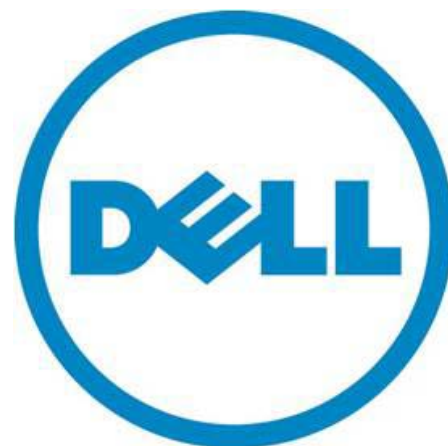


Dell™ PowerEdge™ R510
Near line SAS
4000 Mailboxes using Mailbox
Resiliency
Exchange 2010 Storage Solution

Tested with: ESRP – Storage Version 3.0
Tested Date: May 30, 2010



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Overview

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

*The *ESRP – Storage* program was developed by Microsoft Corporation to provide a common storage testing framework for vendors to provide information on its storage solutions for Microsoft Exchange Server software. For more details on the *Microsoft ESRP – Storage* program, please click <http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.mspx>

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Features

This white paper describes a tested and validated storage solution for a 4000 mailbox Exchange 2010 environment with Data Availability Group. A DAG is the new high availability mechanism in Microsoft Exchange 2010. This model of mailbox resiliency supports multiple copies of Exchange database (up to 16) in a DAG. There is only one active copy of a given Exchange 2010 database at any given time. Secondary copies are periodically synched with the primary copy. Mail clients access the primary (active) copy, and database changes to the primary copy are copied to the secondary (passive) copies in the form of transaction logs. The copied log records are played on the secondary copy to keep the secondary database copies consistent with the primary copy. All hosts within a DAG are configured to be identical. The primary and secondary copy storages do not share storage array controllers or disks.

Dell™ PowerEdge™ R510 is a 2-socket 2U, multi-purpose value server, offering an excellent balance of internal storage, redundancy and value in compact 26" deep chassis. Major features of the server/storage system include:

- Internal capacity for up to 12 3.5-inch, hot-plug, 6.0-Gbps, serial-attached SCSI (SAS) hard drives , 600 GB capacity, and rated at 15K RPM as well as Nearline SAS hard drives (7.2K RPM) with 2TB capacity
- Choice of chassis configuration with 4, 8 or 12 front loading drive bays
- Six-Core and Quad-Core Intel® Xeon® Processor
- Integrated RAID support via a PERC H700 adapter
- In-band enclosure management provided through SCSI enclosure services (SES)
- RAID and system management using Dell™ OpenManage™ Server Administrator Storage Management Service

The PowerEdge™ R510 chassis selected for this solution supports (12) 3.5" drives plus (2) internal 2.5" drives for Windows Server 2008 R2 . The solution presented in this paper utilizes this configuration with each disk housing one Exchange database and its Transaction logs.

Solution Description

The Dell™ PowerEdge™ R510 is a high capacity/high value rack server with balance of internal storage of up to (12) 3.5-inch disk drives and redundancy in a single 2U rack able chassis. The front loading built in expansion enclosure can support 2 Terabyte Near-Line SAS (7200 RPM) drives as well as 10/15K RPM SAS drives with capacities up to 600GB.

[Dell™ PowerEdge™ R510 Rack Server Product Page](#)



Figure 1: Dell™ PowerEdge™ r510 enclosure with (12) 3.5-inch drives bays no bezel

PERC H700 is the internal host-based RAID controller used to connect to the PowerEdge™ R510 front loading backplane that supports the (12) drive bays including an additional (2) internal 2.5" drives. The controller supports 6 Gbps Serial Attached SCSI (SAS) as the storage interconnect technology and PCI Express 2.0 (PCI-E) as the host-based interconnect technology.

The PERC H700 controller offers:

- 8 port LSI 2108 Chipset
- 512MB of customized DDR2 400MHz, Error-Correcting Code (ECC) cache memory with optional upgrade to 512MB
- 6 Gbps maximum speed for each SAS lane
- Two internal x4 ("by four") mini-SAS wide ports, each aggregating 4 SAS lanes for a total bandwidth per port of 12.0 Gbps

- x8 PCI E host interface for a total bandwidth of 32.0 Gbps
- Up to 72 hours of intelligent, transportable, battery-backed, cache memory

The presented solution is a Data Availability Group solution for up to 4000 mailboxes. It includes a single primary PowerEdge™ R510 server that supports (12) front loading 3.5" storage enclosures. The secondary server 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 0.1 IOPS per user with a 3073 MB mailbox size. This IO profile for Exchange 2010 represents about 100 messages (sent/received) per mailbox per day. Sometimes additional applications, such as certain mobile messaging applications, can raise the IOPS profile of a user as high as three or four times that of normal. Using 7.2K RPM drives gives more than enough performance achieving over 30% more than the target of 720 IOPS. Single disk RAID 0 virtual drives were configured in this manner to exhibit each disk's maximum IOPS.

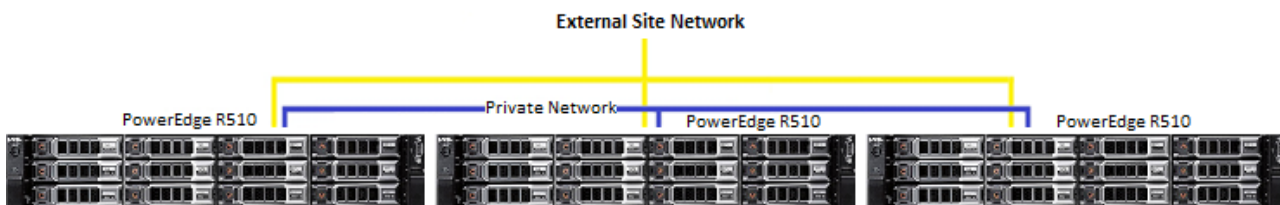


Figure 2: Test Setup Diagram

Microsoft Exchange Server System:

Server	Dell™ PowerEdge™ R510
CPU	2 Intel®Xeon®CPU;5570@2.93GHz
Memory	64 GB DDR2 ECC
NIC	Broadcom NeXtreme II
RAID Controller	PERC H700 (FW Version 4.5.0.64)
Internal Disks	2 Seagate 146GB 15K RPM SAS(ST9146852SS)

Built in Storage System:

Storage System	Dell™ PowerEdge™ R510
Disks	12 Seagate 2TB 7.2K RPM NL-SAS (ST32000444SS) Drives
RAID Controller	PERC H700 4.5.0.64

Storage Configuration:

The storage configuration per enclosure was as follows:

- A single RAID 0 volume was created from each physical disk from 0 through 11 on the front loading PowerEdge™ R510 bays. These volumes were used for Exchange Information stores and transaction logs.

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 the server scalability are:

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

All these factors are beyond the scope 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 deployment. 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 small to mid size organizations hosting up to 4000 Exchange 2010 mailboxes. The configuration used for testing was as follows:

- Number of mailboxes : 4000
- Number of hosts attached to the storage system: 1
- User IO profile: 0.1 I/O Operation per second
- 3072 MB Mailbox quota per mailbox
- 24x7 Background Database Maintenance enabled
- Data Availability Group (DAG) for Mailbox Resiliency

The table below summarizes the testing environment.

Simulated Exchange Configuration

Number of Exchange mailboxes simulated	4000
Number of Database Availability Groups (DAGs)	1
Number of servers/DAG	3
Number of active mailboxes/server	4000
Number of databases/host	12
Number of copies/database	3
Number of mailboxes/database	333
Simulated profile: I/O's per second per mailbox (IOPS, include 20% headroom)	0.1
Database LUN size	22348 GB
Log LUN size	N/A
Total database size for performance testing	11,919 GB
% storage capacity used by Exchange database**	53%

**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™ R510 + PERC H700 Firmware 4.5.0.64
Storage cache	512MB – PERC H700 RAID controller cache
Number of storage controllers	1
Number of storage ports	2
Maximum bandwidth of storage connectivity to host	6Gbit
Switch type/model/firmware revision	N/A
HBA model and firmware	PERC H700 (RAID controller)
Number of HBA's/host	1
Host server type	Dell™ PowerEdge™ R510 2 Intel® Xeon® CPU; X5555@2.67GHz 64GB memory
Total number of disks tested in solution	12 total
Maximum number of spindles can be hosted in server	14 total

Storage Software

HBA driver	Dell™ PERC H700
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	N/A
Host OS	Windows Server 2008 R2 Enterprise X64 Edition
ESE.dll file version	14.0.639.19
Replication solution name/version	N/A

Primary Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed and firmware revision	Seagate 2TB 7.2K RPM NL-SAS (ST32000444SS) Drives
Raw capacity per disk (GB)	2048GB
Number of physical disks in test	12
Total raw storage capacity (GB)	24,576 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	1
Raid level	RAID 0
Total formatted capacity	22,349.40GB
Storage capacity utilization	90.93%
Database capacity utilization	48.9%

Replication Configuration

Replication mechanism	Exchange 2010 Data Availability Group Mailbox Resiliency
Number of links	2
Simulated link distance	LAN
Link type	IP
Link bandwidth	Gigabit Ethernet (1 Gbps)

The figure below shows the DAG configuration with 24 active database copies and 48 passive copies.

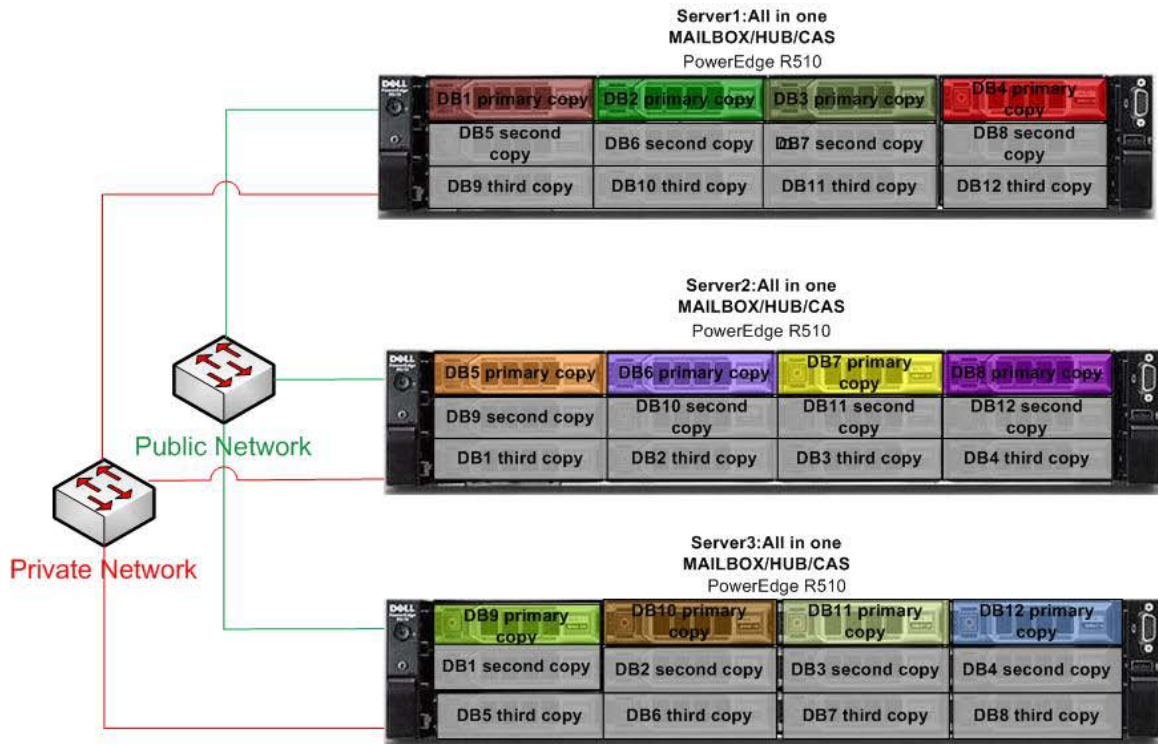


Figure 3: Layout of Mailbox Databases with active and passive copies

Best Practices

Exchange Server 2007 and 2010 overcome the memory limitations of previous Exchange versions by providing support as a 64-bit application capable of running on supported x64 platforms. On Windows Server 2008 R2 x64 Edition about 2TB of addressable memory is available for the kernel mode and the user mode applications. Both the application and kernel can have sufficient memory for operations, allowing the Extensible Storage Engine (ESE) in Exchange Server 2010 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. Based on testing using the ESRP framework, we would recommend the following best practices to help improve the I/O subsystem performance:

1. Exchange 2010 is an IO intensive application. Sharing Exchange 2010 storage resources with other applications may negatively impact the performance of Exchange 2010 deployment and therefore is not recommended.
2. In our testing, the database and log folders shared the same physical disk. Other testing indicated that separating the database folders from log folders on to different set of disks does not provide a noticeable performance advantage. In an Exchange Server 2010 resiliency solution, separating the database and log folders is no longer a required best practice.
3. For Exchange 2010 Database, it is recommended that the size of elements within a RAID stripe be set 512K for best performance.
4. Windows NTFS allocation unit size for Exchange 2010 database partitions should be set to 64K for best performance. For log partitions, if separated from database, the default allocation unit size should be used.
5. Exchange Server 2010 storage latencies are most often related the number of disks available for given a workload. Windows Performance

Monitor may be used to monitor Exchange Server 2010 database counters. Average database read latencies (Avg. Disk sec/Read) should not exceed 20ms.

For Exchange Server 2010 Mailbox Storage Design, please visit <http://technet.microsoft.com/en-us/library/dd346703.aspx>

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 tape
- LAN/SAN based backup etc.

In this solution, DAG is used to maintain a passive database copy on a separate storage system. This passive copy of the database may be used to perform to tape or disk.

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 [Dell™ and Exchange Server 2010](#)

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 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 event log file? No errors reported on event log.
No
- Any errors reported in during the [database](#) and [log](#) checksum process?
No

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:

Database I/O	
Database Disks Transfers/sec	580
Total Database Disks Reads/sec	357
Total Database Disks Writes/sec	223
Average Database Disk Read Latency (ms)	14.895
Average Database Disk Write Latency (ms)	1.267
Transaction Log I/O	
Log Disks Writes/sec	201.72
Average Log Disk Write Latency (ms)	.269

Database Backup/Recovery Performance

There are two tests reports in this section. The first one is to measure the sequential read rate of the database files, and the second is to measure the recovery/replay performance (playing transaction logs in to the database).

Database Read-only [Performance](#)

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

MB read/sec per database	126.98
MB read/sec total per server	1523.81

Transaction Log Recovery/Replay [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)	4.46
---	------

Conclusion

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

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

Appendix A: Stress Testing

Microsoft Exchange Server **Jetstress Tool**

Stress Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name WIN-E743M4CDB71

Test Description 500gb nl-sas
4000 users
3gb mailbox size
3 threads
24hr stress test

Test Start Time 5/25/2010 8:27:41 PM

Test End Time 5/26/2010 8:35:24 PM

Collection Start Time 5/25/2010 8:35:08 PM

Collection End Time 5/26/2010 8:34:57 PM

Jetstress Version 14.01.0043.000

Ese Version 14.00.0639.019

Operating System Windows Server 2008 R2 Standard (6.1.7600.0)

Performance Log C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\Stress_2010_5_25_20_28_7.blg
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\DBChecksum_2010_5_26_20_35_24.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 571.07

Target Transactional I/O per Second 400

Initial Database Size (bytes) 12888543330304

Final Database Size (bytes) 12909993000960

Database Files (Count) 12

Jetstress System Parameters

Thread Count 3 (per database)

Minimum Database Cache 384.0 MB

Maximum Database Cache 3072.0 MB

Insert Operations 40%

Delete Operations 20%

Replace Operations 5%

Read Operations 35%

Lazy Commits 70%

Run Background Database Maintenance True
Number of Copies per Database 3

Database Configuration

- Instance2824.1** Log Path: C:\Amnt\Disk1
Database: C:\Amnt\Disk1\Jetstress001001.edb
- Instance2824.2** Log Path: C:\Amnt\Disk2
Database: C:\Amnt\Disk2\Jetstress002001.edb
- Instance2824.3** Log Path: C:\Amnt\Disk3
Database: C:\Amnt\Disk3\Jetstress003001.edb
- Instance2824.4** Log Path: C:\Amnt\Disk4
Database: C:\Amnt\Disk4\Jetstress004001.edb
- Instance2824.5** Log Path: C:\Amnt\Disk5
Database: C:\Amnt\Disk5\Jetstress005001.edb
- Instance2824.6** Log Path: C:\Amnt\Disk6
Database: C:\Amnt\Disk6\Jetstress006001.edb
- Instance2824.7** Log Path: C:\Amnt\Disk7
Database: C:\Amnt\Disk7\Jetstress007001.edb
- Instance2824.8** Log Path: C:\Amnt\Disk8
Database: C:\Amnt\Disk8\Jetstress008001.edb
- Instance2824.9** Log Path: C:\Amnt\Disk9
Database: C:\Amnt\Disk9\Jetstress009001.edb
- Instance2824.10** Log Path: C:\Amnt\Disk10
Database: C:\Amnt\Disk10\Jetstress010001.edb
- Instance2824.11** Log Path: C:\Amnt\Disk11
Database: C:\Amnt\Disk11\Jetstress011001.edb
- Instance2824.12** Log Path: C:\Amnt\Disk12
Database: C:\Amnt\Disk12\Jetstress012001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O DB Reads Avg Latency (msec)	I/O DB Writes Avg Latency (msec)	I/O DB Reads/sec	I/O DB Writes/sec	I/O DB Reads Average Bytes	I/O DB Writes Average Bytes	I/O Log Reads Avg Latency (msec)	I/O Log Writes Avg Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Avg Bytes	I/O Log Writes Avg Bytes
Instance2824.1	17.457	1.592	29.382	18.292	37056.094	36487.898	0.000	0.294	0.000	16.963	0.000	4511.275
Instance2824.2	18.655	1.515	29.392	18.293	36967.542	36481.387	0.000	0.294	0.000	16.974	0.000	4501.068
Instance2824.3	14.345	1.479	29.400	18.304	37636.556	36499.204	0.000	0.263	0.000	16.967	0.000	4525.898
Instance2824.4	15.086	1.422	29.408	18.286	37361.577	36505.203	0.000	0.266	0.000	16.887	0.000	4513.550
Instance2824.5	16.077	1.382	29.261	18.200	37313.951	36534.574	0.000	0.295	0.000	16.840	0.000	4498.520
Instance2824.6	15.124	1.343	29.344	18.251	37705.941	36506.606	0.000	0.276	0.000	16.898	0.000	4504.380
Instance2824.7	15.182	1.295	29.489	18.367	37482.754	36517.377	0.000	0.259	0.000	17.062	0.000	4527.418
Instance2824.8	16.292	1.225	29.182	18.137	37278.578	36522.517	0.000	0.287	0.000	16.862	0.000	4526.761
Instance2824.9	14.460	1.161	29.252	18.195	37512.398	36509.396	0.000	0.281	0.000	16.893	0.000	4536.148
Instance2824.10	14.914	1.079	29.334	18.240	37691.634	36510.361	0.000	0.283	0.000	16.902	0.000	4504.544
Instance2824.11	15.919	1.017	29.104	18.088	37314.895	36540.343	0.000	0.301	0.000	16.783	0.000	4537.661
Instance2824.12	16.517	0.908	29.492	18.376	37135.327	36519.368	0.000	0.258	0.000	17.041	0.000	4510.739

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2824.1	26.511	261759.954
Instance2824.2	26.371	261778.778
Instance2824.3	27.879	261763.421
Instance2824.4	27.440	261757.697
Instance2824.5	27.138	261759.561
Instance2824.6	27.580	261765.917
Instance2824.7	27.379	261768.102
Instance2824.8	26.940	261758.201
Instance2824.9	27.881	261774.445
Instance2824.10	27.684	261748.925
Instance2824.11	27.144	261750.294
Instance2824.12	27.012	261760.076

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2824.1	0.614	119762.851
Instance2824.2	0.612	119330.323
Instance2824.3	0.616	119996.756
Instance2824.4	0.610	119065.557
Instance2824.5	0.608	118252.146
Instance2824.6	0.611	118816.015
Instance2824.7	0.619	120575.596
Instance2824.8	0.612	119533.129
Instance2824.9	0.615	120049.290
Instance2824.10	0.610	118842.029

Instance2824.11	0.611	119308.973
Instance2824.12	0.617	120232.516

Total I/O Performance

MSExchange Database ==> Instances	I/O DB Reads Avg Latency (msec)	I/O DB Writes Avg Latency (msec)	I/O DB Reads/sec	I/O DB Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Avg Latency (msec)	I/O Log Writes Avg Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2824.1	17.457	1.592	55.893	18.292	143638.115	36487.898	4.009	0.294	0.614	16.963	119762.851	4511.275
Instance2824.2	18.655	1.515	55.763	18.293	143282.730	36481.387	4.441	0.294	0.612	16.974	119330.323	4501.068
Instance2824.3	14.345	1.479	57.279	18.304	146723.418	36499.204	3.445	0.263	0.616	16.967	119996.756	4525.898
Instance2824.4	15.086	1.422	56.848	18.286	145675.378	36505.203	3.720	0.266	0.610	16.887	119065.557	4513.550
Instance2824.5	16.077	1.382	56.399	18.200	145311.647	36534.574	3.844	0.295	0.608	16.840	118252.146	4498.520
Instance2824.6	15.124	1.343	56.925	18.251	146263.438	36506.606	4.009	0.276	0.611	16.898	118816.015	4504.380
Instance2824.7	15.182	1.295	56.868	18.367	145463.873	36517.377	3.696	0.259	0.619	17.062	120575.596	4527.418
Instance2824.8	16.292	1.225	56.123	18.137	145034.629	36522.517	4.240	0.287	0.612	16.862	119533.129	4526.761
Instance2824.9	14.460	1.161	57.132	18.195	146952.426	36509.396	3.717	0.281	0.615	16.893	120049.290	4536.148
Instance2824.10	14.914	1.079	57.019	18.240	146479.129	36510.361	3.988	0.283	0.610	16.902	118842.029	4504.544
Instance2824.11	15.919	1.017	56.248	18.088	145622.342	36540.343	4.223	0.301	0.611	16.783	119308.973	4537.661
Instance2824.12	16.517	0.908	56.504	18.376	144517.714	36519.368	3.661	0.258	0.617	17.041	120232.516	4510.739

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.690	0.000	2.619
Available Mbytes	19432.346	19403.000	19734.000
Free System Page Table Entries	33555527.995	33555525.000	33555528.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	55918685.318	55840768.000	56057856.000
Pool Paged Bytes	103802992.551	103473152.000	104091648.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log5/25/2010 8:27:41 PM -- Jetstress testing begins ...
5/25/2010 8:27:41 PM -- Prepare testing begins ...
5/25/2010 8:27:54 PM -- Attaching databases ...
5/25/2010 8:27:54 PM -- Prepare testing ends.
5/25/2010 8:27:54 PM -- Dispatching transactions begins ...
5/25/2010 8:27:54 PM -- Database cache settings: (minimum: 384.0 MB, maximum: 3.0 GB)
5/25/2010 8:27:54 PM -- Database flush thresholds: (start: 30.7 MB, stop: 61.4 MB)
5/25/2010 8:28:07 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
5/25/2010 8:28:07 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
5/25/2010 8:28:18 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
5/25/2010 8:28:18 PM -- Performance logging begins (interval: 15000 ms).
5/25/2010 8:28:18 PM -- Attaining prerequisites:
5/25/2010 8:35:08 PM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 2900435000.0 (lower bound: 2899103000.0, upper bound: none)
5/26/2010 8:35:08 PM -- Performance logging ends.
5/26/2010 8:35:08 PM -- JetInterop batch transaction stats: 127735, 127866, 128329, 127841, 127530, 127820, 128544, 127624, 128162, 127759, 127564 and 128522.
5/26/2010 8:35:08 PM -- Dispatching transactions ends.

5/26/2010 8:35:08 PM -- Shutting down databases ...
5/26/2010 8:35:24 PM -- Instance2824.1 (complete), Instance2824.2 (complete), Instance2824.3 (complete), Instance2824.4 (complete), Instance2824.5 (complete), Instance2824.6 (complete), Instance2824.7 (complete), Instance2824.8 (complete), Instance2824.9 (complete), Instance2824.10 (complete), Instance2824.11 (complete) and Instance2824.12 (complete)
5/26/2010 8:35:25 PM -- Performance logging begins (interval: 30000 ms).
5/26/2010 8:35:25 PM -- Verifying database checksums ...
5/26/2010 11:08:00 PM -- C:\Amnt\Disk1 (100% processed), C:\Amnt\Disk2 (100% processed), C:\Amnt\Disk3 (100% processed), C:\Amnt\Disk4 (100% processed), C:\Amnt\Disk5 (100% processed), C:\Amnt\Disk6 (100% processed), C:\Amnt\Disk7 (100% processed), C:\Amnt\Disk8 (100% processed), C:\Amnt\Disk9 (100% processed), C:\Amnt\Disk10 (100% processed), C:\Amnt\Disk11 (100% processed) and C:\Amnt\Disk12 (100% processed)
5/26/2010 11:08:00 PM -- Performance logging ends.
5/26/2010 11:08:00 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\DBChecksum_2010_5_26_20_35_24.blg](#) has 285 samples.
5/26/2010 11:08:05 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\DBChecksum_2010_5_26_20_35_24.html](#) is saved.
5/26/2010 11:08:05 PM -- Verifying log checksums ...
5/26/2010 11:08:06 PM -- C:\Amnt\Disk1 (11 log(s) processed), C:\Amnt\Disk2 (10 log(s) processed), C:\Amnt\Disk3 (9 log(s) processed), C:\Amnt\Disk4 (12 log(s) processed), C:\Amnt\Disk5 (10 log(s) processed), C:\Amnt\Disk6 (10 log(s) processed), C:\Amnt\Disk7 (9 log(s) processed), C:\Amnt\Disk8 (11 log(s) processed), C:\Amnt\Disk9 (11 log(s) processed), C:\Amnt\Disk10 (11 log(s) processed), C:\Amnt\Disk11 (10 log(s) processed) and C:\Amnt\Disk12 (11 log(s) processed)
5/26/2010 11:08:06 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\Stress_2010_5_25_20_28_7.blg](#) has 5777 samples.
5/26/2010 11:08:06 PM -- Creating test report ...
5/26/2010 11:08:57 PM -- Instance2824.1 has 17.5 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.1 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.1 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.2 has 18.7 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.2 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.2 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.3 has 14.3 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.3 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.3 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.4 has 15.1 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.4 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.4 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.5 has 16.1 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.5 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.5 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.6 has 15.1 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.6 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.6 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.7 has 15.2 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.7 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.7 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.8 has 16.3 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.8 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.8 has 0.3 for I/O Log Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.9 has 14.5 for I/O Database Reads Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.9 has 0.3 for I/O Log Writes Average Latency.
5/26/2010 11:08:57 PM -- Instance2824.9 has 0.3 for I/O Log Reads Average Latency.

5/26/2010 11:08:57 PM -- Instance2824.10 has 14.9 for I/O Database Reads Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.10 has 0.3 for I/O Log Writes Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.10 has 0.3 for I/O Log Reads Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.11 has 15.9 for I/O Database Reads Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.11 has 0.3 for I/O Log Writes Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.11 has 0.3 for I/O Log Reads Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.12 has 16.5 for I/O Database Reads Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.12 has 0.3 for I/O Log Writes Average Latency.
 5/26/2010 11:08:57 PM -- Instance2824.12 has 0.3 for I/O Log Reads Average Latency.
 5/26/2010 11:08:57 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 5/26/2010 11:08:57 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 5/26/2010 11:08:57 PM --
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_24hrs\Stress_2010_5_25_20_28_7.xml has 5749 samples queried.

Appendix B: Performance Testing

Microsoft Exchange Server **Jetstress Tool**

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name WIN-E743M4CDB7I

Test Description 500gb nl-sas
 4000 users
 3gb mailbox size
 3 threads
 2hr performance run

Test Start Time 5/27/2010 12:16:42 PM

Test End Time 5/27/2010 2:24:19 PM

Collection Start Time 5/27/2010 12:24:02 PM

Collection End Time 5/27/2010 2:24:00 PM

Jetstress Version 14.01.0043.000

Ese Version 14.00.0639.019

Operating System Windows Server 2008 R2 Standard (6.1.7600.0)

Performance Log C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\Performance_2010_5_27_12_17_7.blg
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\DBChecksum_2010_5_27_14_24_19.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 580.229

Target Transactional I/O per Second 400

Initial Database Size (bytes) 12912316645376

Final Database Size (bytes) 12914229248000
Database Files (Count) 12

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 384.0 MB
Maximum Database Cache 3072.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 3

Database Configuration

Instance3212.1 Log Path: C:\Amnt\Disk1
Database: C:\Amnt\Disk1\Jetstress001001.edb

Instance3212.2 Log Path: C:\Amnt\Disk2
Database: C:\Amnt\Disk2\Jetstress002001.edb

Instance3212.3 Log Path: C:\Amnt\Disk3
Database: C:\Amnt\Disk3\Jetstress003001.edb

Instance3212.4 Log Path: C:\Amnt\Disk4
Database: C:\Amnt\Disk4\Jetstress004001.edb

Instance3212.5 Log Path: C:\Amnt\Disk5
Database: C:\Amnt\Disk5\Jetstress005001.edb

Instance3212.6 Log Path: C:\Amnt\Disk6
Database: C:\Amnt\Disk6\Jetstress006001.edb

Instance3212.7 Log Path: C:\Amnt\Disk7
Database: C:\Amnt\Disk7\Jetstress007001.edb

Instance3212.8 Log Path: C:\Amnt\Disk8
Database: C:\Amnt\Disk8\Jetstress008001.edb

Instance3212.9 Log Path: C:\Amnt\Disk9
Database: C:\Amnt\Disk9\Jetstress009001.edb

Instance3212.10 Log Path: C:\Amnt\Disk10
Database: C:\Amnt\Disk10\Jetstress010001.edb

Instance3212.11 Log Path: C:\Amnt\Disk11

Database: C:\Amnt\Disk11\Jetstress011001.edb

Instance3212.12 Log Path: C:\Amnt\Disk12

Database: C:\Amnt\Disk12\Jetstress012001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O DB Reads Avg Latency (msec)	I/O DB Writes Avg Latency (msec)	I/O DB Reads/sec	I/O DB Writes/sec	I/O DB Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Avg Latency (msec)	I/O Log Writes Avg Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3212.1	15.709	1.582	29.789	18.488	37437.919	35928.770	0.000	0.288	0.000	16.708	0.000	4528.982
Instance3212.2	17.660	1.490	29.793	18.555	36981.423	35948.553	0.000	0.280	0.000	16.799	0.000	4526.953
Instance3212.3	13.650	1.453	29.408	18.374	37913.317	35852.153	0.000	0.304	0.000	16.572	0.000	4485.806
Instance3212.4	14.377	1.392	29.572	18.323	37740.012	35976.919	0.000	0.279	0.000	16.853	0.000	4499.544
Instance3212.5	15.390	1.373	29.824	18.659	37595.001	35972.200	0.000	0.273	0.000	16.783	0.000	4547.645
Instance3212.6	14.189	1.317	29.758	18.470	37338.440	36124.475	0.000	0.286	0.000	16.951	0.000	4610.864
Instance3212.7	13.839	1.279	30.184	18.707	37395.894	35972.895	0.000	0.256	0.000	16.794	0.000	4477.934
Instance3212.8	14.860	1.206	29.869	18.688	37077.179	35921.264	0.000	0.256	0.000	16.894	0.000	4537.810
Instance3212.9	15.019	1.144	29.946	18.812	38087.165	36001.617	0.000	0.230	0.000	16.922	0.000	4553.036
Instance3212.10	14.280	1.067	29.792	18.678	37195.114	35964.915	0.000	0.236	0.000	16.754	0.000	4524.640
Instance3212.11	14.088	1.008	29.553	18.466	37512.338	35997.668	0.000	0.282	0.000	16.732	0.000	4579.071
Instance3212.12	15.681	0.890	29.862	18.662	37630.176	35919.004	0.000	0.252	0.000	16.954	0.000	4520.777

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3212.1	27.763	261813.232
Instance3212.2	27.114	261821.456
Instance3212.3	28.409	261753.956
Instance3212.4	28.175	261771.107
Instance3212.5	27.853	261814.813
Instance3212.6	28.245	261835.216
Instance3212.7	28.358	261840.558
Instance3212.8	27.979	261839.163
Instance3212.9	27.830	261838.679
Instance3212.10	28.250	261854.532
Instance3212.11	28.338	261791.407
Instance3212.12	27.658	261805.275

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance3212.1	0.608	117980.192
Instance3212.2	0.610	118899.135
Instance3212.3	0.595	115552.616
Instance3212.4	0.608	118016.800
Instance3212.5	0.610	119334.279

Instance3212.6	0.625	121452.014
Instance3212.7	0.603	117009.162
Instance3212.8	0.610	119341.990
Instance3212.9	0.620	120711.631
Instance3212.10	0.608	118284.055
Instance3212.11	0.613	118951.222
Instance3212.12	0.610	119355.299

Total I/O Performance

MSExchange Database ==> Instances	I/O DB Reads Avg Latency (msec)	I/O DB Writes Avg Latency (msec)	I/O DB Reads /sec	I/O DB Writes/sec	I/O DB Reads Avg Bytes	I/O DB Writes Avg Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads /sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3212.1	15.709	1.582	57.551	18.488	145676.228	35928.770	4.423	0.288	0.608	16.708	117980.192	4528.982
Instance3212.2	17.660	1.490	56.907	18.555	144108.984	35948.553	4.404	0.280	0.610	16.799	118899.135	4526.953
Instance3212.3	13.650	1.453	57.817	18.374	147898.924	35852.153	3.142	0.304	0.595	16.572	115552.616	4485.806
Instance3212.4	14.377	1.392	57.747	18.323	147046.402	35976.919	4.482	0.279	0.608	16.853	118016.800	4499.544
Instance3212.5	15.390	1.373	57.677	18.659	145873.645	35972.200	3.720	0.273	0.610	16.783	119334.279	4547.645
Instance3212.6	14.189	1.317	58.004	18.470	146658.755	36124.475	3.779	0.286	0.625	16.951	121452.014	4610.864
Instance3212.7	13.839	1.279	58.541	18.707	146117.716	35972.895	3.391	0.256	0.603	16.794	117009.162	4477.934
Instance3212.8	14.860	1.206	57.848	18.688	145786.073	35921.264	3.697	0.256	0.610	16.894	119341.990	4537.810
Instance3212.9	15.019	1.144	57.777	18.812	145865.454	36001.617	3.245	0.230	0.620	16.922	120711.631	4553.036
Instance3212.10	14.280	1.067	58.042	18.678	146540.808	35964.915	3.809	0.236	0.608	16.754	118284.055	4524.640
Instance3212.11	14.088	1.008	57.891	18.466	147299.178	35997.668	3.406	0.282	0.613	16.732	118951.222	4579.071
Instance3212.12	15.681	0.890	57.520	18.662	145422.647	35919.004	3.212	0.252	0.610	16.954	119355.299	4520.777

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.645	0.000	2.570
Available Mbytes	19400.492	19368.000	19667.000
Free System Page Table Entries	33555529.648	33555528.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	56509875.200	56496128.000	56541184.000
Pool Paged Bytes	109673437.867	109109248.000	137019392.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log5/27/2010 12:16:42 PM -- Jetstress testing begins ...

5/27/2010 12:16:42 PM -- Prepare testing begins ...

5/27/2010 12:16:54 PM -- Attaching databases ...

5/27/2010 12:16:54 PM -- Prepare testing ends.

5/27/2010 12:16:54 PM -- Dispatching transactions begins ...

5/27/2010 12:16:54 PM -- Database cache settings: (minimum: 384.0 MB, maximum: 3.0 GB)

5/27/2010 12:16:54 PM -- Database flush thresholds: (start: 30.7 MB, stop: 61.4 MB)

5/27/2010 12:17:07 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

5/27/2010 12:17:07 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

5/27/2010 12:17:18 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

5/27/2010 12:17:18 PM -- Performance logging begins (interval: 15000 ms).

5/27/2010 12:17:18 PM -- Attaining prerequisites:
5/27/2010 12:24:02 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 2902589000.0 (lower bound: 2899103000.0, upper bound: none)
5/27/2010 2:24:03 PM -- Performance logging ends.
5/27/2010 2:24:03 PM -- JetInterop batch transaction stats: 11210, 11167, 11089, 11088, 11210, 11089, 11237, 11258, 11319, 11285, 11090 and 11235.
5/27/2010 2:24:03 PM -- Dispatching transactions ends.
5/27/2010 2:24:03 PM -- Shutting down databases ...
5/27/2010 2:24:19 PM -- Instance3212.1 (complete), Instance3212.2 (complete), Instance3212.3 (complete), Instance3212.4 (complete), Instance3212.5 (complete), Instance3212.6 (complete), Instance3212.7 (complete), Instance3212.8 (complete), Instance3212.9 (complete), Instance3212.10 (complete), Instance3212.11 (complete) and Instance3212.12 (complete)
5/27/2010 2:24:20 PM -- Performance logging begins (interval: 30000 ms).
5/27/2010 2:24:20 PM -- Verifying database checksums ...
5/27/2010 4:56:18 PM -- C:\Amnt\Disk1 (100% processed), C:\Amnt\Disk2 (100% processed), C:\Amnt\Disk3 (100% processed), C:\Amnt\Disk4 (100% processed), C:\Amnt\Disk5 (100% processed), C:\Amnt\Disk6 (100% processed), C:\Amnt\Disk7 (100% processed), C:\Amnt\Disk8 (100% processed), C:\Amnt\Disk9 (100% processed), C:\Amnt\Disk10 (100% processed), C:\Amnt\Disk11 (100% processed) and C:\Amnt\Disk12 (100% processed)
5/27/2010 4:56:18 PM -- Performance logging ends.
5/27/2010 4:56:18 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\DBChecksum_2010_5_27_14_24_19.blg](#) has 284 samples.
5/27/2010 4:56:23 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\DBChecksum_2010_5_27_14_24_19.html](#) is saved.
5/27/2010 4:56:23 PM -- Verifying log checksums ...
5/27/2010 4:56:24 PM -- C:\Amnt\Disk1 (11 log(s) processed), C:\Amnt\Disk2 (11 log(s) processed), C:\Amnt\Disk3 (10 log(s) processed), C:\Amnt\Disk4 (11 log(s) processed), C:\Amnt\Disk5 (10 log(s) processed), C:\Amnt\Disk6 (12 log(s) processed), C:\Amnt\Disk7 (12 log(s) processed), C:\Amnt\Disk8 (11 log(s) processed), C:\Amnt\Disk9 (9 log(s) processed), C:\Amnt\Disk10 (9 log(s) processed), C:\Amnt\Disk11 (11 log(s) processed) and C:\Amnt\Disk12 (9 log(s) processed)
5/27/2010 4:56:24 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\Performance_2010_5_27_12_17_7.blg](#) has 506 samples.
5/27/2010 4:56:24 PM -- Creating test report ...
5/27/2010 4:56:29 PM -- Instance3212.1 has 15.7 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.1 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.1 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.2 has 17.7 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.2 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.2 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.3 has 13.6 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.3 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.3 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.4 has 14.4 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.4 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.4 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.5 has 15.4 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.5 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.5 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.6 has 14.2 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.6 has 0.3 for I/O Log Writes Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.6 has 0.3 for I/O Log Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.7 has 13.8 for I/O Database Reads Average Latency.
5/27/2010 4:56:29 PM -- Instance3212.7 has 0.3 for I/O Log Writes Average Latency.

5/27/2010 4:56:29 PM -- Instance3212.7 has 0.3 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.8 has 14.9 for I/O Database Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.8 has 0.3 for I/O Log Writes Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.8 has 0.3 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.9 has 15.0 for I/O Database Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.9 has 0.2 for I/O Log Writes Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.9 has 0.2 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.10 has 14.3 for I/O Database Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.10 has 0.2 for I/O Log Writes Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.10 has 0.2 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.11 has 14.1 for I/O Database Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.11 has 0.3 for I/O Log Writes Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.11 has 0.3 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.12 has 15.7 for I/O Database Reads Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.12 has 0.3 for I/O Log Writes Average Latency.
 5/27/2010 4:56:29 PM -- Instance3212.12 has 0.3 for I/O Log Reads Average Latency.
 5/27/2010 4:56:29 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 5/27/2010 4:56:29 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 5/27/2010 4:56:29 PM --
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_2hrs\Performance_2010_5_27_12_17_7.xml has 479 samples queried.

Appendix C Backup Testing

Database backup Test Result Report

Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance1712.1	1026330.09	02:15:13	126.50
Instance1712.2	1026322.09	02:15:45	126.00
Instance1712.3	1026322.09	02:14:15	127.41
Instance1712.4	1026314.09	02:12:39	128.93
Instance1712.5	1026306.09	02:19:01	123.03
Instance1712.6	1026322.09	02:13:50	127.80
Instance1712.7	1026338.09	02:12:11	129.40
Instance1712.8	1026314.09	02:14:13	127.44
Instance1712.9	1026338.09	02:13:04	128.53
Instance1712.10	1026314.09	02:15:10	126.54
Instance1712.11	1026322.09	02:13:33	128.08
Instance1712.12	1026330.09	02:17:47	124.15

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 384.0 MB
Maximum Database Cache 3072.0 MB
Insert Operations 40%

Delete Operations	20%
Replace Operations	5%
Read Operations	35%
Lazy Commits	70%

Database Configuration

Instance1712.1 Log Path: C:\Amnt\Disk1
Database: C:\Amnt\Disk1\Jetstress001001.edb

Instance1712.2 Log Path: C:\Amnt\Disk2
Database: C:\Amnt\Disk2\Jetstress002001.edb

Instance1712.3 Log Path: C:\Amnt\Disk3
Database: C:\Amnt\Disk3\Jetstress003001.edb

Instance1712.4 Log Path: C:\Amnt\Disk4
Database: C:\Amnt\Disk4\Jetstress004001.edb

Instance1712.5 Log Path: C:\Amnt\Disk5
Database: C:\Amnt\Disk5\Jetstress005001.edb

Instance1712.6 Log Path: C:\Amnt\Disk6
Database: C:\Amnt\Disk6\Jetstress006001.edb

Instance1712.7 Log Path: C:\Amnt\Disk7
Database: C:\Amnt\Disk7\Jetstress007001.edb

Instance1712.8 Log Path: C:\Amnt\Disk8
Database: C:\Amnt\Disk8\Jetstress008001.edb

Instance1712.9 Log Path: C:\Amnt\Disk9
Database: C:\Amnt\Disk9\Jetstress009001.edb

Instance1712.10 Log Path: C:\Amnt\Disk10
Database: C:\Amnt\Disk10\Jetstress010001.edb

Instance1712.11 Log Path: C:\Amnt\Disk11
Database: C:\Amnt\Disk11\Jetstress011001.edb

Instance1712.12 Log Path: C:\Amnt\Disk12
Database: C:\Amnt\Disk12\Jetstress012001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance1712.1	2.925	0.000	505.937	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.2	2.972	0.000	504.023	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.3	2.945	0.000	509.711	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.4	2.909	0.000	515.816	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.5	3.005	0.000	492.186	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.6	2.906	0.000	511.328	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.7	2.882	0.000	517.624	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.8	2.931	0.000	509.778	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.9	2.918	0.000	514.304	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.10	2.957	0.000	506.189	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.11	2.926	0.000	512.488	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance1712.12	2.992	0.000	496.588	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.215	0.321	4.064
Available Mbytes	22640.238	22630.000	22642.000
Free System Page Table Entries	33555528.412	33555528.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	56602150.816	56598528.000	56614912.000
Pool Paged Bytes	109977807.018	109563904.000	110133248.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log5/27/2010 8:36:56 PM -- Jetstress testing begins ...
 5/27/2010 8:36:56 PM -- Prepare testing begins ...
 5/27/2010 8:37:08 PM -- Attaching databases ...
 5/27/2010 8:37:08 PM -- Prepare testing ends.
 5/27/2010 8:37:27 PM -- Performance logging begins (interval: 30000 ms).
 5/27/2010 8:37:27 PM -- Backing up databases ...
 5/27/2010 10:56:28 PM -- Performance logging ends.
 5/27/2010 10:56:28 PM -- Instance1712.1 (100% processed), Instance1712.2 (100% processed), Instance1712.3 (100% processed), Instance1712.4 (100% processed), Instance1712.5 (100% processed), Instance1712.6 (100% processed), Instance1712.7 (100% processed), Instance1712.8 (100% processed), Instance1712.9 (100% processed), Instance1712.10 (100% processed), Instance1712.11 (100% processed) and Instance1712.12 (100% processed)
 5/27/2010 10:56:28 PM --
[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_dbbackup\DatabaseBackup_2010_5_27_20_37_8.blg](#) has 277 samples.
 5/27/2010 10:56:28 PM -- Creating test report ...

Appendix D Soft Recovery Testing

SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance3820.1	504	2220.8043007
Instance3820.2	510	2382.8417853
Instance3820.3	506	2188.4498439
Instance3820.4	505	2161.6645968
Instance3820.5	502	2291.0824241
Instance3820.6	505	2252.893557
Instance3820.7	507	2314.6852656
Instance3820.8	504	2236.4511282
Instance3820.9	514	2215.5002914
Instance3820.10	511	2333.7796991
Instance3820.11	500	2244.4071421
Instance3820.12	511	2272.783592

Database Configuration

Instance3820.1 Log Path: C:\Amnt\Disk1
Database: C:\Amnt\Disk1\Jetstress001001.edb

Instance3820.2 Log Path: C:\Amnt\Disk2
Database: C:\Amnt\Disk2\Jetstress002001.edb

Instance3820.3 Log Path: C:\Amnt\Disk3
Database: C:\Amnt\Disk3\Jetstress003001.edb

Instance3820.4 Log Path: C:\Amnt\Disk4
Database: C:\Amnt\Disk4\Jetstress004001.edb

Instance3820.5 Log Path: C:\Amnt\Disk5
Database: C:\Amnt\Disk5\Jetstress005001.edb

Instance3820.6 Log Path: C:\Amnt\Disk6
Database: C:\Amnt\Disk6\Jetstress006001.edb

Instance3820.7 Log Path: C:\Amnt\Disk7
Database: C:\Amnt\Disk7\Jetstress007001.edb

Instance3820.8 Log Path: C:\Amnt\Disk8
Database: C:\Amnt\Disk8\Jetstress008001.edb

Instance3820.9 Log Path: C:\Amnt\Disk9
Database: C:\Amnt\Disk9\Jetstress009001.edb

Instance3820.10 Log Path: C:\Amnt\Disk10
 Database: C:\Amnt\Disk10\Jetstress010001.edb

Instance3820.11 Log Path: C:\Amnt\Disk11
 Database: C:\Amnt\Disk11\Jetstress011001.edb

Instance3820.12 Log Path: C:\Amnt\Disk12
 Database: C:\Amnt\Disk12\Jetstress012001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Avg Bytes	I/O Log Writes Avg Bytes
Instance3820.1	914.481	66.465	127.104	1.363	38195.399	32172.218	29.669	0.002	2.045	0.001	208517.650	0.931
Instance3820.2	1043.850	61.520	117.663	1.284	38118.129	32047.215	34.523	0.000	1.926	0.001	199901.882	0.866
Instance3820.3	881.021	55.124	127.306	1.388	38087.255	32164.538	30.605	0.005	2.084	0.005	211168.492	1.886
Instance3820.4	851.029	68.491	130.161	1.402	38112.139	32401.194	26.743	0.007	2.105	0.003	212124.923	1.910
Instance3820.5	989.416	60.695	121.896	1.312	38074.275	32018.028	28.778	0.000	1.969	0.000	204423.562	0.000
Instance3820.6	892.356	46.296	125.538	1.341	38216.414	32180.760	44.028	0.000	2.012	0.000	208255.535	0.000
Instance3820.7	983.625	56.119	120.593	1.314	38153.019	32368.390	33.893	0.001	1.971	0.001	207185.385	0.892
Instance3820.8	933.070	76.427	124.977	1.354	38080.769	31999.076	28.554	0.383	2.030	0.001	206653.979	0.924
Instance3820.9	947.933	53.401	126.611	1.393	38290.327	32588.940	34.892	0.001	2.090	0.001	213982.816	0.933
Instance3820.10	1005.534	60.379	120.465	1.313	38245.439	32257.772	33.482	0.000	1.969	0.000	203562.345	0.000
Instance3820.11	947.682	62.779	125.010	1.335	38099.354	32296.518	29.538	0.000	2.003	0.000	202293.567	0.000
Instance3820.12	926.555	69.180	123.846	1.348	38195.918	32011.368	25.674	0.000	2.022	0.000	207725.424	0.000

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3820.1	0.000	0.000
Instance3820.2	0.000	0.000
Instance3820.3	0.000	0.000
Instance3820.4	0.000	0.000
Instance3820.5	0.000	0.000
Instance3820.6	0.000	0.000
Instance3820.7	0.000	0.000
Instance3820.8	0.000	0.000
Instance3820.9	0.000	0.000
Instance3820.10	0.000	0.000
Instance3820.11	0.000	0.000
Instance3820.12	0.000	0.000

Total I/O Performance

MSExchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3820.1	914.481	66.465	127.104	1.363	38195.399	32172.218	29.669	0.002	2.045	0.001	208517.650	0.931
Instance3820.2	1043.850	61.520	117.663	1.284	38118.129	32047.215	34.523	0.000	1.926	0.001	199901.882	0.866
Instance3820.3	881.021	55.124	127.306	1.388	38087.255	32164.538	30.605	0.005	2.084	0.005	211168.492	1.886
Instance3820.4	851.029	68.491	130.161	1.402	38112.139	32401.194	26.743	0.007	2.105	0.003	212124.923	1.910
Instance3820.5	989.416	60.695	121.896	1.312	38074.275	32018.028	28.778	0.000	1.969	0.000	204423.562	0.000
Instance3820.6	892.356	46.296	125.538	1.341	38216.414	32180.760	44.028	0.000	2.012	0.000	208255.535	0.000
Instance3820.7	983.625	56.119	120.593	1.314	38153.019	32368.390	33.893	0.001	1.971	0.001	207185.385	0.892
Instance3820.8	933.070	76.427	124.977	1.354	38080.769	31999.076	28.554	0.383	2.030	0.001	206653.979	0.924
Instance3820.9	947.933	53.401	126.611	1.393	38290.327	32588.940	34.892	0.001	2.090	0.001	213982.816	0.933
Instance3820.10	1005.534	60.379	120.465	1.313	38245.439	32257.772	33.482	0.000	1.969	0.000	203562.345	0.000
Instance3820.11	947.682	62.779	125.010	1.335	38099.354	32296.518	29.538	0.000	2.003	0.000	202293.567	0.000
Instance3820.12	926.555	69.180	123.846	1.348	38195.918	32011.368	25.674	0.000	2.022	0.000	207725.424	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.201	0.000	6.783
Available Mbytes	19461.775	19374.000	22444.000
Free System Page Table Entries	33555529.736	33555525.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	69288392.649	57446400.000	71106560.000
Pool Paged Bytes	111229052.541	111202304.000	111333376.000
Database Page Fault Stalls/sec	0.000	0.000	0.249

Test Log5/28/2010 3:29:08 PM -- Jetstress testing begins ...

5/28/2010 3:29:09 PM -- Prepare testing begins ...

5/28/2010 3:29:21 PM -- Attaching databases ...

5/28/2010 3:29:21 PM -- Prepare testing ends.

5/28/2010 3:29:21 PM -- Dispatching transactions begins ...

5/28/2010 3:29:21 PM -- Database cache settings: (minimum: 384.0 MB, maximum: 3.0 GB)

5/28/2010 3:29:21 PM -- Database flush thresholds: (start: 30.7 MB, stop: 61.4 MB)

5/28/2010 3:29:34 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

5/28/2010 3:29:34 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

5/28/2010 3:29:40 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

5/28/2010 3:29:40 PM -- Performance logging begins (interval: 15000 ms).

5/28/2010 3:29:40 PM -- Generating log files ...

5/28/2010 7:04:12 PM -- C:\Amnt\Disk1 (101.0% generated), C:\Amnt\Disk2 (102.2% generated), C:\Amnt\Disk3 (101.4% generated), C:\Amnt\Disk4 (101.2% generated), C:\Amnt\Disk5 (100.6% generated), C:\Amnt\Disk6 (101.2% generated), C:\Amnt\Disk7 (101.6% generated), C:\Amnt\Disk8 (101.0% generated), C:\Amnt\Disk9 (103.0% generated), C:\Amnt\Disk10 (102.4% generated), C:\Amnt\Disk11 (100.2% generated) and C:\Amnt\Disk12 (102.4% generated)

5/28/2010 7:04:12 PM -- Performance logging ends.

5/28/2010 7:04:12 PM -- JetInterop batch transaction stats: 22080, 22264, 21944, 22195, 21923, 22044, 21948, 21987, 22442, 22278, 22020 and 22238.

5/28/2010 7:04:12 PM -- Dispatching transactions ends.
5/28/2010 7:04:12 PM -- Shutting down databases ...
5/28/2010 7:04:29 PM -- Instance3820.1 (complete), Instance3820.2 (complete),
Instance3820.3 (complete), Instance3820.4 (complete), Instance3820.5 (complete),
Instance3820.6 (complete), Instance3820.7 (complete), Instance3820.8 (complete),
Instance3820.9 (complete), Instance3820.10 (complete), Instance3820.11 (complete) and
Instance3820.12 (complete)
5/28/2010 7:04:29 PM --
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_softrecov\Performance_2010_5_28_15_29_34.blg has 856 samples.
5/28/2010 7:04:29 PM -- Creating test report ...
5/28/2010 7:04:34 PM -- Instance3820.1 has 18.4 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.1 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.1 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.2 has 20.4 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.2 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.2 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.3 has 15.9 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.3 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.3 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.4 has 16.5 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.4 has 0.2 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.4 has 0.2 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.5 has 18.3 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.5 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.5 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.6 has 17.2 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.6 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.6 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.7 has 16.2 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.7 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.7 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.8 has 17.0 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.8 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.8 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.9 has 16.8 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.9 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.9 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.10 has 16.6 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.10 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.10 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.11 has 16.9 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.11 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.11 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.12 has 17.9 for I/O Database Reads Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.12 has 0.3 for I/O Log Writes Average Latency.
5/28/2010 7:04:34 PM -- Instance3820.12 has 0.3 for I/O Log Reads Average Latency.
5/28/2010 7:04:34 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/28/2010 7:04:34 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/28/2010 7:04:34 PM --
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_softrecov\Performance_2010_5_28_15_29_34.xml has 855 samples queried.
5/28/2010 7:04:34 PM --
C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_softrecov\Performance_2010_5_28_15_29_34.html is saved.
5/28/2010 7:04:40 PM -- Performance logging begins (interval: 4000 ms).
5/28/2010 7:04:40 PM -- Recovering databases ...
5/28/2010 7:44:23 PM -- Performance logging ends.
5/28/2010 7:44:23 PM -- Instance3820.1 (2220.8043007), Instance3820.2 (2382.8417853),

Instance3820.3 (2188.4498439), Instance3820.4 (2161.6645968), Instance3820.5 (2291.0824241), Instance3820.6 (2252.893557), Instance3820.7 (2314.6852656), Instance3820.8 (2236.4511282), Instance3820.9 (2215.5002914), Instance3820.10 (2333.7796991), Instance3820.11 (2244.4071421) and Instance3820.12 (2272.783592)
5/28/2010 7:44:23 PM --

[C:\Jetstress\results\4000users_3gbmailbox_3threads_1mbp_softrecov\SoftRecovery_2010_5_28_19_4_34.blg](#) has 592 samples.

5/28/2010 7:44:23 PM -- Creating test report ...