.64
<b>HBA QueueTarget Setting</b>	N/A
<b>HBA QueueDepth Setting</b>	N/A
<b>Multi-Pathing</b>	No
<b>Host OS</b>	Windows Server 2003 Enterprise X64 Edition SP2
<b>ESE.dll file version</b>	8.0.685.24
<b>Replication solution name/version</b>	Cluster Continuous Replication (CCR)

#### Replicated Storage Disk Configuration (Mailbox Store Disks):

<b>Disk type, speed and firmware revision</b>	Seagate SAS 15K (ST33006555ss/Rev S512) 300 GB Drives
<b>Raw capacity per disk (GB)</b>	300 GB

<b>Number of physical disks in test</b>	6
<b>Total raw storage capacity (GB)</b>	1800
<b>Number of disks per LUN</b>	6
<b>Raid level</b>	RAID 10
<b>Total formatted capacity</b>	836 GB
<b>Storage capacity utilization</b>	836 GB / 1800 GB = 46%
<b>Database capacity utilization</b>	489 GB / 1800 GB = 27%

### Replicated Storage Disk Configuration (Transactional Log Disks):

<b>Disk type, speed and firmware revision</b>	Seagate SAS 15K (ST33006555ss/Rev S512) 300 GB Drives
<b>Raw capacity per disk (GB)</b>	300 GB
<b>Number of Spindles in test</b>	2
<b>total raw storage capacity (GB)</b>	600 GB
<b>Number of disks per LUN</b>	2
<b>Raid level</b>	RAID 1
<b>Total formatted capacity</b>	278 GB

## Best Practices

The older versions of Exchange including Exchange Server 2003 are 32-bit applications and are limited by the amount of addressable memory. Roughly 3GB of user mode virtual memory can be utilized for Exchange Server 2003 and the remaining 1GB is required for the kernel.

Exchange Server 2007 overcomes the memory limitations by providing support as a 64-bit application capable of running on supported x64 platforms. On Windows Server 2003 x64 Editions about 8TB of addressable memory is available for the kernel mode and the user mode applications. Support for up to 1TB of physical RAM is provided on Windows Server 2003 Enterprise x64 Editions. Both the application and kernel can have sufficient memory for operations, allowing the Extensible Storage Engine (EXE) in Exchange Server 2007 to utilize more memory to buffer data pages. The result is a reduction in the number of I/Os, specifically the read operations, required to the disk sub-system. The total number of database disk I/O operations for a given user load is dependent on the available system memory. For a given load, the total database disk I/O operations required per second (IOPS) decreases over a period with increase in system memory. This decrease in database IOPS is primarily caused by a decrease in database reads.

Even with the decrease in database IOPS using larger server memory, Exchange server remains a disk I/O intensive application. The disk subsystem should be capable to support both the capacity and I/O throughput demands of the application. Here are some best practices to help improve the I/O subsystem performance:

- Exchange Server can benefit from having the disk partitions track-aligned. For Windows 2003 Server SP1 or above use DiskPart to verify that your disk tracks are sector-aligned. Use a value of 64 to align the Exchange disks to a 64 KB boundary. In Exchange Server 2007, the data page size is increased from 4KB to 8KB and can provide I/O optimization in certain scenarios by containing larger messages within a page and holding internal data structures within one page due to the larger page size.
- Exchange Server 2007 also provides support for more storage groups to host mailbox database stores or databases – up to 50 storage groups per server, compared to 4 in Exchange 2003. This enables splitting user mailboxes across multiple available storage groups, providing ease of management for administrative operations such as backup/restore. Besides management ease, splitting mailboxes across multiple storage groups provides increased log checkpoint depth available for user data operations. In certain scenarios dirty data pages can be optimized to reside in memory for a longer period of time

and reduce the number of write I/O operations required to the disk sub-system. The solution described in this paper contains five storage groups with 400 users per storage group.

- Due to the high I/O demand, it is best to have dedicated disks for Exchange 2007. This will isolate the Exchange I/O's to dedicated set of disks and prevent other applications from competing for I/O throughput with Exchange disks. This will also help troubleshoot any disk latency issues as Exchange will have its own set of dedicated spindles.
- It is also recommended to place the database and transaction logs onto separate set of disks. The transaction logs generate 100% serial write I/O's to disk while the database generates 100% random read/writes. Isolating the transaction log and database I/O's onto separate disks will prevent mixing of serial and random I/O's and help improve performance.

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

For further details about the PowerEdge 2900 III server, please refer to [PowerEdge 2900 III Documentation](#).

## ***Backup strategy***

To protect e-mail data from potential disasters having a well designed and implemented backup solution is critical. Depending on the requirements of an environment different backup strategies may be implemented such as:

- Backup to disk
- Backup to tape
- LAN/SAN based backup etc.

The tests performed for backup include: backup-to-disk (read only) and log replay. The backup-to-disk test measures the read I/O performance by running a checksum on all the databases and log files. This test can help determine what kind of database read throughput can be achieved during backups. The backup speed and throughput achieved will depend upon the backup device used. The log replay test was used to measure the maximum rate at which the log files can be played against the databases. This is used to determine the restore times and also database write throughput can be achieved during a log recovery.

## **Contact for Additional Information**

For additional information please visit <http://www.dell.com/exchange2007>.

## Test Result Summary

This section provides a high level summary of the test data from ESRP and the link to the detailed html reports which are generated by ESRP testing framework. Please click on the underlined headings below to view the html report for each test.

### ***Reliability***

A number of tests in the framework are to check Reliability tests runs for 24 hours. The goal is to verify that the storage can handle high IO load for a long period of time. Both log and database files will be analyzed for integrity after the stress test to ensure no database/log corruption.

The following list provides an overview: (click on the underlined word will show the html report after the reliability tests run)

- Any errors reported in the saved eventlog file?  
No errors were reported in the eventlog file.
- Any errors reported in during the database and log checksum process?
  - No errors were reported in the [database](#) and [log](#) checksum process.
- If backup to disk test is done, any errors reported during the process?
  - Backup to disk was not tested

## **Primary Storage [Performance Results](#)**

The Primary Storage performance testing is designed to exercise the storage with maximum sustainable Exchange type of IO for 2 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 of the logical disk I/O's and average of all the logical disks I/O latency in the 2 hours test duration. Each server is listed separately and the aggregate numbers across all servers is listed as well.

### **Individual Server Metrics:**

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

<b>Database I/O</b>	
Average Database Disk Transfers/sec	741
Average Database Disk Reads/sec	394
Average Database Disk Writes/sec	348
Average Database Disk Read Latency (ms)	13
Average Database Disk Write Latency (ms)	2
<b>Transaction Log I/O</b>	
Average Log Disk Writes/sec	234
Average Log Disk Write Latency (ms)	0.1

## ***Streaming Backup/Recovery Performance***

ESRP Version 2.0 release supports only streaming backup type for testing. There are three tests in this section. The first two tests measure the database and log read I/O performance metrics by running a checksum on all the databases and log files. A third test to measure the end-to-end performance when the databases are backed up to disks was not performed.

### **[Database Read-only Performance](#)**

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

MB read/sec per storage group	76.8 (Average)
MB read/sec total	307

## Log Read-only Performance

The test is to measure the maximum rate at which the log files can be played against the databases. 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)	0.40 Seconds
---	--------------

## **Conclusion**

This document was developed by Dell storage solution providers, and reviewed by the Microsoft Exchange Product team. The test results/data presented in this document are based on the tests introduced in the ESRP test framework. Customers should not use the data for their pre-deployment verification. Each customer environment is different, and it is still necessary for each customer to go through the exercises to validate the storage design for their specific environment.

ESRP program is not designed to be a benchmarking program; tests are not designed to achieve the maximum throughput for a given solution. Rather, it is focused on producing best practices from vendors for Exchange applications. So the data presented in this document should not be used for direct comparisons among the solutions.

# Appendix A: Performance Testing

## *Performance Test Result Report*

Test Summary

**Overall Test Result** **Pass**

**Machine Name** POWEREDGER 2900 III

**Test Description** 1000 User Mailboxes  
500 MB per Mailbox  
R10 of 6\* 15K RPM disk drives; 300GB each  
R1 of 2\*15K RPM disk drives ; 300GB each  
4 Storage groups  
1 Database per Storage Group

**Test Start Time** 1/24/2008 4:29:56 PM

**Test End Time** 1/24/2008 8:00:35 PM

**Jetstress Version** 08.01.0177.000

**Ese Version** 08.00.0685.024

**Operating System** Microsoft Windows Server 2003 R2 Service Pack 2  
(5.2.3790.131072)

**Performance Log** [C:\Program Files\Exchange\Jetstress\performance\Performance\\_2008\\_1\\_24\\_17\\_52\\_38.blg](C:\Program Files\Exchange\Jetstress\performance\Performance_2008_1_24_17_52_38.blg)  
[C:\Program Files\Exchange\Jetstress\performance\DBChecksum\\_2008\\_1\\_24\\_20\\_0\\_35.blg](C:\Program Files\Exchange\Jetstress\performance\DBChecksum_2008_1_24_20_0_35.blg)

Database Sizing and Throughput

**Achieved I/O per Second** 755.603

**Target I/O per Second** 500

**Initial database size** 524316901376

**Final database size** 531716177920

**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 (M:)	0.014	0.002	386.966	368.637	(n/a)
Log (L:)	0.000	9.12311977110201E-05	0.000	257.260	10185.628

### Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.245	0.573	2.188
Available MBytes	6285.054	6227.000	6312.000
Free System Page Table Entries	16760379.000	16760379.000	16760379.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	37995921.067	37986304.000	38027264.000
Pool Paged Bytes	40306304.000	40247296.000	40333312.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log1/24/2008 4:29:56 PM -- Jetstress testing begins ...

1/24/2008 4:29:56 PM -- Prepare testing begins ...  
 1/24/2008 4:29:56 PM -- Duplicating 4 databases:  
 1/24/2008 5:52:30 PM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).  
 1/24/2008 5:52:34 PM -- Attaching databases ...  
 1/24/2008 5:52:34 PM -- Prepare testing ends.  
 1/24/2008 5:52:34 PM -- Dispatching transactions begins ...  
 1/24/2008 5:52:34 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 1/24/2008 5:52:34 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 1/24/2008 5:52:38 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).  
 1/24/2008 5:52:38 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).  
 1/24/2008 5:52:39 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
 1/24/2008 5:52:39 PM -- Performance logging begins (interval: 15000 ms).  
 1/24/2008 5:52:39 PM -- Attaining prerequisites:  
 1/24/2008 6:00:12 PM -- \Database(JetstressWin)\Database Cache Size, Last: 967458800.0 (lower bound: 966367600.0, upper bound: none)  
 1/24/2008 8:00:13 PM -- Performance logging ends.  
 1/24/2008 8:00:13 PM -- JetInterop batch transaction stats: 44155, 43921, 43824, and 44407.  
 1/24/2008 8:00:14 PM -- Dispatching transactions ends.  
 1/24/2008 8:00:14 PM -- Shutting down databases ...  
 1/24/2008 8:00:35 PM -- Instance2100.1 (complete), Instance2100.2 (complete), Instance2100.3 (complete), and Instance2100.4 (complete)  
 1/24/2008 8:00:35 PM -- Performance logging begins (interval: 15000 ms).  
 1/24/2008 8:00:35 PM -- Verifying database checksums ...  
 1/24/2008 8:30:17 PM -- M: (100% processed)  
 1/24/2008 8:30:18 PM -- Performance logging ends.  
 1/24/2008 8:30:18 PM -- [C:\Program Files\Exchange Jetstress\performance\DBChecksum\\_2008\\_1\\_24\\_20\\_0\\_35.blg](C:\Program Files\Exchange Jetstress\performance\DBChecksum_2008_1_24_20_0_35.blg) has 118 samples.  
 1/24/2008 8:30:20 PM -- [C:\Program Files\Exchange Jetstress\performance\DBChecksum\\_2008\\_1\\_24\\_20\\_0\\_35.html](C:\Program Files\Exchange Jetstress\performance\DBChecksum_2008_1_24_20_0_35.html) is saved.

1/24/2008 8:30:20 PM -- Verifying log checksums ...  
 1/24/2008 8:30:23 PM -- L:\LOG1 (22 logs passed), L:\LOG2 (22 logs passed), L:\LOG3 (22 logs passed), and L:\LOG4 (22 logs passed)  
 1/24/2008 8:30:23 PM -- [C:\Program Files\Exchange\Jetstress\performance\Performance\\_2008\\_1\\_24\\_17\\_52\\_38.blg](C:\Program Files\Exchange\Jetstress\performance\Performance_2008_1_24_17_52_38.blg) has 510 samples.  
 1/24/2008 8:30:23 PM -- Creating test report ...  
 1/24/2008 8:30:26 PM -- Volume M: has 0.0137 for Avg. Disk sec/Read.  
 1/24/2008 8:30:26 PM -- Volume L: has 0.0001 for Avg. Disk sec/Write.  
 1/24/2008 8:30:26 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.  
 1/24/2008 8:30:26 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 1/24/2008 8:30:26 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
 1/24/2008 8:30:26 PM -- [C:\Program Files\Exchange\Jetstress\performance\Performance\\_2008\\_1\\_24\\_17\\_52\\_38.xml](C:\Program Files\Exchange\Jetstress\performance\Performance_2008_1_24_17_52_38.xml) has 479 samples queried.

## Database Checksum Test Result Report

### Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
M:\DATA1\Jetstress1.edb	16218498	0	0	0	126707 MBytes / 428 seconds
M:\DATA2\Jetstress1.edb	16225410	0	0	0	126761 MBytes / 424 seconds
M:\DATA3\Jetstress1.edb	16230530	0	0	0	126801 MBytes / 446 seconds
M:\DATA4\Jetstress1.edb	16232322	0	0	0	126815 MBytes / 481 seconds
(Sum)	64906760	0	0	0	507084 MBytes / 1781 seconds

### Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
M:	0.181	2.99145299145299E-06	4558.269	0.001

### Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	7.169	5.833	9.089
Available MBytes	7309.856	7307.000	7311.000
Free System Page Table Entries	16760379.000	16760379.000	16760379.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	39384359.051	39346176.000	39489536.000

Pool Paged Bytes

40141285.966 40030208.000 40165376.000

Test Log 1/24/2008 4:29:56 PM -- Jetstress testing begins ...  
1/24/2008 4:29:56 PM -- Prepare testing begins ...  
1/24/2008 4:29:56 PM -- Duplicating 4 databases:  
1/24/2008 5:52:30 PM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).  
1/24/2008 5:52:34 PM -- Attaching databases ...  
1/24/2008 5:52:34 PM -- Prepare testing ends.  
1/24/2008 5:52:34 PM -- Dispatching transactions begins ...  
1/24/2008 5:52:34 PM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
1/24/2008 5:52:34 PM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
1/24/2008 5:52:38 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).  
1/24/2008 5:52:38 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).  
1/24/2008 5:52:39 PM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
1/24/2008 5:52:39 PM -- Performance logging begins (interval: 15000 ms).  
1/24/2008 5:52:39 PM -- Attaining prerequisites:  
1/24/2008 6:00:12 PM -- \Database(JetstressWin)\Database Cache Size, Last: 967458800.0 (lower bound: 966367600.0, upper bound: none)  
1/24/2008 8:00:13 PM -- Performance logging ends.  
1/24/2008 8:00:13 PM -- JetInterop batch transaction stats: 44155, 43921, 43824, and 44407.  
1/24/2008 8:00:14 PM -- Dispatching transactions ends.  
1/24/2008 8:00:14 PM -- Shutting down databases ...  
1/24/2008 8:00:35 PM -- Instance2100.1 (complete), Instance2100.2 (complete), Instance2100.3 (complete), and Instance2100.4 (complete)  
1/24/2008 8:00:35 PM -- Performance logging begins (interval: 15000 ms).  
1/24/2008 8:00:35 PM -- Verifying database checksums ...  
1/24/2008 8:30:17 PM -- M: (100% processed)  
1/24/2008 8:30:18 PM -- Performance logging ends.  
1/24/2008 8:30:18 PM -- [C:\Program Files\Exchange\Jetstress\performance\DBChecksum\\_2008\\_1\\_24\\_20\\_0\\_35.blg](C:\Program Files\Exchange\Jetstress\performance\DBChecksum_2008_1_24_20_0_35.blg) has 118 samples.

## Appendix B: Stress Testing

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

Test Summary

**Overall Test**    **Pass**

**Result**

**Machine Name** POWEREDGER 2900 III

**Test**            1000 User Mailboxes

**Description**    500 MB per Mailbox  
R10 of 6\* 15K RPM disk drives; 300GB each  
R1 of 2\*15K RPM disk drives ; 300GB each  
4 Storage groups  
1 Database per Storage Group

**Test Start Time**    1/25/2008 10:20:59 AM

**Test End Time**    1/26/2008 11:50:58 AM

**Jetstress**        08.01.0177.000

**Version**

**Ese Version** 08.00.0685.024  
**Operating System** Microsoft Windows Server 2003 R2 Service Pack 2 (5.2.3790.131072)  
**Performance Log** [C:\Program Files\Exchange\Jetstress\Stress\Stress\\_2008\\_1\\_25\\_11\\_43\\_21.blg](#)  
[C:\Program Files\Exchange\Jetstress\Stress\DBChecksum\\_2008\\_1\\_26\\_11\\_50\\_58.blg](#)

Database Sizing and Throughput

**Achieved I/O per Second** 742.377  
**Target I/O per Second** 500  
**Initial database size** 524316901376  
**Final database size** 598642589696  
**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 (M:)	0.013	0.002	394.398	347.978	(n/a)
Log (L:)	0.000	8.66960738255336E-05	0.000	233.895	10131.743

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.267	0.443	9.818
Available MBytes	6273.890	6209.000	6303.000
Free System Page Table Entries	16760379.000	16760379.000	16760379.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	38390544.356	38387712.000	38436864.000
Pool Paged Bytes	42200212.622	41918464.000	43212800.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log1/25/2008 10:20:59 AM -- Jetstress testing begins ...

1/25/2008 10:20:59 AM -- Prepare testing begins ...  
1/25/2008 10:21:00 AM -- Duplicating 4 databases:  
1/25/2008 11:43:12 AM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).  
1/25/2008 11:43:17 AM -- Attaching databases ...  
1/25/2008 11:43:17 AM -- Prepare testing ends.  
1/25/2008 11:43:17 AM -- Dispatching transactions begins ...  
1/25/2008 11:43:17 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
1/25/2008 11:43:17 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
1/25/2008 11:43:21 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).  
1/25/2008 11:43:21 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).  
1/25/2008 11:43:22 AM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
1/25/2008 11:43:22 AM -- Performance logging begins (interval: 15000 ms).  
1/25/2008 11:43:22 AM -- Attaining prerequisites:  
1/25/2008 11:50:32 AM -- \Database(JetstressWin)\Database Cache Size, Last: 967843800.0 (lower bound: 966367600.0, upper bound: none)  
1/26/2008 11:50:34 AM -- Performance logging ends.  
1/26/2008 11:50:34 AM -- JetInterop batch transaction stats: 449903, 450208, 450321, and 448844.  
1/26/2008 11:50:34 AM -- Dispatching transactions ends.  
1/26/2008 11:50:34 AM -- Shutting down databases ...  
1/26/2008 11:50:58 AM -- Instance1156.1 (complete), Instance1156.2 (complete), Instance1156.3 (complete), and Instance1156.4 (complete)  
1/26/2008 11:50:59 AM -- Performance logging begins (interval: 30000 ms).  
1/26/2008 11:50:59 AM -- Verifying database checksums ...  
1/26/2008 12:26:49 PM -- M: (100% processed)  
1/26/2008 12:26:50 PM -- Performance logging ends.  
1/26/2008 12:26:50 PM -- [C:\Program Files\Exchange Jetstress\Stress\DBChecksum\\_2008\\_1\\_26\\_11\\_50\\_58.blg](C:\Program Files\Exchange Jetstress\Stress\DBChecksum_2008_1_26_11_50_58.blg) has 71 samples.  
1/26/2008 12:26:52 PM -- [C:\Program Files\Exchange Jetstress\Stress\DBChecksum\\_2008\\_1\\_26\\_11\\_50\\_58.html](C:\Program Files\Exchange Jetstress\Stress\DBChecksum_2008_1_26_11_50_58.html) is saved.  
1/26/2008 12:26:52 PM -- Verifying log checksums ...  
1/26/2008 12:26:55 PM -- L:\LOG1 (22 logs passed), L:\LOG2 (22 logs passed), L:\LOG3 (22 logs passed), and L:\LOG4 (22 logs passed)  
1/26/2008 12:26:55 PM -- [C:\Program Files\Exchange Jetstress\Stress\Stress\\_2008\\_1\\_25\\_11\\_43\\_21.blg](C:\Program Files\Exchange Jetstress\Stress\Stress_2008_1_25_11_43_21.blg) has 5788 samples.  
1/26/2008 12:26:55 PM -- Creating test report ...  
1/26/2008 12:27:24 PM -- Volume M: has 0.0134 for Avg. Disk sec/Read.  
1/26/2008 12:27:24 PM -- Volume L: has 0.0001 for Avg. Disk sec/Write.  
1/26/2008 12:27:24 PM -- Volume L: has 0.0000 for Avg. Disk sec/Read.  
1/26/2008 12:27:24 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
1/26/2008 12:27:24 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
1/26/2008 12:27:24 PM -- [C:\Program Files\Exchange Jetstress\Stress\Stress\\_2008\\_1\\_25\\_11\\_43\\_21.xml](C:\Program Files\Exchange Jetstress\Stress\Stress_2008_1_25_11_43_21.xml) has 5759 samples queried.

## Stress Test - Database Checksum Result Report

### Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page no pages	File length / seconds taken
M:\DATA1\Jetstress1.edb	18286978	0	0	0	142867 MBytes / 608 seconds
M:\DATA2\Jetstress1.edb	18259586	0	0	0	142653 MBytes / 565 seconds
M:\DATA3\Jetstress1.edb	18272386	0	0	0	142753 MBytes / 491 seconds
M:\DATA4\Jetstress1.edb	18257538	0	0	0	142637 MBytes / 484 seconds
(Sum)	73076488	0	0	0	570910 MBytes / 2150 seconds

### Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec
M:	0.177	0.000	4269.339	0.000

### Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	6.648	4.818	8.112
Available MBytes	7287.901	7285.000	7289.000
Free System Page Table Entries	16760379.000	16760379.000	16760379.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	39456941.070	39448576.000	39473152.000
Pool Paged Bytes	43188570.141	43048960.000	43253760.000

Test Log 1/25/2008 10:20:59 AM -- Jetstress testing begins ...

1/25/2008 10:20:59 AM -- Prepare testing begins ...

1/25/2008 10:21:00 AM -- Duplicating 4 databases:

1/25/2008 11:43:12 AM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).

1/25/2008 11:43:17 AM -- Attaching databases ...

1/25/2008 11:43:17 AM -- Prepare testing ends.  
 1/25/2008 11:43:17 AM -- Dispatching transactions begins ...  
 1/25/2008 11:43:17 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
 1/25/2008 11:43:17 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
 1/25/2008 11:43:21 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).  
 1/25/2008 11:43:21 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).  
 1/25/2008 11:43:22 AM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.  
 1/25/2008 11:43:22 AM -- Performance logging begins (interval: 15000 ms).  
 1/25/2008 11:43:22 AM -- Attaining prerequisites:  
 1/25/2008 11:50:32 AM -- \Database(JetstressWin)\Database Cache Size, Last: 967843800.0 (lower bound: 966367600.0, upper bound: none)  
 1/26/2008 11:50:34 AM -- Performance logging ends.  
 1/26/2008 11:50:34 AM -- JetInterop batch transaction stats: 449903, 450208, 450321, and 448844.  
 1/26/2008 11:50:34 AM -- Dispatching transactions ends.  
 1/26/2008 11:50:34 AM -- Shutting down databases ...  
 1/26/2008 11:50:58 AM -- Instance1156.1 (complete), Instance1156.2 (complete), Instance1156.3 (complete), and Instance1156.4 (complete)  
 1/26/2008 11:50:59 AM -- Performance logging begins (interval: 30000 ms).  
 1/26/2008 11:50:59 AM -- Verifying database checksums ...  
 1/26/2008 12:26:49 PM -- M: (100% processed)  
 1/26/2008 12:26:50 PM -- Performance logging ends.  
 1/26/2008 12:26:50 PM -- [C:\Program Files\Exchange Jetstress\Stress\DBChecksum\\_2008\\_1\\_26\\_11\\_50\\_58.blg](#) has 71 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
Instance1940.1	125010.90	00:37:25	55.67
Instance1940.2	125010.90	00:36:10	57.60
Instance1940.3	125010.90	00:29:47	69.95
Instance1940.4	125010.90	00:26:43	77.96

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 (M:)	0.002	7.50860108197065E-05	1789.008	0.064	(n/a)
Log (L:)	0.000	7.88776612256342E-06	0.000	0.070	983.714

### Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	4.744	1.354	8.281
Available MBytes	7309.342	7308.000	7310.000
Free System Page Table Entries	16760339.000	16760339.000	16760339.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	37635340.027	37634048.000	37646336.000
Pool Paged Bytes	33616201.879	33173504.000	33648640.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log2/11/2008 3:45:33 PM -- Jetstress testing begins ...

2/11/2008 3:45:33 PM -- Prepare testing begins ...

2/11/2008 3:45:34 PM -- Duplicating 4 databases:

2/11/2008 5:09:27 PM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).

2/11/2008 5:09:31 PM -- Attaching databases ...

2/11/2008 5:09:31 PM -- Prepare testing ends.

2/11/2008 5:09:36 PM -- Performance logging begins (interval: 15000 ms).

2/11/2008 5:09:36 PM -- Streaming backup databases ...

2/11/2008 5:47:02 PM -- Performance logging ends.

2/11/2008 5:47:02 PM -- Instance1940.1 (100% processed), Instance1940.2 (100% processed), Instance1940.3 (100% processed), and Instance1940.4 (100% processed)

2/11/2008 5:47:02 PM -- [C:\Program Files\Exchange Jetstress\Backup\StreamingBackup\\_2008\\_2\\_11\\_17\\_9\\_31.blg](C:\Program Files\Exchange Jetstress\Backup\StreamingBackup_2008_2_11_17_9_31.blg) has 149 samples.

2/11/2008 5:47:03 PM -- Creating test report ...

## Appendix D: Soft Recovery Testing

### SoftRecovery Test Result Report

#### Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2240.1	505	188
Instance2240.2	512	218.25
Instance2240.3	500	211
Instance2240.4	506	169

#### Disk Subsystem Performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (M:)	0.051	0.002	1750.348	38.099	(n/a)
Log (L:)	0.001	0.000	307.407	10.523	7447.090

#### Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.604	1.367	6.055
Available MBytes	6530.835	6330.000	7364.000
Free System Page Table Entries	16760379.000	16760379.000	16760379.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	38314021.578	38256640.000	38395904.000
Pool Paged Bytes	44959988.257	44470272.000	44982272.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log1/30/2008 8:27:54 AM -- Jetstress testing begins ...

1/30/2008 8:27:54 AM -- Prepare testing begins ...

1/30/2008 8:27:54 AM -- Creating M:\DATA1\Jetstress1.edb.

1/30/2008 8:27:54 AM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)

1/30/2008 8:27:54 AM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)

1/30/2008 8:36:58 AM -- 60.0% of 122.1 GB complete (4463391 records inserted).

1/30/2008 8:48:28 AM -- 100.0% of 122.1 GB complete (7146218 records inserted).

1/30/2008 8:48:30 AM -- Duplicating 4 databases:

1/30/2008 9:45:00 AM -- 100.0% of 488.3 GB complete (488.3 GB duplicated).

1/30/2008 9:45:04 AM -- Attaching databases ...

1/30/2008 9:45:04 AM -- Prepare testing ends.

1/30/2008 9:45:04 AM -- Dispatching transactions begins ...

1/30/2008 9:45:04 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

1/30/2008 9:45:04 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

1/30/2008 9:45:08 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

1/30/2008 9:45:08 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

1/30/2008 9:45:09 AM -- Operation mix: Sessions 4, Inserts 25%, Deletes 10%, Replaces 50%, Reads 15%, Lazy Commits 80%.

1/30/2008 9:45:09 AM -- Performance logging begins (interval: 15000 ms).

1/30/2008 9:45:09 AM -- Generating log files ...  
1/30/2008 10:11:42 AM -- L:\LOG1 (101.2% generated), L:\LOG2 (102.4% generated),  
L:\LOG3 (100.2% generated), and L:\LOG4 (101.2% generated)  
1/30/2008 10:11:43 AM -- Performance logging ends.  
1/30/2008 10:11:43 AM -- JetInterop batch transaction stats: 9875, 9879, 9747, and 10007.  
1/30/2008 10:11:43 AM -- Dispatching transactions ends.  
1/30/2008 10:11:43 AM -- Shutting down databases ...  
1/30/2008 10:12:08 AM -- Instance2240.1 (complete), Instance2240.2 (complete),  
Instance2240.3 (complete), and Instance2240.4 (complete)  
1/30/2008 10:12:08 AM -- [C:\Program Files\Exchange  
Jetstress\SoftRecovery\Performance\\_2008\\_1\\_30\\_9\\_45\\_8.blg](#) has 106 samples.  
1/30/2008 10:12:08 AM -- Creating test report ...  
1/30/2008 10:12:08 AM -- Volume M: has 0.0136 for Avg. Disk sec/Read.  
1/30/2008 10:12:08 AM -- Volume L: has 0.0001 for Avg. Disk sec/Write.  
1/30/2008 10:12:08 AM -- Volume L: has 0.0002 for Avg. Disk sec/Read.  
1/30/2008 10:12:08 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
1/30/2008 10:12:08 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
1/30/2008 10:12:08 AM -- [C:\Program Files\Exchange  
Jetstress\SoftRecovery\Performance\\_2008\\_1\\_30\\_9\\_45\\_8.xml](#) has 105 samples queried.  
1/30/2008 10:12:09 AM -- [C:\Program Files\Exchange  
Jetstress\SoftRecovery\Performance\\_2008\\_1\\_30\\_9\\_45\\_8.html](#) is saved.  
1/30/2008 10:12:11 AM -- Performance logging begins (interval: 2000 ms).  
1/30/2008 10:12:11 AM -- Recovering databases ...  
1/30/2008 10:15:50 AM -- Performance logging ends.  
1/30/2008 10:15:50 AM -- Instance2240.1 (188), Instance2240.2 (218.25), Instance2240.3  
(211), and Instance2240.4 (169)  
1/30/2008 10:15:50 AM -- [C:\Program Files\Exchange  
Jetstress\SoftRecovery\SoftRecovery\\_2008\\_1\\_30\\_10\\_12\\_9.blg](#) has 109 samples.  
1/30/2008 10:15:50 AM -- Creating test report ...