

ESRP Storage Program
EMC VNXe3300 (1,000 User)
Mailbox Resiliency Storage Solution for
Microsoft Exchange 2010

Tested with: ESRP – Storage Version 3.0
Tested Date: 4/25/2011

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Overview

This document provides information on an EMC® VNXe3300™ 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, visit the website <http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.msp>

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Features

This document describes an approach that can be used to configure Microsoft Exchange 2010 with an EMC VNXe3300 platform.

The EMC VNXe 3300 delivers exceptional flexibility for the small-to-medium business user, combining a unique, application-driven management environment with a complete consolidation for all IP storage needs. The VNXe 3300 provides a simplified and affordable IP storage solutions designed specifically for customers who require enterprise-class reliability in a system that is very easy to install, configure, manage, and service. It eliminates the need to hire storage experts by consolidating application data onto a networked storage solution. Easy-to-use application-aware wizards automate the storage provisioning for Microsoft Exchange, VMware datastores, shared folders, generic iSCSI volumes and Hyper-V using embedded best practices engines.

The key feature of the VNXe storage platform is that storage is strongly tied to an application so that the storage view of the environment can easily be translated into applications that drive a business.

The VNXe supports the following applications:

- Microsoft Exchange
- VMware datastores
- Hyper-V datastores
- Shared folders (CIFS and NFS)
- Generic application storage using iSCSI

Apart from the application centric design, customers can benefit from the new VNXe features such as:

- Next-generation unified storage, optimized for virtualized applications.
- Capacity optimization features that includes file deduplication and compression, thin provisioning, and application-consistent snapshots and replicas
- High availability, designed to deliver five 9s availability.
- Multiprotocol support for file and block.
- Simplified management with EMC Unisphere™ for a single management interface for all file, block, and replication needs.
- File-level retention (FLR) feature provides a way to set file-based permissions to limit write access to the files for a specific period of time. On a VNXe platform, the FLR feature can be enabled for shared folders and VMware NFS datastores.

Designing and sizing the storage for Exchange 2010 is a complicated process, which is driven by the performance, reliability, and scalability to meet the recommended guidelines and metrics of Exchange 2010 and the organization requirements. This solution describes the optimal way to configure Microsoft Exchange 2010 mailbox resiliency with VNXe platforms.

The performance results and best practices described in this document provide proven guidelines to configure VNXe3300 for high-performance Exchange email environments with mailbox resiliency. For this solution, a VNXe3300 platform with 600 GB 15k rpm SAS disks was used and configured for 1,000 Exchange 2010 users. Each of the 1,000 users had an I/O profile of 0.24 IOPS and a mailbox size of 1.5 GB.

Solution Description

This solution uses the inbuilt high availability and mailbox resiliency framework built into Microsoft Exchange Server 2010 Database Availability Groups (DAG).

A DAG is a group of up to 16 mailbox servers that hosts a set of databases and provides automatic database-level recovery from failures that affect individual servers or databases. Any server in a DAG can host a copy of a mailbox database of any other server in the same DAG. When a server is

added to a DAG, it works with the other servers in the same DAG to provide automatic recovery from failures that affect mailbox databases, such as a disk failure or server failure.

This solution uses two copies of each Exchange database. One of the copies is on the primary VNXe and the other copy is on the secondary VNXe. The storage is configured on the two VNXe3300 platforms with a RAID 5 (6+1) group on the first shelf. Each RAID group holds two Exchange databases and the accompanying logs.

VNXe platforms are application-aware and has inbuilt intelligence to calculate the storage space requirements according to the mailbox count and mailbox size specified.

The following steps describe how storage is created and allocated to the Exchange server:

1. A storage pool is created specifically for Exchange 2010 over a RAID 5 (6+1) group, which provides the storage space required for the databases and logs. VNXe automatically recommends the disk type that is appropriate for storage.
2. An Exchange storage resource which is a member of DAG is created over the pool. This membership decides the provisioning best practices that will be applied. The Exchange storage resource holds the virtual disks for Exchange database and log which share the same backend spindles. These virtual disks are sized according to the number of mailboxes and the mailbox size for each mailbox is specified.

Microsoft Exchange 2010 on EMC VNXe Series—Deployment Guide available on EMC Powerlink[®] provides more information on the Exchange storage provisioning wizard of the VNXe platform.

If this disk layout is properly configured, it aligns with the Microsoft Exchange Server recommendations of a well-performing system—from both a disk capacity and end-user perspective.

In this particular testing, one server was used to simulate the Exchange environment.

Figure 1 shows the reference architecture for the tested Exchange 2010 solution on EMC VNXe3300.

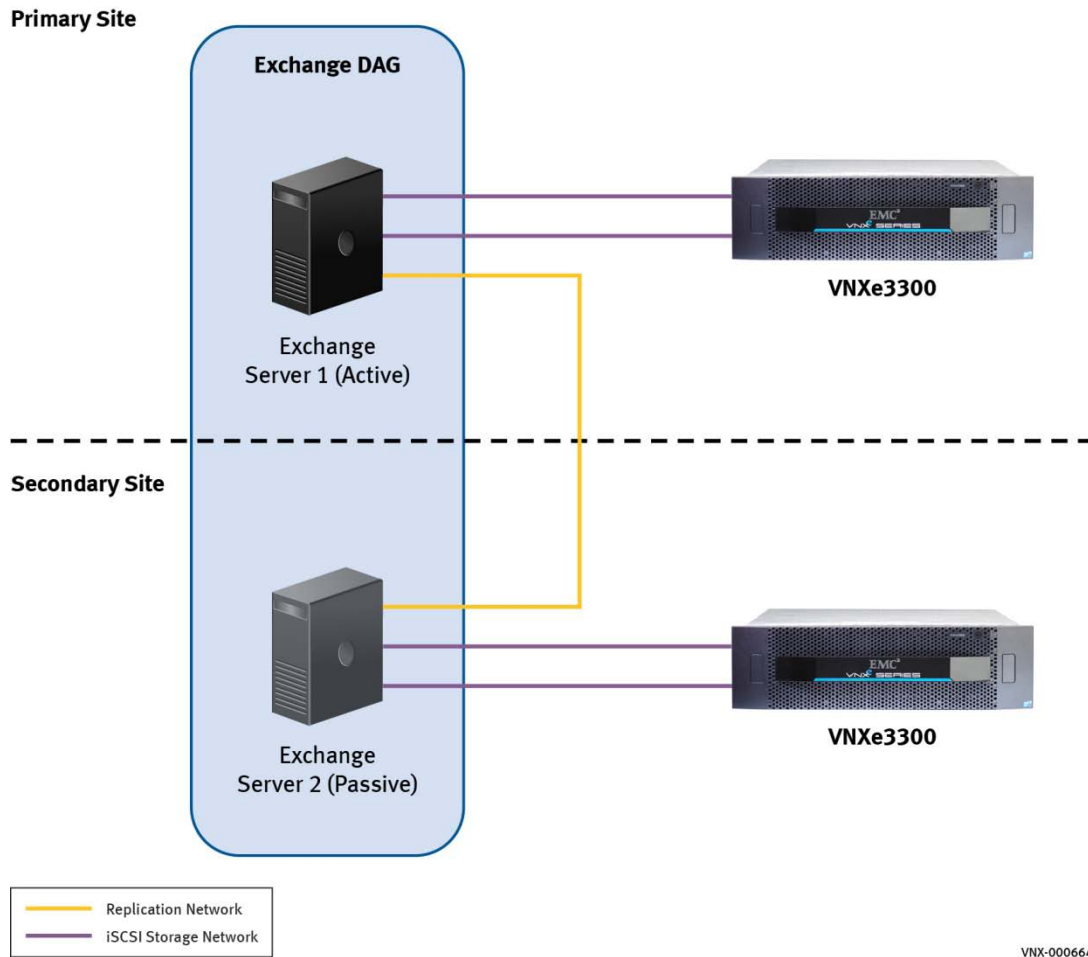
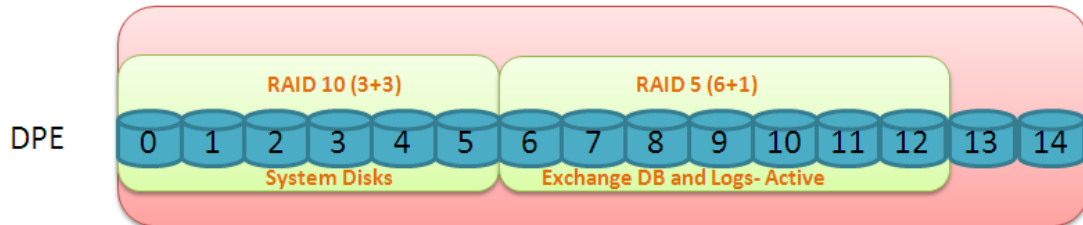


Figure 1: Reference Architecture

Figure 2 shows the disk layout for the tested Exchange 2010 solution on VNXe3300.

Primary Site Disk Layout



Secondary Site Disk Layout

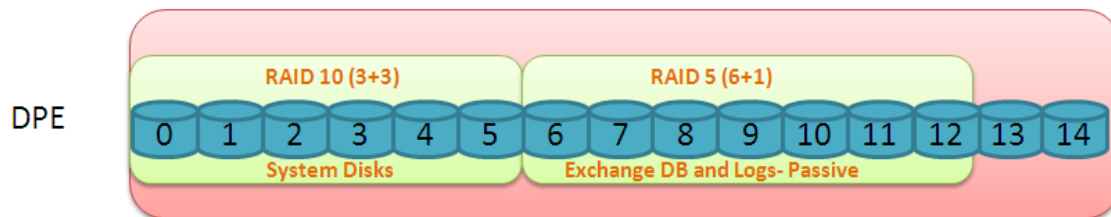


Figure 2: Disk Configuration

The 1,000 users are evenly distributed between the two Exchange databases. Each RAID group consists of both database and logs. The ESRP-Storage program focuses on storage solution testing to address performance and reliability issues with the storage design. However, storage is not the only factor to take into consideration when designing a scale-up Exchange solution.

Other factors that affect the server scalability are:

- Processor utilization
- 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 how to identify and address performance bottlenecks in an Exchange system, refer to article Troubleshooting Microsoft Exchange Server Performance, available at <http://go.microsoft.com/fwlink/?LinkId=23454>.

Targeted Customer Profile

This solution is intended for small-to-medium enterprise Exchange customers to consolidate their Exchange users on a high-performance, highly-available storage platform.

The solution is designed to support the customer profile with the following assumptions:

- 1,000 Exchange 2010 users.
- Two Exchange mailbox servers in an Exchange 2010 DAG configuration of which one is active.
- User I/O profile tested is 0.20 IOPs/ user with 20 percentage headroom (200 messages sent/received per mailbox per day)
- User mailbox size - 1.5 GB
- Database maintenance strategy used is Background Database Maintenance 24x7.
- Mailbox Resiliency with 2 copies of each mailbox database is used.
- Two VNXe3300 platforms (one tested)

Tested Deployment

The tables in this section summarize the testing environment.

Simulated Exchange Configuration

[Table 1](#) describes the simulated Exchange configuration.

Table 1: Simulated Exchange Configuration

Number of Exchange mailboxes simulated	1,000
Number of DAGs	1
Number of servers/DAG	2
Number of active mailboxes/server	1,000
Number of databases/host	2
Number of copies/database	2
Number of mailboxes/database	500
Simulated profile: I/O's per second per mailbox (IOPS, include 20% headroom)	0.24
Database LUN size	1.186 TB
Log LUN size	75 GB
Total database size for performance testing	1955 GB
% storage capacity used by Exchange database**	80.45%

**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.

Storage Hardware

Table 2 describes the storage hardware.

Table 2: Storage Hardware Details

Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	VNXe3300, VNXe Operating environment 2.0.2.13042
Number of storage controllers	2
Number of storage ports	4
Maximum bandwidth of storage connectivity to host	2 x 1 Gb/s iSCSI, total bandwidth 2 Gb/s
Switch type/model/firmware revision	Cisco/6509-E/IOS Version 12.2
HBA model and firmware	Intel[R] PRO/1000 PT without jumbo frames enabled
Number of HBAs/host	1 dual-port NIC
Host server type	Server 2950 with 4 x Intel 2.99 GHz Xeon CPU 32 GB memory
Total number of disks tested in solution	7
Maximum number of spindles that can be hosted in the storage	120

Storage Software

Table 3 describes the storage software.

Table 3: Storage Software Details

HBA driver	Microsoft iSCSI software initiator inbuilt with Microsoft Windows Server 2008 R2 64-bit
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multipathing	MCS with round-robin policy
Host OS	Microsoft Windows Server 2008 R2 64-bit
ESE.dll file version	14.01.0218.012
Replication solution name/version	N/A

Storage Disk Configuration (Mailbox Store Disks)

Table 4 lists the storage disk configuration for the environment.

Table 4: Storage Disk Configuration – Mailbox Store Disks

Disk type, speed and firmware revision	15k rpm SAS disks
Raw capacity per disk (GB)	600 GB
Number of physical disks in test	7
Total raw storage capacity (GB)	4200 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	Seven disks per two LUNs
RAID level	RAID 5 (6+1)
Total formatted capacity	3211.26 GB
Storage capacity utilization	76.4%
Database capacity utilization	46.5%

Storage Disk Configuration (Transactional Log Disks)

Table 5 describes the storage disk configuration of transactional log disks for the environment

Table 5: Storage Disk Configuration – Transactional Log Disks

Disk type, speed and firmware revision	15k rpm SAS disks
Raw capacity per disk (GB)	600 GB
Number of Spindles in test	7
total raw storage capacity (GB)	4200 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	Seven disks per two LUNs
RAID level	RAID 5 (6+1)
Total formatted capacity	3211.64 GB

Best Practices

In this solution, each RAID 5 (6+1) configuration satisfies the capacity and performance requirements for 1,000 users with a mailbox size of 1.5 GB and a user profile of 0.24 IOPS (including 20 percent overhead). This ensures that the response times remain well within the required Microsoft thresholds. After the number of disks is determined for the original Exchange data, this number must be scaled up to satisfy each copy of the data within a DAG.

Microsoft Exchange Server 2010 has changed significantly since early versions of Exchange, particularly when it comes to I/O and storage. There have been many changes to the core schema and the extensible storage engine (ESE) to reduce I/O. The changes also enable the use of RAID 5 as an optimal RAID configuration.

For more information on EMC solutions for Microsoft Exchange Server, visit the following EMC website:

<http://www.emc.com/solutions/application-environment/microsoft/solutions-for-microsoft-exchange-unified-communications.htm>

Exchange server is a disk-intensive application. For Exchange 2010 best practices on EMC storage design, refer to the *Deployment Guidelines for Microsoft Exchange 2010 with EMC Unified Storage – Best Practices Planning* white paper available on Powerlink

Core Storage

Based on the testing run using an ESRP framework, EMC recommends the following best practices to improve the storage performance with Exchange solutions:

1. Use the default alignment (in Microsoft Windows 2008) while creating volumes for Microsoft Exchange-related disks. Format the database and log volumes with a 64 KB boundary.
2. Isolate Microsoft Exchange server database workload from other I/O-intensive applications or workloads. This ensures the highest level of performance for Exchange and simplifies troubleshooting in the event of a disk-related Microsoft Exchange performance issue
3. When DAG is used, the maximum database size can be up to 2 TB.
4. Performance and capacity should be the primary consideration when sizing and configuring the disks. In other words, keep the mailbox size requirement in mind while tuning for the best performance.
5. The network traffic between Exchange Server and the storage for iSCSI traffic should be isolated from the management network and other networks in the data center to get best performance.
6. When DAG is used the database and log can be placed on the same disks, otherwise place the database and log on different sets of disks.

Backup strategy

N/A

Contact for Additional Information

EMC recommends you to consult the EMC professional services to assist with the design and development of a similar solution. For information regarding this or any other EMC solution, use the following numbers:

United States:	(800) 782-4362 (SVC-4EMC)
Canada:	(800) 543-4782 (543-4SVC)
Worldwide:	(508) 497-7901

For additional information on EMC products and services available to customers and partners, refer to <http://EMC.com> or <http://powerlink.EMC.com>

Test Result Summary

This section provides a high-level summary of the test data from ESRP and the link to the detailed html reports that are generated by the ESRP testing framework. The html report for each test is provided in the following sections:

- [Appendix B: Stress Test Report \(24-hour Performance Test\)](#)
- [Appendix C: Performance Test Results](#)
- [Appendix E: Read-Only Backup Test Results](#)
- [Appendix F: SoftRecovery Test Results](#)

Reliability

A number of tests in the framework are to check reliability tests run for 24 hours. The goal is to verify if storage can handle high I/O load for a long period of time. Both log and database files are analyzed for integrity after the stress test to ensure that there is no database or log corruption.

The reliability test executed on EMC VNXe3300 provided the following results:

- No errors reported on the event log file for storage reliability testing
- No errors reported during the database and log checksum process

[Appendix B: Stress Test Report \(24-hour performance test\)](#) on page 17 provides the Jetstress performance results (24-hour performance test).

Storage Performance Results

The primary storage performance testing is designed to exercise the storage with a maximum sustainable Exchange type of I/O for 2 hours. The test is to show how long it takes for the storage to respond to an I/O under load.

Table 6 shows the sum of all of the logical disk I/Os and average of all the logical disks I/O latency in the 2-hour test duration. Each server is listed separately and the aggregate numbers across all servers is listed as well.

Individual Server Metrics:

Table 6 shows the sum of I/Os across Storage Groups and the average latency across all Storage Groups on a per-server basis.

Table 6: Individual Server Metrics

Database I/O	
Database Disks Transfers/sec	329.489
Database Disks Reads/sec	204.28
Database Disks Writes/sec	125.209
Average Database Disk Read Latency (ms)	12.774
Average Database Disk Write Latency (ms)	8.475
Transaction Log I/O	
Log Disks Writes/sec	100.076
Average Log Disk Write Latency (ms)	3.553

Database Backup/Recovery Performance

There are two tests reports in this section. Table 7 is used to measure the sequential read rate of the database files. Table 8 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. Table 7 shows the average rate for a single database file.

Table 7: Database Read-Only Performance

MB read/sec per database	58.415
MB read/sec total per server	116.83

Transaction Log Recovery/Replay Performance

The test is to measure the maximum rate at which the log files can be played against the databases. Table 8 shows the average rate for 500 log files played in a single storage group. Each log file is 1 MB in size.

Table 8: Transaction Log Recovery/Reply Performance

Average time to play one Log file (sec)	2.23
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Conclusion

VNXe3300 is more than capable to support deployments of up to 1,000 users at 0.24 IOPS per user. A careful analysis of each environment must be performed to understand the specific requirements of the architecture and to adopt a solution that best fits those needs. The information included in this document verifies that VNXe3300 can support a high-performance Exchange configuration.

This document is developed by EMC and reviewed by the Microsoft Exchange Product team. The test results or data presented in this document are based on the tests introduced in the ESRP test framework. Customers should not quote the data directly for the predeployment 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 given 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: User Mailbox Sizing

Two limiting factors are used to estimate maximum user mailbox sizes for Exchange — disk storage capacity and IOPS on the database spindles. The maximum number of users operating at the 20 ms database latency limit was 1,900 users for a jetstress thread count of six. If support for more than 1,900 users are required, then extra IOPS support must be added to this solution (indicated in orange in [Figure 1](#)).

As the number of users decrease, the average mailbox size also increases.

[Figure 1](#) shows the maximum mailbox size per user that can be increased, if required, by adding spindles to the configuration (indicated in yellow in [Figure 1](#)).

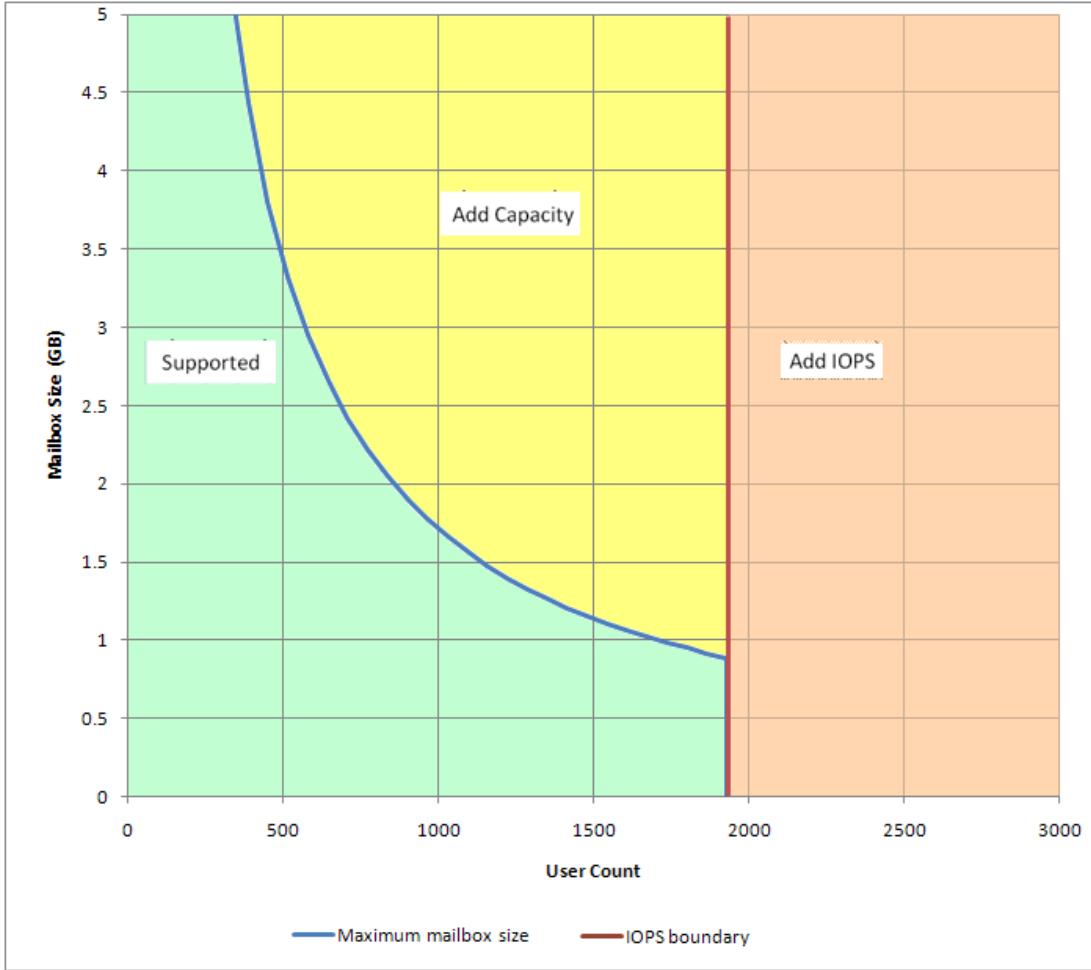


Figure 3: Disk Configuration

It can be noted from the graph that the tested environment supports the desired mailbox size for 1,000 Exchange 2010 users.

Table 9 lists some of the maximum user counts and mailbox size that this solution supports

Table 9: Maximum user count

Maximum user count	Mailbox size (GB)
500	3
750	2
1,000	1.5
1,500	1
1,800	0.5

Appendix B: Stress Test Report (24-hour Performance Test)

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name EX8PESRP01

Test

Description

Test Start Time 4/30/2011 3:30:38 PM

Test End Time 5/1/2011 3:33:42 PM

Collection Start Time 4/30/2011 3:33:39 PM

Collection End Time 5/1/2011 3:33:35 PM

Jetstress Version 14.01.0180.003

Ese Version 14.01.0218.012

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange\Jetstress\ESRP\Performance_2011_4_30_15_30_44.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 325.851

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 2088348286976

Final Database Size (bytes) 2099966509056

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

Instance2732.1 Log Path: L:\
Database: E:\Jetstress001001.edb

Instance2732.2 Log Path: M:\
Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2732.1	12.5	9.13	100.2	62.52	33744	35513	0.00	4.07	0.000	45.00	0.00	5356
	17	3	20	9	.792	.620	0	6		7	0	.979
Instance2732.2	12.4	6.48	100.4	62.67	33711	35512	0.00	2.97	0.000	47.57	0.00	5093
	86	5	31	1	.261	.156	0	0		4	0	.747

Background Database Maintenance I/O Performance

MSExchange Database Instance	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2732.1	26.876	261730.891
Instance2732.2	26.735	261744.963

Log Replication I/O Performance

MSExchange Database Instance	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2732.1	0.991	232312.378
Instance2732.2	0.993	232156.560

Total I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2732.1	12.5	9.13	100.2	62.52	33744	35513	0.00	4.07	0.000	45.00	0.00	5356
	17	3	20	9	.792	.620	0	6		7	0	.979
Instance2732.2	12.4	6.48	100.4	62.67	33711	35512	0.00	2.97	0.000	47.57	0.00	5093
	86	5	31	1	.261	.156	0	0		4	0	.747

	(msec)	(msec)					(ec)	(ec)				
Instance 2732.1	12.5	9.13	127.0	62.52	8195	3551	6.55	4.07	0.991	45.00	23231	5356
	17	3	95	9	4.540	3.620	3	6		7	2.378	.979
Instance 2732.2	12.4	6.48	127.1	62.67	8165	3551	5.43	2.97	0.993	47.57	23215	5093
	86	5	66	1	2.233	2.156	4	0		4	6.560	.747

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.003	1.405	27.677
Available MBytes	14340.464	14013.000	14399.000
Free System Page Table Entries	33555628.195	33555398.000	33556614.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65072011.099	64966656.000	65327104.000
Pool Paged Bytes	216256113.432	214867968.000	219901952.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/30/2011 3:30:38 PM -- Jetstress testing begins ...
4/30/2011 3:30:38 PM -- Prepare testing begins ...
4/30/2011 3:30:41 PM -- Attaching databases ...
4/30/2011 3:30:41 PM -- Prepare testing ends.
4/30/2011 3:30:41 PM -- Dispatching transactions begins ...
4/30/2011 3:30:41 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/30/2011 3:30:41 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/30/2011 3:30:44 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/30/2011 3:30:44 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/30/2011 3:30:48 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/30/2011 3:30:48 PM -- Performance logging begins (interval: 15000 ms).
4/30/2011 3:30:48 PM -- Attaining prerequisites:
4/30/2011 3:33:39 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 485900300.0 (lower bound: 483183800.0, upper bound: none)
5/1/2011 3:33:39 PM -- Performance logging ends.
5/1/2011 3:33:39 PM -- JetInterop batch transaction stats: 415024 and 414940.
5/1/2011 3:33:39 PM -- Dispatching transactions ends.
5/1/2011 3:33:39 PM -- Shutting down databases ...
5/1/2011 3:33:42 PM -- Instance2732.1 (complete) and Instance2732.2 (complete)
5/1/2011 3:33:42 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_30_15_30_44.blg](#) has 5766 samples.
5/1/2011 3:33:42 PM -- Creating test report ...
5/1/2011 3:33:59 PM -- Instance2732.1 has 12.5 for I/O Database Reads Average Latency.
5/1/2011 3:33:59 PM -- Instance2732.1 has 4.1 for I/O Log Writes Average Latency.
5/1/2011 3:33:59 PM -- Instance2732.1 has 4.1 for I/O Log Reads Average Latency.
5/1/2011 3:33:59 PM -- Instance2732.2 has 12.5 for I/O Database Reads Average Latency.
5/1/2011 3:33:59 PM -- Instance2732.2 has 3.0 for I/O Log Writes Average Latency.
5/1/2011 3:33:59 PM -- Instance2732.2 has 3.0 for I/O Log Reads Average Latency.

5/1/2011 3:33:59 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 5/1/2011 3:33:59 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 5/1/2011 3:33:59 PM -- <C:\Program Files\Exchange>
Jetstress\ESRP\Performance_2011_4_30_15_30_44.xml has 5754 samples queried.

Stress test report – Checksum Statistics

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
E:\Jetstress001001.edb	32049474	0	0	0	1001546 MBytes / 12026 sec
F:\Jetstress002001.edb	32036418	0	0	0	1001138 MBytes / 12706 sec
(Sum)	64085892	0	0	0	2002684 MBytes / 12707 sec

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
E:	0.047	0.000	1332.788	0.000	65535.927
F:	0.050	0.000	1259.445	0.000	65535.929

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	21.591	11.747	44.283
Available MBytes	14838.778	14525.000	14849.000
Free System Page Table Entries	33555589.400	33555573.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65454767.508	65388544.000	65613824.000
Pool Paged Bytes	219325539.253	219279360.000	220049408.000

Test Log 4/30/2011 3:30:38 PM -- Jetstress testing begins ...
 4/30/2011 3:30:38 PM -- Prepare testing begins ...
 4/30/2011 3:30:41 PM -- Attaching databases ...
 4/30/2011 3:30:41 PM -- Prepare testing ends.
 4/30/2011 3:30:41 PM -- Dispatching transactions begins ...
 4/30/2011 3:30:41 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
 4/30/2011 3:30:41 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
 4/30/2011 3:30:44 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
 4/30/2011 3:30:44 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

4/30/2011 3:30:48 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

4/30/2011 3:30:48 PM -- Performance logging begins (interval: 15000 ms).

4/30/2011 3:30:48 PM -- Attaining prerequisites:

4/30/2011 3:33:39 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 485900300.0 (lower bound: 483183800.0, upper bound: none)

5/1/2011 3:33:39 PM -- Performance logging ends.

5/1/2011 3:33:39 PM -- JetInterop batch transaction stats: 415024 and 414940.

5/1/2011 3:33:39 PM -- Dispatching transactions ends.

5/1/2011 3:33:39 PM -- Shutting down databases ...

5/1/2011 3:33:42 PM -- Instance2732.1 (complete) and Instance2732.2 (complete)

5/1/2011 3:33:42 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_30_15_30_44.blg](#) has 5766 samples.

5/1/2011 3:33:42 PM -- Creating test report ...

5/1/2011 3:33:59 PM -- Instance2732.1 has 12.5 for I/O Database Reads Average Latency.

5/1/2011 3:33:59 PM -- Instance2732.1 has 4.1 for I/O Log Writes Average Latency.

5/1/2011 3:33:59 PM -- Instance2732.1 has 4.1 for I/O Log Reads Average Latency.

5/1/2011 3:33:59 PM -- Instance2732.2 has 12.5 for I/O Database Reads Average Latency.

5/1/2011 3:33:59 PM -- Instance2732.2 has 3.0 for I/O Log Writes Average Latency.

5/1/2011 3:33:59 PM -- Instance2732.2 has 3.0 for I/O Log Reads Average Latency.

5/1/2011 3:33:59 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

5/1/2011 3:33:59 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/1/2011 3:33:59 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_30_15_30_44.xml](#) has 5754 samples queried.

5/1/2011 3:33:59 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_30_15_30_44.html](#) is saved.

5/1/2011 3:34:00 PM -- Performance logging begins (interval: 30000 ms).

5/1/2011 3:34:00 PM -- Verifying database checksums ...

5/1/2011 7:05:47 PM -- E: (100% processed) and F: (100% processed)

5/1/2011 7:05:47 PM -- Performance logging ends.

5/1/2011 7:05:47 PM -- [C:\Program Files\Exchange Jetstress\ESRP\DBChecksum_2011_5_1_15_33_59.blg](#) has 423 samples.

Appendix C: Performance Test Results

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name EX8PESRP01

Test Description

Test Start Time 4/21/2011 3:43:49 AM

Test End Time 4/21/2011 5:46:04 AM

Collection Start Time 4/21/2011 3:46:01 AM

Collection End Time 4/21/2011 5:45:48 AM

Jetstress Version 14.01.0180.003

Ese Version 14.01.0218.012

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange\Jetstress\ESRP\Performance_2011_4_21_3_43_56.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 329.489

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 2086905446400

Final Database Size (bytes) 2087979188224

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

Instance3328.1 Log Path: L:\
Database: E:\Jetstress001001.edb

Instance3328.2 Log Path: M:\
Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3328.1	12.056	8.037	102.641	62.924	33763.495	37486.773	0.000	2.914	0.000	51.545	0.000	5173.336
Instance3328.2	13.492	8.912	101.639	62.285	33465.724	37574.287	0.000	4.192	0.000	48.531	0.000	5464.255

Background Database Maintenance I/O Performance

MSExchange Database Instance	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3328.1	27.226	261718.563
Instance3328.2	23.420	261690.190

Log Replication I/O Performance

MSExchange Database Instance	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance3328.1	1.093	232553.766
Instance3328.2	1.091	232054.978

Total I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3328.1	12.056	8.037	102.641	62.924	33763.495	37486.773	0.000	2.914	0.000	51.545	0.000	5173.336
Instance3328.2	13.492	8.912	101.639	62.285	33465.724	37574.287	0.000	4.192	0.000	48.531	0.000	5464.255

	(msec)	(msec)					(ec)	(ec)				
Instance 3328.1	12.0	8.03	129.8	62.92	8155	3748	5.26	2.91	1.093	51.54	23255	5173
	56	7	67	4	2.830	6.773	7	4		5	3.766	.336
Instance 3328.2	13.4	8.91	125.0	62.28	7620	3757	6.50	4.19	1.091	48.53	23205	5464
	92	2	60	5	6.333	4.287	9	2		1	4.978	.255

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.968	1.689	11.720
Available MBytes	14535.409	14502.000	14565.000
Free System Page Table Entries	33555553.221	33555062.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	46623989.846	43171840.000	47656960.000
Pool Paged Bytes	114262340.944	106061824.000	116740096.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/21/2011 3:43:49 AM -- Jetstress testing begins ...
4/21/2011 3:43:49 AM -- Prepare testing begins ...
4/21/2011 3:43:52 AM -- Attaching databases ...
4/21/2011 3:43:52 AM -- Prepare testing ends.
4/21/2011 3:43:52 AM -- Dispatching transactions begins ...
4/21/2011 3:43:52 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/21/2011 3:43:52 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/21/2011 3:43:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/21/2011 3:43:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/21/2011 3:43:59 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/21/2011 3:43:59 AM -- Performance logging begins (interval: 15000 ms).
4/21/2011 3:43:59 AM -- Attaining prerequisites:
4/21/2011 3:46:01 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 483729400.0 (lower bound: 483183800.0, upper bound: none)
4/21/2011 5:46:02 AM -- Performance logging ends.
4/21/2011 5:46:02 AM -- JetInterop batch transaction stats: 38399 and 38362.
4/21/2011 5:46:02 AM -- Dispatching transactions ends.
4/21/2011 5:46:02 AM -- Shutting down databases ...
4/21/2011 5:46:04 AM -- Instance3328.1 (complete) and Instance3328.2 (complete)
4/21/2011 5:46:04 AM -- C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_21_3_43_56.blg has 487 samples.
4/21/2011 5:46:04 AM -- Creating test report ...
4/21/2011 5:46:06 AM -- Instance3328.1 has 12.1 for I/O Database Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.1 has 2.9 for I/O Log Writes Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.1 has 2.9 for I/O Log Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 13.5 for I/O Database Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 4.2 for I/O Log Writes Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 4.2 for I/O Log Reads Average Latency.
4/21/2011 5:46:06 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/21/2011 5:46:06 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/21/2011 5:46:06 AM -- C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_21_3_43_56.blg

[Jetstress\ESRP\Performance_2011_4_21_3_43_56.xml](#) has 478 samples queried.

Performance test report – Checksum Statistics

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
E:\Jetstress001001.edb	31852866	0	0	0	995402 MBytes / 12298 sec
F:\Jetstress002001.edb	31867202	0	0	0	995850 MBytes / 12613 sec
(Sum)	63720068	0	0	0	1991252 MBytes / 12614 sec

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
E:	0.048	0.000	1295.446	0.000	65536.000
F:	0.049	0.000	1262.765	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	21.295	17.970	28.222
Available MBytes	15042.012	15035.000	15049.000
Free System Page Table Entries	33555593.045	33555573.000	33556094.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	49006611.505	48488448.000	49307648.000
Pool Paged Bytes	116925966.629	116842496.000	117145600.000

Test Log 4/21/2011 3:43:49 AM -- Jetstress testing begins ...
 4/21/2011 3:43:49 AM -- Prepare testing begins ...
 4/21/2011 3:43:52 AM -- Attaching databases ...
 4/21/2011 3:43:52 AM -- Prepare testing ends.
 4/21/2011 3:43:52 AM -- Dispatching transactions begins ...
 4/21/2011 3:43:52 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
 4/21/2011 3:43:52 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
 4/21/2011 3:43:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
 4/21/2011 3:43:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
 4/21/2011 3:43:59 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 4/21/2011 3:43:59 AM -- Performance logging begins (interval: 15000 ms).

4/21/2011 3:43:59 AM -- Attaining prerequisites:
4/21/2011 3:46:01 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 483729400.0 (lower bound: 483183800.0, upper bound: none)
4/21/2011 5:46:02 AM -- Performance logging ends.
4/21/2011 5:46:02 AM -- JetInterop batch transaction stats: 38399 and 38362.
4/21/2011 5:46:02 AM -- Dispatching transactions ends.
4/21/2011 5:46:02 AM -- Shutting down databases ...
4/21/2011 5:46:04 AM -- Instance3328.1 (complete) and Instance3328.2 (complete)
4/21/2011 5:46:04 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_21_3_43_56.blg](#) has 487 samples.
4/21/2011 5:46:04 AM -- Creating test report ...
4/21/2011 5:46:06 AM -- Instance3328.1 has 12.1 for I/O Database Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.1 has 2.9 for I/O Log Writes Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.1 has 2.9 for I/O Log Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 13.5 for I/O Database Reads Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 4.2 for I/O Log Writes Average Latency.
4/21/2011 5:46:06 AM -- Instance3328.2 has 4.2 for I/O Log Reads Average Latency.
4/21/2011 5:46:06 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/21/2011 5:46:06 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/21/2011 5:46:06 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_21_3_43_56.xml](#) has 478 samples queried.
4/21/2011 5:46:06 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_21_3_43_56.html](#) is saved.
4/21/2011 5:46:07 AM -- Performance logging begins (interval: 30000 ms).
4/21/2011 5:46:07 AM -- Verifying database checksums ...
4/21/2011 9:16:22 AM -- E: (100% processed) and F: (100% processed)
4/21/2011 9:16:22 AM -- Performance logging ends.
4/21/2011 9:16:22 AM -- [C:\Program Files\Exchange Jetstress\ESRP\DBChecksum_2011_4_21_5_46_6.blg](#) has 420 samples.

Appendix D: Maximum Solution IOPS Test Results

The storage configuration shown in [Figure 2](#) on page 8 is the EMC-recommended configuration for a 1,000 Exchange user workload with 0.24 IOPS per user. The results shown for the three-thread Jetstress test show that this storage configuration achieved excellent results, with considerable room for growth.

Often the observed user workload in customer environments is greater than expected. For example, the use of BlackBerry and MAPI journaling devices can significantly increase the I/O workload generated by a set of users. EMC prides itself on delivering solutions that meet and exceed customer requirements and hence the configurations are designed with considerable headroom.

The tested configuration could easily satisfy the ESRP criteria and subsequent tests were run to determine the upper limit of the configuration. The Jetstress thread count was increased from three to six without modifying any of the other components. The achieved IOPS increased from 329 to 462 with a 40 percent increase. Though this workload is not recommended for customers, as it is close to the maximum acceptable disk latency for ESRP, it highlights the headroom for the recommended solution.

Maximum Solution Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name EX8PESRP01

Test Description

Test Start Time 4/29/2011 12:56:44 AM

Test End Time 4/29/2011 2:58:20 AM

Collection Start Time 4/29/2011 12:58:18 AM

Collection End Time 4/29/2011 2:58:14 AM

Jetstress Version 14.01.0180.003

Ese Version 14.01.0218.012

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange\Jetstress\ESRP\Stress_2011_4_29_0_56_51.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 462.483

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 2086905446400

Final Database Size (bytes) 2088348286976

Database Files (Count) 2

Jetstress System Parameters

Thread Count 6 (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

Instance2804.1 Log Path: L:\

Database: E:\Jetstress001001.edb

Instance2804.2 Log Path: M:\
Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Data base Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2804.1	17.9	14.7	144.6	87.01	33024	37341	0.00	7.94	0.000	48.79	0.00	7172
	20	31	17	0	.538	.700	0	7		9	0	.335
Instance2804.2	18.1	9.58	144.0	86.83	33089	37313	0.00	3.69	0.000	61.35	0.00	5827
	53	3	24	3	.535	.962	0	0		1	0	.491

Background Database Maintenance I/O Performance

MSExchange Database Instance	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2804.1	23.548	261758.410
Instance2804.2	18.353	261664.973

Log Replication I/O Performance

MSExchange Database Instance	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2804.1	1.469	232556.525
Instance2804.2	1.481	232544.702

Total I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Data base Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2804.1	17.9	14.7	168.1	87.01	6505	3734	7.91	7.94	1.469	48.79	23255	7172

2804.1	20	31	65	0	3.504	1.700	1	7	9	6.525	.335	
Instance	18.1	9.58	162.3	86.83	5892	3731	5.50	3.69	1.481	61.35	23254	5827
2804.2	53	3	76	3	4.428	3.962	6	0	1	4.702	.491	

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	4.390	2.936	14.605
Available MBytes	14416.015	14388.000	14435.000
Free System Page Table Entries	33555635.596	33555515.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	50178747.733	50147328.000	50266112.000
Pool Paged Bytes	108829149.867	108761088.000	111702016.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/29/2011 12:56:44 AM -- Jetstress testing begins ...
4/29/2011 12:56:44 AM -- Prepare testing begins ...
4/29/2011 12:56:47 AM -- Attaching databases ...
4/29/2011 12:56:47 AM -- Prepare testing ends.
4/29/2011 12:56:47 AM -- Dispatching transactions begins ...
4/29/2011 12:56:47 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/29/2011 12:56:47 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/29/2011 12:56:51 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
4/29/2011 12:56:51 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
4/29/2011 12:56:55 AM -- Operation mix: Sessions 6, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/29/2011 12:56:55 AM -- Performance logging begins (interval: 15000 ms).
4/29/2011 12:56:55 AM -- Attaining prerequisites:
4/29/2011 12:58:18 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 485347300.0 (lower bound: 483183800.0, upper bound: none)
4/29/2011 2:58:19 AM -- Performance logging ends.
4/29/2011 2:58:19 AM -- JetInterop batch transaction stats: 51991 and 52147.
4/29/2011 2:58:19 AM -- Dispatching transactions ends.
4/29/2011 2:58:19 AM -- Shutting down databases ...
4/29/2011 2:58:20 AM -- Instance2804.1 (complete) and Instance2804.2 (complete)
4/29/2011 2:58:20 AM -- C:\Program Files\Exchange Jetstress\ESRP\Stress_2011_4_29_0_56_51.blg has 485 samples.
4/29/2011 2:58:20 AM -- Creating test report ...
4/29/2011 2:58:22 AM -- Instance2804.1 has 17.9 for I/O Database Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.1 has 7.9 for I/O Log Writes Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.1 has 7.9 for I/O Log Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 18.2 for I/O Database Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 3.7 for I/O Log Writes Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 3.7 for I/O Log Reads Average Latency.
4/29/2011 2:58:22 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/29/2011 2:58:22 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/29/2011 2:58:22 AM -- C:\Program Files\Exchange Jetstress\ESRP\Stress_2011_4_29_0_56_51.xml has 479 samples queried.

Maximum Solution Test Report – Checksum Statistics

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
E:\Jetstress001001.edb	31872578	0	0	0	996018 MBytes / 12045 sec
F:\Jetstress002001.edb	31858754	0	0	0	995586 MBytes / 12655 sec
(Sum)	63731332	0	0	0	1991604 MBytes / 12655 sec

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
E:	0.047	0.000	1323.417	0.000	65536.000
F:	0.050	0.000	1257.464	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	21.653	16.164	28.300
Available MBytes	14918.173	14897.000	14927.000
Free System Page Table Entries	33555592.392	33555573.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	51175180.770	50814976.000	51372032.000
Pool Paged Bytes	112493137.482	109068288.000	113434624.000

Test Log 4/29/2011 12:56:44 AM -- Jetstress testing begins ...
 4/29/2011 12:56:44 AM -- Prepare testing begins ...
 4/29/2011 12:56:47 AM -- Attaching databases ...
 4/29/2011 12:56:47 AM -- Prepare testing ends.
 4/29/2011 12:56:47 AM -- Dispatching transactions begins ...
 4/29/2011 12:56:47 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
 4/29/2011 12:56:47 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
 4/29/2011 12:56:51 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
 4/29/2011 12:56:51 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
 4/29/2011 12:56:55 AM -- Operation mix: Sessions 6, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 4/29/2011 12:56:55 AM -- Performance logging begins (interval: 15000 ms).
 4/29/2011 12:56:55 AM -- Attaining prerequisites:
 4/29/2011 12:58:18 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 485347300.0 (lower bound: 483183800.0, upper bound: none)

4/29/2011 2:58:19 AM -- Performance logging ends.
4/29/2011 2:58:19 AM -- JetInterop batch transaction stats: 51991 and 52147.
4/29/2011 2:58:19 AM -- Dispatching transactions ends.
4/29/2011 2:58:19 AM -- Shutting down databases ...
4/29/2011 2:58:20 AM -- Instance2804.1 (complete) and Instance2804.2 (complete)
4/29/2011 2:58:20 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Stress_2011_4_29_0_56_51.blg](#) has 485 samples.
4/29/2011 2:58:20 AM -- Creating test report ...
4/29/2011 2:58:22 AM -- Instance2804.1 has 17.9 for I/O Database Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.1 has 7.9 for I/O Log Writes Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.1 has 7.9 for I/O Log Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 18.2 for I/O Database Reads Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 3.7 for I/O Log Writes Average Latency.
4/29/2011 2:58:22 AM -- Instance2804.2 has 3.7 for I/O Log Reads Average Latency.
4/29/2011 2:58:22 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/29/2011 2:58:22 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/29/2011 2:58:22 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Stress_2011_4_29_0_56_51.xml](#) has 479 samples queried.
4/29/2011 2:58:23 AM -- [C:\Program Files\Exchange Jetstress\ESRP\Stress_2011_4_29_0_56_51.html](#) is saved.
4/29/2011 2:58:24 AM -- Performance logging begins (interval: 30000 ms).
4/29/2011 2:58:24 AM -- Verifying database checksums ...
4/29/2011 6:29:20 AM -- E: (100% processed) and F: (100% processed)
4/29/2011 6:29:20 AM -- Performance logging ends.
4/29/2011 6:29:20 AM -- [C:\Program Files\Exchange Jetstress\ESRP\DBChecksum_2011_4_29_2_58_23.blg](#) has 421 samples.

Appendix E: Read-Only Backup Test Results

Database backup Test Result Report

Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance3236.1	994882.09	04:41:38	58.87
Instance3236.2	994882.09	04:46:05	57.96

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

Instance3236.1 Log Path: L:\
 Database: E:\Jetstress001001.edb

Instance3236.2 Log Path: M:\
 Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Database Reads/s/sec	I/O Database Writes/s/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/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 3236.1	7.097	0.000	235.641	0.000	26214.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 3236.2	7.207	0.000	231.861	0.000	26214.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	13.897	6.341	23.194
Available MBytes	15073.954	14983.000	15087.000
Free System Page Table Entries	33555493.447	33555062.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	47752186.620	47558656.000	47837184.000
Pool Paged Bytes	111339035.797	109731840.000	201306112.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 5/7/2011 12:28:05 AM -- Jetstress testing begins ...
 5/7/2011 12:28:05 AM -- Prepare testing begins ...
 5/7/2011 12:28:08 AM -- Attaching databases ...
 5/7/2011 12:28:08 AM -- Prepare testing ends.
 5/7/2011 12:28:13 AM -- Performance logging begins (interval: 30000 ms).
 5/7/2011 12:28:13 AM -- Backing up databases ...
 5/7/2011 5:14:19 AM -- Performance logging ends.
 5/7/2011 5:14:19 AM -- Instance3236.1 (100% processed) and Instance3236.2 (100% processed)
 5/7/2011 5:14:19 AM -- [C:\Program Files\Exchange Jetstress\ESRP\DatabaseBackup_2011_5_7_0_28_8.blg](#) has 571 samples.
 5/7/2011 5:14:19 AM -- Creating test report ...

Appendix F: SoftRecovery Test Results

SoftRecovery Test Result Report

SoftRecovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance3764.1	501	1114.9027582
Instance3764.2	501	1121.0023689

Database Configuration

Instance3764.1 Log Path: L:\
Database: E:\Jetstress001001.edb

Instance3764.2 Log Path: M:\
Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Write s/sec	I/O Database Reads Average Bytes	I/O Database Write Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s/sec	I/O Log Write s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3764.1	23.619	8.428	318.556	2.693	41139.813	29864.506	9.398	0.003	4.043	0.011	206473.033	0.926
Instance3764.2	21.356	10.678	320.097	2.678	41280.907	29349.755	6.912	0.011	4.022	0.012	203266.798	0.921

Background Database Maintenance I/O Performance

MSExchange Database Instance	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3764.1	18.136	261656.567
Instance3764.2	13.804	261664.347

Total I/O Performance

MSExchange Database Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Data base Reads/s/sec	I/O Database Write s/sec	I/O Database Reads Average Bytes	I/O Database Write Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s/sec	I/O Log Write s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance3764.1	23.619	8.428	318.556	2.693	41139.813	29864.506	9.398	0.003	4.043	0.011	206473.033	0.926
Instance3764.2	21.356	10.678	320.097	2.678	41280.907	29349.755	6.912	0.011	4.022	0.012	203266.798	0.921

	Age Late ncy (msec)	Age Late ncy (msec)			Bytes	ge Bytes	Late ncy (msec)	Late ncy (msec)				Byte s
Instance 3764.1	23.6 19	8.42 8	336.6 91	2.693	5301 7.889	2986 4.506	9.39 8	0.00 3	4.043	0.011	20647 3.033	0.92 6
Instance 3764.2	21.3 56	10.6 78	333.9 01	2.678	5039 1.896	2934 9.755	6.91 2	0.01 1	4.022	0.012	20326 6.798	0.92 1

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.027	1.356	12.790
Available MBytes	14509.822	14333.000	15004.000
Free System Page Table Entries	33555589.788	33555574.000	33556094.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	43757803.318	43708416.000	43835392.000
Pool Paged Bytes	102105573.343	101249024.000	285184000.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/25/2011 11:25:50 AM -- Jetstress testing begins ...
4/25/2011 11:25:50 AM -- Prepare testing begins ...
4/25/2011 11:25:53 AM -- Attaching databases ...
4/25/2011 11:25:53 AM -- Prepare testing ends.
4/25/2011 11:25:53 AM -- Dispatching transactions begins ...
4/25/2011 11:25:53 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/25/2011 11:25:53 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/25/2011 11:25:57 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/25/2011 11:25:57 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/25/2011 11:26:00 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/25/2011 11:26:00 AM -- Performance logging begins (interval: 15000 ms).
4/25/2011 11:26:00 AM -- Generating log files ...
4/25/2011 12:30:35 PM -- L:\ (100.2% generated) and M:\ (100.2% generated)
4/25/2011 12:30:35 PM -- Performance logging ends.
4/25/2011 12:30:35 PM -- JetInterop batch transaction stats: 21423 and 21508.
4/25/2011 12:30:35 PM -- Dispatching transactions ends.
4/25/2011 12:30:35 PM -- Shutting down databases ...
4/25/2011 12:30:37 PM -- Instance3764.1 (complete) and Instance3764.2 (complete)
4/25/2011 12:30:37 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.blg](#) has 258 samples.
4/25/2011 12:30:37 PM -- Creating test report ...
4/25/2011 12:30:38 PM -- Instance3764.1 has 11.5 for I/O Database Reads Average Latency.
4/25/2011 12:30:38 PM -- Instance3764.1 has 4.0 for I/O Log Writes Average Latency.
4/25/2011 12:30:38 PM -- Instance3764.1 has 4.0 for I/O Log Reads Average Latency.
4/25/2011 12:30:38 PM -- Instance3764.2 has 11.7 for I/O Database Reads Average Latency.
4/25/2011 12:30:38 PM -- Instance3764.2 has 3.1 for I/O Log Writes Average Latency.
4/25/2011 12:30:38 PM -- Instance3764.2 has 3.1 for I/O Log Reads Average Latency.
4/25/2011 12:30:38 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

4/25/2011 12:30:38 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/25/2011 12:30:38 PM -- C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.xml has 257 samples queried.
 4/25/2011 12:30:39 PM -- C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.html is saved.
 4/25/2011 12:30:41 PM -- Performance logging begins (interval: 2000 ms).
 4/25/2011 12:30:41 PM -- Recovering databases ...
 4/25/2011 12:49:22 PM -- Performance logging ends.
 4/25/2011 12:49:22 PM -- Instance3764.1 (1114.9027582) and Instance3764.2 (1121.0023689)
 4/25/2011 12:49:23 PM -- C:\Program Files\Exchange Jetstress\ESRP\SoftRecovery_2011_4_25_12_30_39.blg has 557 samples.
 4/25/2011 12:49:23 PM -- Creating test report ...

Soft Recovery Test Report – Test Results

Test Summary

Overall Test Result **Pass**

Machine Name EX8PESRP01

Test

Description

Test Start Time 4/25/2011 11:25:50 AM

Test End Time 4/25/2011 12:30:37 PM

Collection Start Time 4/25/2011 11:26:15 AM

Collection End Time 4/25/2011 12:30:32 PM

Jetstress Version 14.01.0180.003

Ese Version 14.01.0218.012

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 338.57

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 2086452461568

Final Database Size (bytes) 2087048052736

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%

Database Configuration

Instance3764.1 Log Path: L:\
 Database: E:\Jetstress001001.edb

Instance3764.2 Log Path: M:\
 Database: F:\Jetstress002001.edb

Transactional I/O Performance

MSExchange Instance	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s/sec	I/O Database Writes/s/sec	I/O Database Average Bytes	I/O Database Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 3764.1	11.531	10.859	104.953	64.291	32769.041	37637.769	0.000	3.972	0.000	51.106	0.000	5494.530
Instance 3764.2	11.686	7.036	105.062	64.264	32769.813	37569.373	0.000	3.138	0.000	53.723	0.000	5257.093

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.150	1.143	3.560
Available MBytes	14514.609	14505.000	14928.000
Free System Page Table Entries	33555657.864	33555414.000	33556102.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	43417996.899	43159552.000	43511808.000
Pool Paged Bytes	101253405.767	101081088.000	101670912.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 4/25/2011 11:25:50 AM -- Jetstress testing begins ...
 4/25/2011 11:25:50 AM -- Prepare testing begins ...
 4/25/2011 11:25:53 AM -- Attaching databases ...
 4/25/2011 11:25:53 AM -- Prepare testing ends.
 4/25/2011 11:25:53 AM -- Dispatching transactions begins ...
 4/25/2011 11:25:53 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0

MB)

4/25/2011 11:25:53 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)

4/25/2011 11:25:57 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

4/25/2011 11:25:57 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

4/25/2011 11:26:00 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

4/25/2011 11:26:00 AM -- Performance logging begins (interval: 15000 ms).

4/25/2011 11:26:00 AM -- Generating log files ...

4/25/2011 12:30:35 PM -- L:\ (100.2% generated) and M:\ (100.2% generated)

4/25/2011 12:30:35 PM -- Performance logging ends.

4/25/2011 12:30:35 PM -- JetInterop batch transaction stats: 21423 and 21508.

4/25/2011 12:30:35 PM -- Dispatching transactions ends.

4/25/2011 12:30:35 PM -- Shutting down databases ...

4/25/2011 12:30:37 PM -- Instance3764.1 (complete) and Instance3764.2 (complete)

4/25/2011 12:30:37 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.blg](#) has 258 samples.

4/25/2011 12:30:37 PM -- Creating test report ...

4/25/2011 12:30:38 PM -- Instance3764.1 has 11.5 for I/O Database Reads Average Latency.

4/25/2011 12:30:38 PM -- Instance3764.1 has 4.0 for I/O Log Writes Average Latency.

4/25/2011 12:30:38 PM -- Instance3764.1 has 4.0 for I/O Log Reads Average Latency.

4/25/2011 12:30:38 PM -- Instance3764.2 has 11.7 for I/O Database Reads Average Latency.

4/25/2011 12:30:38 PM -- Instance3764.2 has 3.1 for I/O Log Writes Average Latency.

4/25/2011 12:30:38 PM -- Instance3764.2 has 3.1 for I/O Log Reads Average Latency.

4/25/2011 12:30:38 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

4/25/2011 12:30:38 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

4/25/2011 12:30:38 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.xml](#) has 257 samples queried.

4/25/2011 12:30:39 PM -- [C:\Program Files\Exchange Jetstress\ESRP\Performance_2011_4_25_11_25_57.html](#) is saved.

4/25/2011 12:30:41 PM -- Performance logging begins (interval: 2000 ms).

4/25/2011 12:30:41 PM -- Recovering databases ...

4/25/2011 12:49:22 PM -- Performance logging ends.

4/25/2011 12:49:22 PM -- Instance3764.1 (1114.9027582) and Instance3764.2 (1121.0023689)

4/25/2011 12:49:23 PM -- [C:\Program Files\Exchange Jetstress\ESRP\SoftRecovery_2011_4_25_12_30_39.blg](#) has 557 samples.

4/25/2011 12:49:23 PM -- Creating test report ...