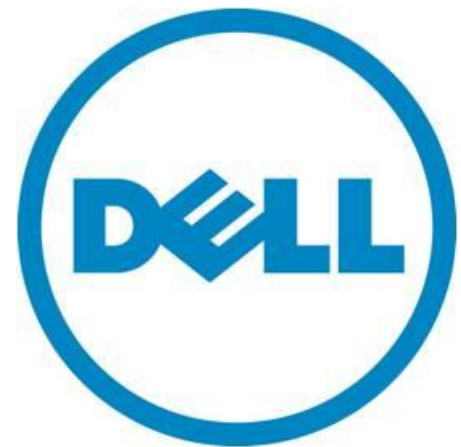


Dell™ PowerEdge™ R510
Near line SAS
1100 Mailboxes using Mailbox
Resiliency
Exchange 2010 Storage Solution



Tested with: ESRP – Storage Version 3.0
Tested Date: September 25, 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 1100 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 8 3.5-inch, hot-plug, 6.0-Gbps, serial-attached SCSI (SAS) or Nearline-SAS (NL-SAS) hard drives. 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 a total of (8) 3.5" drives. The solution presented in this paper utilizes two front loading bays that house two (2) 500GB NL-SAS drives where Windows 2008 R2 was installed. Six (6) 2TB NL-SAS drives filled the remaining six (6) drive bays that housed two Exchange Databases and their transaction logs.

Solution Description

The Dell™ PowerEdge™ R510 is a high capacity/high value rack server with balance of internal storage of up to (8) 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 (8) 3.5-inch drives bays

PERC™ H700 is the internal host-based RAID controller used to connect to the PowerEdge™ R510 front loading backplane that supports the eight (8) drive bays. 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 1100 mailboxes. It includes a single primary PowerEdge™ R510 server that supports (8) front loading 3.5” disk drives. 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 0.15 IOPS per user with a 4096 MB mailbox size. This IO profile for Exchange 2010 represents about 150 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 20% more than the target of 165 IOPS. One six (6) disk RAID 10 virtual drive was 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;5670@2.93GHz
Memory	64 GB DDR2 ECC
NIC	Broadcom NeXtreme II
RAID Controller	PERC H700 (FW Version:2.0.03-0772)

Built in Storage System:

Storage System	Dell™ PowerEdge™ R510
Disks for Operating System:	2 Seagate 500GB 7.2k RPM NL-SAS (ST3500414SS)
Disks used for DAG setup:	6 Seagate 2TB 7.2K RPM NL-SAS (ST32000444SS) Drives
RAID Controller	PERC H700 (4.5.0.64)

Storage Configuration:

The storage configuration per system was as follows:

- Two (2) RAID 1 500GB NL-SAS drives used for Operating System Install
- A single RAID 10 volume was created from six (6) physical disks from slot 2 through slot 7 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 : 1,100
- Number of hosts attached to the storage system: 1
- User IO profile: 0.15 I/O Operation per second
- 4096 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	1100
Number of Database Availability Groups (DAGs)	1
Number of servers/DAG	2
Number of active mailboxes/server	1100
Number of databases/host	2
Number of copies/database	2
Number of mailboxes/database	550
Simulated profile: I/O's per second per mailbox (IOPS, include 20% headroom)	0.15
Database LUN size	6114 GB
Log LUN size	N/A
Total database size for performance testing	4,409 GB
% storage capacity used by Exchange database**	78.9%

**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 12.3.0-0032, A02
Storage cache	512MB – PERC H700 RAID controller cache
Number of storage controllers	1
Number of storage ports	2
Maximum bandwidth of storage	6GBit

connectivity to host	
Switch type/model/firmware revision	N/A
HBA model and firmware	PERC H700 (12.3.0-0032, A02)
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	6 total
Maximum number of spindles can be hosted in server	8 total

Storage Software

HBA driver	Dell™ PERC H700 (4.5.0.64)
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)

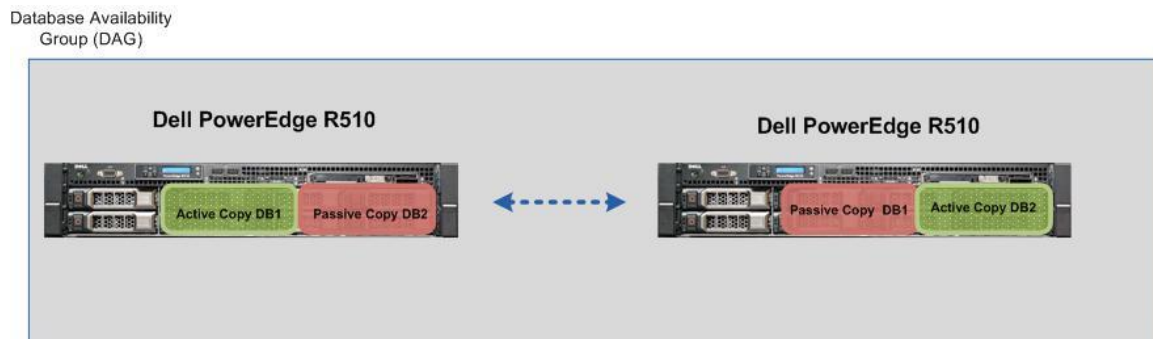
Disk type, speed and firmware revision	Seagate 2TB 7.2K RPM NL-SAS (ST32000444SS) Drives
Raw capacity per disk (GB)	2048GB
Number of physical disks in test	6
Total raw storage capacity (GB)	6,114 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	1
Raid level	RAID 10
Total formatted capacity	5587 GB
Storage capacity utilization	91.38%
Database capacity utilization	72.11%

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 2 active database copies and 2 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](#) 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	202.999
Total Database Disks Reads/sec	129.188
Total Database Disks Writes/sec	73.812
Average Database Disk Read Latency (ms)	18.108
Average Database Disk Write Latency (ms)	.381
Transaction Log I/O	
Log Disks Writes/sec	34.8855
Average Log Disk Write Latency (ms)	.1595

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	341.255
MB read/sec total per server	682.51

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)	2.99
---	------

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-2BRU9VH1I4E
Test Description	1100 Mailboxes .15 4096 Mailbox Size 3 threads
Test Start Time	9/21/2010 7:43:13 PM
Test End Time	9/22/2010 7:46:08 PM
Collection Start Time	9/21/2010 7:46:01 PM
Collection End Time	9/22/2010 7:45:50 PM
Jetstress Version	14.01.0043.000
Ese Version	14.00.0639.019
Operating System	Windows Server 2008 R2 Enterprise (6.1.7600.0)
Performance Log	C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\Stress_2010_9_21_19_43_18.blg

C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\DBChecksum_2010_9_22_19_46_8.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 208.595
Target Transactional I/O per Second 165
Initial Database Size (bytes) 4725873442816
Final Database Size (bytes) 4733087645696
Database Files (Count) 2

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 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 2

Database Configuration

Instance1948.1 Log Path: C:\drive1\database1
Database: C:\drive1\database1\Jetstress001001.edb

Instance1948.2 Log Path: C:\drive1\database2
Database: C:\drive1\database2\Jetstress002001.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
Instance1948.1	18.128	0.413	65.802	38.197	33879.627	35821.514	0.000	0.152	0.000	465	00	18.146
Instance1948.2	17.309	0.407	66.174	38.422	34051.581	35824.463	0.000	0.153	0.000	557	00	16.666

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Average Bytes
Instance1948.1	26.070	261961.640
Instance1948.2	26.273	261962.842

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance1948.1	0.619	216727.697
Instance1948.2	0.620	215539.485

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
Instance1948.1	18.128	0.413	91.872	38.197	98600.270	35821.514	1.065	0.152	0.619	34.465	216727.697	4448.146
Instance1948.2	17.309	0.407	92.447	38.422	98822.824	35824.463	0.985	0.153	0.620	34.557	215539.485	4446.666

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.306	0.000	1.910
Available MBytes	30194.361	30165.000	30217.000
Free System Page Table Entries	33555528.259	33555524.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	54677267.077	54550528.000	54829056.000
Pool Paged Bytes	84479086.458	82309120.000	110223360.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log9/21/2010 7:43:13 PM -- Jetstress testing begins ...

9/21/2010 7:43:13 PM -- Prepare testing begins ...

9/21/2010 7:43:16 PM -- Attaching databases ...

9/21/2010 7:43:16 PM -- Prepare testing ends.

9/21/2010 7:43:16 PM -- Dispatching transactions begins ...

9/21/2010 7:43:16 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)

9/21/2010 7:43:16 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)

9/21/2010 7:43:18 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).

9/21/2010 7:43:18 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).

9/21/2010 7:43:22 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

9/21/2010 7:43:22 PM -- Performance logging begins (interval: 15000 ms).

9/21/2010 7:43:22 PM -- Attaining prerequisites:

9/21/2010 7:46:01 PM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 483774500.0 (lower bound: 483183800.0, upper bound: none)

9/22/2010 7:46:01 PM -- Performance logging ends.

9/22/2010 7:46:02 PM -- JetInterop batch transaction stats: 257397 and 258106.

9/22/2010 7:46:02 PM -- Dispatching transactions ends.

9/22/2010 7:46:02 PM -- Shutting down databases ...

9/22/2010 7:46:08 PM -- Instance1948.1 (complete) and Instance1948.2 (complete)

9/22/2010 7:46:09 PM -- Performance logging begins (interval: 30000 ms).

9/22/2010 7:46:09 PM -- Verifying database checksums ...

9/22/2010 11:17:06 PM -- C:\drive1 (100% processed)

9/22/2010 11:17:06 PM -- Performance logging ends.

9/22/2010 11:17:06 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\DBChecksum_2010_9_22_19_46_8.blg has 421 samples.

9/22/2010 11:17:08 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\DBChecksum_2010_9_22_19_46_8.html is saved.

9/22/2010 11:17:08 PM -- Verifying log checksums ...

9/22/2010 11:17:09 PM -- C:\drive1\database1 (7 log(s) processed) and C:\drive1\database2 (7 log(s) processed)

9/22/2010 11:17:09 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\Stress_2010_9_21_19_43_18.blg has 5767 samples.

9/22/2010 11:17:09 PM -- Creating test report ...

9/22/2010 11:17:18 PM -- Instance1948.1 has 18.1 for I/O Database Reads Average Latency.

9/22/2010 11:17:18 PM -- Instance1948.1 has 0.2 for I/O Log Writes Average Latency.

9/22/2010 11:17:18 PM -- Instance1948.1 has 0.2 for I/O Log Reads Average Latency.

9/22/2010 11:17:18 PM -- Instance1948.2 has 17.3 for I/O Database Reads Average Latency.

9/22/2010 11:17:18 PM -- Instance1948.2 has 0.2 for I/O Log Writes Average Latency.

9/22/2010 11:17:18 PM -- Instance1948.2 has 0.2 for I/O Log Reads Average Latency.

9/22/2010 11:17:18 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

9/22/2010 11:17:18 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

9/22/2010 11:17:18 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\stressrun_gold_24hrs\Stress_2010_9_21_19_43_18.xml has 5756 samples queried.

Appendix B: Performance Testing

Microsoft Exchange Server **Jetstress Tool**

Performance Test Result Report

Test Summary

Overall Test Result	Pass
Machine Name	WIN-2BRU9VH1I4E
Test Description	1100 Mailboxes .15 4096 Mailbox Size 3 threads
Test Start Time	9/21/2010 1:16:45 PM
Test End Time	9/21/2010 3:19:49 PM
Collection Start Time	9/21/2010 1:19:44 PM
Collection End Time	9/21/2010 3:19:42 PM
Jetstress Version	14.01.0043.000
Ese Version	14.00.0639.019
Operating System	Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\Performance_2010_9_21_13_16_50.blg
C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\DBChecksum_2010_9_21_15_19_49.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 202.999
Target Transactional I/O per Second 165
Initial Database Size (bytes) 4725252685824
Final Database Size (bytes) 4725873442816
Database Files (Count) 2

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 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 2

Database Configuration

Instance2316.1 Log Path: C:\drive1\database1
Database: C:\drive1\database1\Jetstress001001.edb

Instance2316.2 Log Path: C:\drive1\database2
Database: C:\drive1\database2\Jetstress002001.edb

Transactional I/O Performance

MSEExchange 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
Instance2316.1	17.981	0.380	64.852	37.112	34018.604	37042.395	0.000	0.158	0.000	35.039	0.000	4477.887
Instance2316.2	18.235	0.382	64.336	36.700	34192.721	37066.492	0.000	0.161	0.000	34.732	0.000	4467.996

Background Database Maintenance I/O Performance

MSEExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2316.1	26.332	261964.349

Instance2316.2	25.421	261964.725
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Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2316.1	0.632	220423.898
Instance2316.2	0.625	216054.261

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
Instance2316.1	17.981	0.380	91.185	37.112	99845.195	37042.395	0.904	0.158	0.632	35.039	220423.898	4477.887
Instance2316.2	18.235	0.382	89.756	36.700	98701.682	37066.492	0.975	0.161	0.625	34.732	216054.261	4467.996

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.290	0.000	1.702
Available MBytes	30216.977	30192.000	30225.000
Free System Page Table Entries	33555528.900	33555496.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	53744315.733	52793344.000	56262656.000
Pool Paged Bytes	84374220.800	83988480.000	111874048.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log9/21/2010 1:16:45 PM -- Jetstress testing begins ...

9/21/2010 1:16:45 PM -- Prepare testing begins ...

9/21/2010 1:16:47 PM -- Attaching databases ...

9/21/2010 1:16:47 PM -- Prepare testing ends.

9/21/2010 1:16:47 PM -- Dispatching transactions begins ...

9/21/2010 1:16:47 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)

9/21/2010 1:16:47 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)

9/21/2010 1:16:50 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

9/21/2010 1:16:50 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

9/21/2010 1:16:54 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

9/21/2010 1:16:54 PM -- Performance logging begins (interval: 15000 ms).

9/21/2010 1:16:54 PM -- Attaining prerequisites:

9/21/2010 1:19:44 PM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 483942400.0 (lower bound: 483183800.0, upper bound: none)

9/21/2010 3:19:45 PM -- Performance logging ends.

9/21/2010 3:19:45 PM -- JetInterop batch transaction stats: 22380 and 22402.

9/21/2010 3:19:45 PM -- Dispatching transactions ends.

9/21/2010 3:19:45 PM -- Shutting down databases ...

9/21/2010 3:19:49 PM -- Instance2316.1 (complete) and Instance2316.2 (complete)

9/21/2010 3:19:51 PM -- Performance logging begins (interval: 30000 ms).

9/21/2010 3:19:51 PM -- Verifying database checksums ...

9/21/2010 6:51:17 PM -- C:\drive1 (100% processed)
 9/21/2010 6:51:17 PM -- Performance logging ends.
 9/21/2010 6:51:17 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\DBChecksum_2010_9_21_15_19_49.blg has 422 samples.
 9/21/2010 6:51:18 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\DBChecksum_2010_9_21_15_19_49.html is saved.
 9/21/2010 6:51:18 PM -- Verifying log checksums ...
 9/21/2010 6:51:19 PM -- C:\drive1\database1 (7 log(s) processed) and C:\drive1\database2 (7 log(s) processed)
 9/21/2010 6:51:19 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\Performance_2010_9_21_13_16_50.blg has 491 samples.
 9/21/2010 6:51:19 PM -- Creating test report ...
 9/21/2010 6:51:20 PM -- Instance2316.1 has 18.0 for I/O Database Reads Average Latency.
 9/21/2010 6:51:20 PM -- Instance2316.1 has 0.2 for I/O Log Writes Average Latency.
 9/21/2010 6:51:20 PM -- Instance2316.1 has 0.2 for I/O Log Reads Average Latency.
 9/21/2010 6:51:20 PM -- Instance2316.2 has 18.2 for I/O Database Reads Average Latency.
 9/21/2010 6:51:20 PM -- Instance2316.2 has 0.2 for I/O Log Writes Average Latency.
 9/21/2010 6:51:20 PM -- Instance2316.2 has 0.2 for I/O Log Reads Average Latency.
 9/21/2010 6:51:20 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 9/21/2010 6:51:20 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 9/21/2010 6:51:20 PM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\perfrun_gold_2hr_3threads\Performance_2010_9_21_13_16_50.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
Instance2308.1	2256908.09	02:10:44	287.70
Instance2308.2	2256900.09	01:35:16	394.81

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%

Database Configuration

Instance2308.1 Log Path: C:\drive1\database1
 Database: C:\drive1\database1\Jetstress001001.edb

Instance2308.2 Log Path: C:\drive1\database2
 Database: C:\drive1\database2\Jetstress002001.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
Instance2308.1	1.236	0.000	1150.707	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2308.2	0.881	0.000	1579.679	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	1.157	0.000	1.900
Available MBytes	30644.157	30635.000	30647.000
Free System Page Table Entries	33555528.004	33555527.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	55134953.441	55115776.000	55185408.000
Pool Paged Bytes	116805647.693	116723712.000	117018624.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log9/23/2010 3:59:45 AM -- Jetstress testing begins ...
 9/23/2010 3:59:45 AM -- Prepare testing begins ...
 9/23/2010 3:59:47 AM -- Attaching databases ...
 9/23/2010 3:59:47 AM -- Prepare testing ends.
 9/23/2010 3:59:52 AM -- Performance logging begins (interval: 30000 ms).
 9/23/2010 3:59:52 AM -- Backing up databases ...
 9/23/2010 6:10:37 AM -- Performance logging ends.
 9/23/2010 6:10:37 AM -- Instance2308.1 (100% processed) and Instance2308.2 (100% processed)
 9/23/2010 6:10:37 AM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\dbbackup\DatabaseBackup_2010_9_23_3_59_47.blg has 261 samples.
 9/23/2010 6:10:37 AM -- Creating test report ...

Appendix D: Soft Recovery Testing

SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2720.1	500	1560.7203413
Instance2720.2	503	1439.7889289

Database Configuration

Instance2720.1 Log Path: C:\drive1\database1
Database: C:\drive1\database1\Jetstress001001.edb

Instance2720.2 Log Path: C:\drive1\database2
Database: C:\drive1\database2\Jetstress002001.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
Instance2720.1	81.159	11.370	267.033	1.918	35019.408	14563.556	3.566	0.000	2.878	0.000	99179.955	0.000
Instance2720.2	74.988	10.971	285.736	2.092	35076.964	15649.703	4.473	0.000	3.138	0.000	105718.888	0.000

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2720.1	0.000	0.000
Instance2720.2	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
Instance2720.1	81.159	11.370	267.033	1.918	35019.408	14563.556	3.566	0.000	2.878	0.000	99179.955	0.000
Instance2720.2	74.988	10.971	285.736	2.092	35076.964	15649.703	4.473	0.000	3.138	0.000	105718.888	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.265	0.000	10.416
Available Mbytes	30094.506	30084.000	30630.000
Free System Page Table Entries	33555528.027	33555527.000	33555530.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	57039083.190	55418880.000	57847808.000
Pool Paged Bytes	117859461.450	117837824.000	118046720.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log9/23/2010 8:33:22 AM -- Jetstress testing begins ...

9/23/2010 8:33:22 AM -- Prepare testing begins ...

9/23/2010 8:33:24 AM -- Attaching databases ...

9/23/2010 8:33:24 AM -- Prepare testing ends.

9/23/2010 8:33:24 AM -- Dispatching transactions begins ...

9/23/2010 8:33:24 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)

9/23/2010 8:33:24 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)

9/23/2010 8:33:26 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

9/23/2010 8:33:26 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

9/23/2010 8:33:30 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

9/23/2010 8:33:30 AM -- Performance logging begins (interval: 15000 ms).

9/23/2010 8:33:30 AM -- Generating log files ...

9/23/2010 10:22:19 AM -- C:\drive1\database1 (100.2% generated) and C:\drive1\database2 (100.8% generated)

9/23/2010 10:22:19 AM -- Performance logging ends.

9/23/2010 10:22:19 AM -- JetInterop batch transaction stats: 21784 and 21771.

9/23/2010 10:22:19 AM -- Dispatching transactions ends.

9/23/2010 10:22:19 AM -- Shutting down databases ...

9/23/2010 10:22:25 AM -- Instance2720.1 (complete) and Instance2720.2 (complete)

9/23/2010 10:22:25 AM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\softRecovery_gold\Performance_2010_9_23_8_33_26.blg has 435 samples.

9/23/2010 10:22:25 AM -- Creating test report ...

9/23/2010 10:22:26 AM -- Instance2720.1 has 18.1 for I/O Database Reads Average Latency.

9/23/2010 10:22:26 AM -- Instance2720.1 has 0.1 for I/O Log Writes Average Latency.

9/23/2010 10:22:26 AM -- Instance2720.1 has 0.1 for I/O Log Reads Average Latency.

9/23/2010 10:22:26 AM -- Instance2720.2 has 17.6 for I/O Database Reads Average Latency.

9/23/2010 10:22:26 AM -- Instance2720.2 has 0.2 for I/O Log Writes Average Latency.

9/23/2010 10:22:26 AM -- Instance2720.2 has 0.2 for I/O Log Reads Average Latency.

9/23/2010 10:22:26 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.

9/23/2010 10:22:26 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

9/23/2010 10:22:26 AM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\softRecovery_gold\Performance_2010_9_23_8_33_26.xml has 434 samples queried.

9/23/2010 10:22:26 AM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\softRecovery_gold\Performance_2010_9_23_8_33_26.html is saved.

9/23/2010 10:22:28 AM -- Performance logging begins (interval: 2000 ms).

9/23/2010 10:22:28 AM -- Recovering databases ...

9/23/2010 10:48:29 AM -- Performance logging ends.

9/23/2010 10:48:29 AM -- Instance2720.1 (1560.7203413) and Instance2720.2 (1439.7889289)
9/23/2010 10:48:29 AM -- C:\Users\Administrator\Desktop\Jetstress2010-Nov\Results\1100mailboxes\softRecovery_gold\SoftRecovery_2010_9_23_10_22_26.blq has 775 samples.
9/23/2010 10:48:29 AM -- Creating test report ...