

ESRP Storage Program
EMC Celerra NS-120 (1,500 User)
Mailbox Resiliency Storage Solution for
Microsoft Exchange 2010

Tested with: ESRP – Storage Version 3.0
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Overview

This document provides information on an EMC® Celerra® NS-120 storage solution for Microsoft Exchange Server, based on the *Microsoft Exchange Solution Reviewed Program (ESRP) – Storage* program*. For any questions or comments regarding the contents of this document, see [Contact 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 Celerra NS-120 storage system.

The EMC Celerra NS-120 meets the storage needs of a wide range of applications that include:

- Mail/Messaging
- Databases
- File/Print and web services
- Distributed applications
- Remote replication

In addition, the NS-120 supports a wide range of server operating systems such as Microsoft Windows, Linux, Solaris, AIX, and HP-UX.

Celerra NS-120 is a high performance, full function IP storage platform. It delivers NAS and iSCSI capabilities to consolidate application storage and file servers. Easy to deploy and simple to manage, the NS-120 is all-in-one IP

storage for customers looking for enterprise-class capabilities packaged for specific application, departments, and locations.

Celerra NS-120 also supports optical Fibre Channel connections.

Regardless of the configuration, Celerra platforms offer a full suite of advanced functionality:

- Robust snap and replication capabilities offer protection of data
- Celerra File Mover API offers automated policy-based movement of files between tiers of storage
- File-level retention provides disk-based Write Once Read Many (WORM) functionality, which is useful for archiving Exchange e-mails
- Automated volume management and Virtual Provisioning™ improve storage utilization

The performance results and best practices described in this document provide proven guidelines for configuring Celerra NS-120 for high performance Exchange email environments. For this solution, an integrated Celerra NS-120 storage system with 400 GB 10k rpm FC disks was used and configured for 1,500 Exchange 2010 users. Each of the 1,500 users had a very heavy profile of 0.15 IOPS and a mailbox size of 2 GB.

Solution Description

Sizing and configuring storage for Exchange Server is a complicated process, driven by many variables and factors, which vary with different organizations.

The sizing approach taken in this solution is based on performance, capacity, scalability, and reliability to meet and exceed the Microsoft Exchange Server recommended metrics.

This solution utilizes three copies of each Exchange database. Two of these copies are on the primary site storage array. To provide additional protection, a third copy of each database is placed on a secondary site storage array. The storage in the primary site is configured on two different shelves of Celerra NS-120 with three RAID 5 (4+1) groups in each shelf and the storage in the secondary site is configured on a single shelf of Celerra NS-120 with three RAID 5 (4+1) groups. Each RAID group holds one database and the logs for the next database. That means, the first RAID group holds the logs for the second database, the second RAID group holds the logs for the third database and the third RAID group holds the logs for the first database. This storage design ensures that each database and its corresponding logs are in different RAID groups. This storage design can be followed by any organization to implement a Database Availability Group (DAG) configuration.

A DAG is a set of mailbox servers that use continuous replication to provide automatic recovery in the event of failures. A DAG may contain up to 16 mailbox servers, each having a replicated copy of the production databases

and log files. When three copies are used within a DAG, EMC recommends that the third copy is placed on a separate storage array. This will ensure high availability within the site and between two sites.

If this disk layout is properly configured, it will match 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.

[Table 1](#) describes the characteristics of the storage configuration.

Table 1: Storage Configuration

Number of users	1,500
Number of Exchange Servers	3
IOPS per user	0.18 (including 20% overhead)
Mailbox size	2 GB
Number of disks required for databases and logs	15
Disk type	400 GB 10k FC drives
RAID type	RAID 5 (4+1)

Using the performance characteristics of Celerra NS-120 architecture, disk drives (400 GB, 10k) and 15 spindles with I/O capability are required to provide the necessary performance to match the I/O requirements of 1,500 users with 0.18 IOPS and a 3:2 read/write ratio.

[Figure 1](#) shows the reference architecture for the tested Exchange solution on Celerra NS-120.

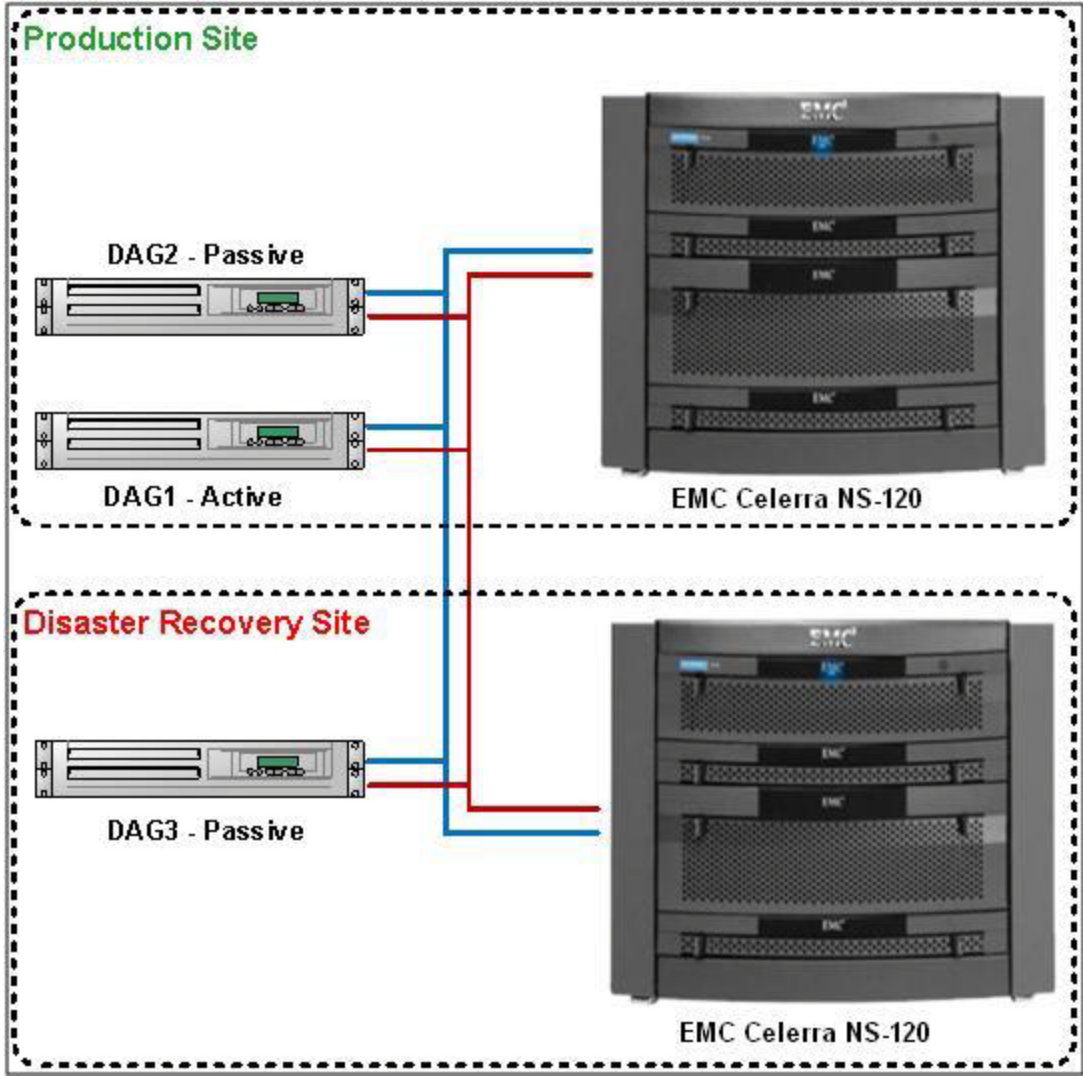


Figure 1: Reference Architecture

Figure 2 shows the disk layout for the tested Exchange solution on Celerra NS-120.

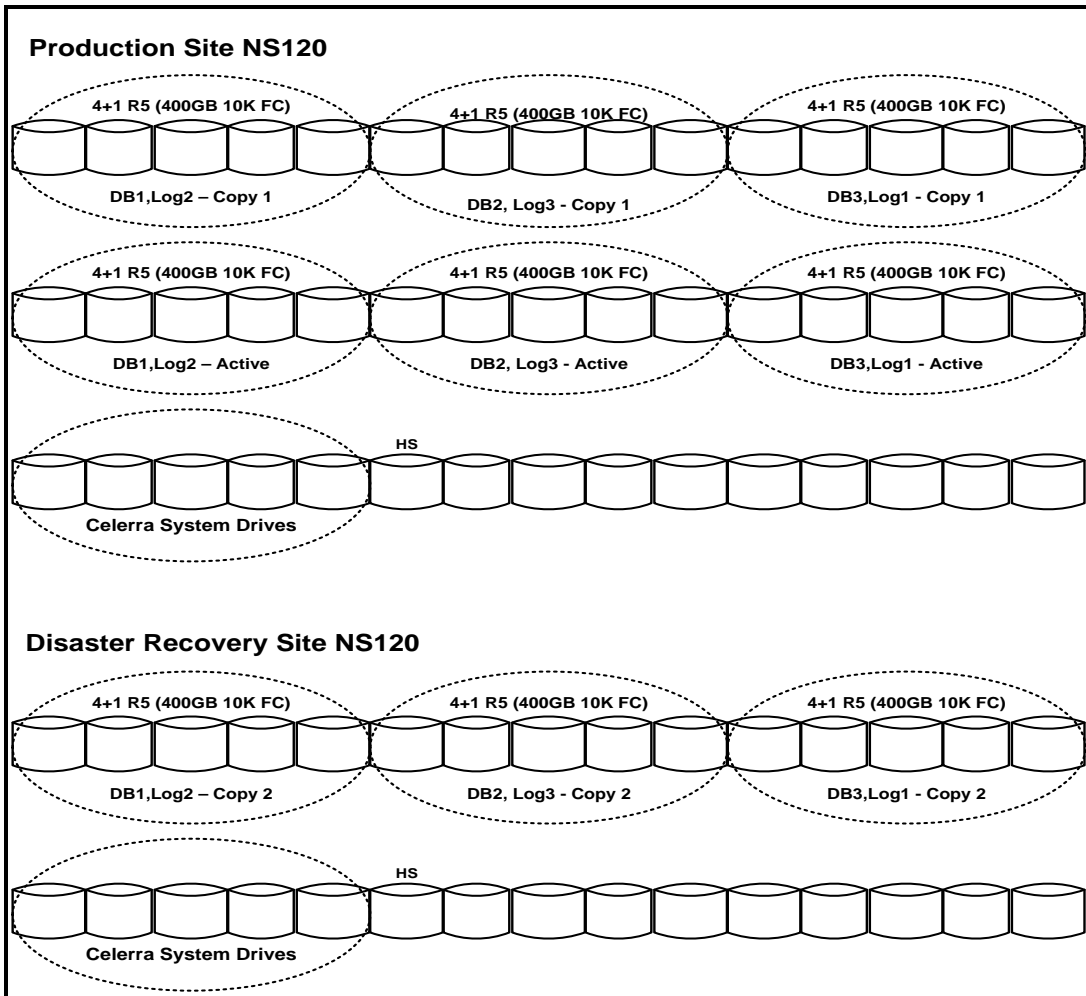


Figure 2: Disk Configuration

The 1,500 users are evenly distributed among three Exchange databases. Each RAID group holds both database and logs but the logs are not of the same database. The two disk volumes in each RAID group are concatenated into one metavolume. The first RAID group holds DB1 and Log2, the second RAID group holds DB2 and Log3, and the third RAID group holds DB3 and Log1.

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 that affect the server scalability are server processor utilization, physical server and virtual memory limitations, resource requirements for other applications, directory and network service latencies, network infrastructure limitations, replication and recovery requirements, and client usage profiles. All these factors are beyond the scope for ESRP-Storage. Therefore, the number of mailboxes hosted per server as part of the tested configuration may not necessarily be viable for some customer deployments.

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

Targeted Customer Profile

The solution is intended for medium-to-large enterprise Exchange customers to consolidate Exchange users on a high-performance, highly-available storage platform. This solution is designed to support 1,500 Exchange users with the following assumptions:

- Three Exchange Jetstress Server
- User I/O profile tested – Very heavy (0.15 per user)
- User mailbox size - 2 GB
- Three Exchange database per server
- DAG used for mailbox resiliency

Tested Deployment

The tables in this section summarize the testing environment.

Simulated Exchange Configuration

Table 2 describes the simulated exchange configuration.

Table 2: Simulated Exchange Configuration

Number of Exchange mailboxes simulated	1,500
Number of Database Availability Groups (DAGs)	3
Number of servers/DAG	3
Number of active mailboxes/server	1,500
Number of databases/host	3
Number of copies/database	3
Number of mailboxes/database	500
Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)	0.18
Database LUN size	1,400 GB
Log LUN size	40 GB
Total database size for performance testing	3,360 GB
% storage capacity used by Exchange database**	80%

**Storage performance characteristics change based on the percentage utilization of the individual disks. Tests that use a small

percentage of the storage (~25 percent) may exhibit reduced throughput if the storage capacity utilization is significantly increased beyond what is tested in this paper.

Storage Hardware

Table 3 describes the storage hardware.

Table 3: Hardware

Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	EMC Celerra NS-120 and EMC DART 5.6.47.11
Storage cache	2 GB split for Read/Write
Number of storage controllers	4 (2 front end and 2 back end)
Number of storage ports	4 (total 8 ports of which 4 are passive/redundant)
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	Broadcom BCM5708C NetXtreme II GigE (NDIS VBD Client) without jumbo frames enabled
Number of HBAs/host	2 dual port HBAs
Host server type	Server 2950 with 4 x Intel 2.99 GHz Xeon CPU and 32 GB memory
Total number of disks tested in solution	15
Maximum number of spindles that can be hosted in the storage	120

Storage Software

Table 4 describes the storage software.

Table 4: Storage Software

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	14.00.0639.019
Replication solution name/version	N/A

Storage Disk Configuration (Mailbox Store Disks)

Table 5 lists the storage disk configuration for the environment

Table 5: Storage Disk Configuration

Disk type, speed and firmware revision	10k rpm Fibre Channel disks
Raw capacity per disk (GB)	400 GB
Number of physical disks in test	15
Total raw storage capacity (GB)	6000 GB
Disk slice size(GB)	N/A
Number of slices per LUN or number of disks per LUN	5 disks per 2 LUNs
RAID-level	RAID 5 (4+1)
Total formatted capacity	4200 GB
Storage capacity utilization	70%
Database capacity utilization	56%

Storage Disk Configuration (Transactional Log Disks)

Table 6 describes the storage disk configuration of transactional log disks for the environment. The transactional log disk utilizes the same disks as the mailbox store database.

Table 6: Storage Disk Configuration

Disk type, speed, and firmware revision	10k rpm Fibre Channel disks
Raw capacity per disk (GB)	400 GB
Number of spindles in test	15
Total raw storage capacity (GB)	6,000 GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	5 disks per 2 LUNs
RAID level	RAID 5 (4+1)
Total formatted capacity	120 GB

Best Practices

In this solution, each RAID 5 (4+1) configuration satisfies the capacity and performance requirements for 500 users with a mailbox size of 2 GB and a user profile of 0.18 IOPs (including 20 percent overhead), ensuring that response times remain well within the required Microsoft thresholds. Once 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 allow the use of RAID 5 as an optimal RAID configuration.

For more information on EMC solutions for Microsoft Exchange Server, refer to

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

Exchange server is a disk-intensive application. Based on the testing run using the ESRP framework, EMC recommends the Exchange 2010 best practices to improve the storage performance.

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

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 iSCSI disks 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 being used with a minimum of three database copies, the maximum database size can be up to 2 TB.
4. Performance and capacity should be the primary consideration while 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 the 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.

Backup strategy

N/A

Contact 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, which are generated by the ESRP testing framework.

Reliability

A number of tests in the framework are to check Reliability tests run for 24 hours. The goal is to verify if the 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 there is no database or log corruption.

The reliability test executed on EMC Celerra NS-120 provided the following results:

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

[Appendix A: Stress Test report \(24 hours performance test\)](#) 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. The data below is the sum of all of the logical disk I/Os and average of all the logical disk I/O latency in the 2-hour test duration.

Individual Server Metrics

[Table 7](#) shows the sum of I/Os across all databases and the average latency across all the databases on the Exchange Server.

Table 7: Individual Server Metrics

Database I/O	
Database Disks Transfers/sec	367
Database Disks Reads/sec	259.25
Database Disks Writes/sec	108.71
Average Database Disk Read Latency (ms)	12.83
Average Database Disk-Write Latency (ms)	5.9
Transaction log I/O	
Log Disks Writes/sec	107.28
Average Log Disk-Write Latency (ms)	2.73

[Appendix B: Performance Test Results](#) provides the 2-hour Jetstress performance test results.

[Appendix C: Maximum Solution IOPS test](#) provides results that characterize the maximum performance of the disk layout.

Database Backup/Recovery Performance

There are two test reports in this section. The first test is to measure the sequential read rate of the database files, and the second test 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 using VSS.

[Table 8](#) shows the average rate for a single database file.

Table 8: Database Read-Only Performance

MB read/sec per database	N/A
MB read/sec total per server	N/A

Transaction Log Recovery/Replay Performance

This test is to measure the maximum rate at which the log files can be replayed against the databases.

Table 9 shows the average rate for 500 log files played in a single storage group. Each log file is 1 MB in size.

Table 9: Transaction Log Recovery/Replay Performance

Average time to play one Log file (sec)	2.79
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Appendix D: [SoftRecovery Test Result](#) shows the results that characterizes the log replay performance.

Conclusion

As this document illustrates, EMC's Celerra NS-120 is more than capable of supporting deployments of up to 1,500 users at 0.18 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 the NS-120 can support a high-performance Exchange configuration.

This document is developed by EMC, and reviewed by the Microsoft Exchange Product team. The test results/data presented in this document are based on the tests introduced in the ESRP test framework. Customers should not quote the data directly for the 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 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: Stress Test Report Results (24 hours performance test)

Microsoft Exchange Server Jetstress

Stress Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 3/25/2010 9:15:52 PM

Test End Time 3/26/2010 9:18:54 PM

Jetstress Version 14.00.0639.012

Ese Version 14.00.0639.019
Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)
Performance Log [C:\Program Files\Exchange Jetstress\Results\Stress_2010_3_25_21_16_3.blg](#)
[C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_26_21_18_54.blg](#)

Database Sizing and Throughput

Achieved Transactional I/O per Second 357.452
Capacity Percentage 100%
Throughput Percentage 100%
Initial Database Size (bytes) 3607780589568
Final Database Size (bytes) 3620942315520
Database Files (Count) 3

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 96.0 MB
Maximum Database Cache 768.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 3

Database Configuration

Instance2992.1 Log Path: J:\
 Database: G:\db1\Jetstress001001.edb

Instance2992.2 Log Path: H:\
 Database: F:\db2\Jetstress002001.edb

Instance2992.3 Log Path: E:\
 Database: I:\db3\Jetstress003001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database Average Bytes	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Average Latency (msec)	I/O Log Average Latency (msec)	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Average Bytes	I/O Log Average Bytes

	c)	c)										
Instance2992.1	13.36	6.659	83.26	35.87	34053	38010	0.00	3.34	0.000	30.16	0.00	5649.226
Instance2992.2	12.93	6.330	83.36	36.00	34158	37982	0.00	3.24	0.000	30.22	0.00	5632.084
Instance2992.3	13.03	6.156	83.14	35.79	34112	38007	0.00	3.31	0.000	30.20	0.00	5663.700

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2992.1	27.883	261849.537
Instance2992.2	28.113	261873.463
Instance2992.3	28.098	261868.002

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2992.1	1.397	221525.059
Instance2992.2	1.397	221759.406
Instance2992.3	1.404	222559.256

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
Instance2992.1	13.36	6.659	111.1	35.87	91201	38010	5.76	3.34	1.397	30.16	221525	5649.226
Instance2992.2	12.93	6.330	111.4	36.00	91583	37982	5.72	3.24	1.397	30.22	221759	5632.084
Instance2992.3	13.03	6.156	111.2	35.79	91641	38007	5.84	3.31	1.404	30.20	222559	5663.700

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.140	1.638	46.076
Available MBytes	29829.345	29581.000	29988.000
Free System Page Table Entries	33555793.618	33555357.000	33556550.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	5107992.963	49524736.000	52092928.000
Pool Paged Bytes	76476718.380	72523776.000	106590208.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 3/25/2010 9:15:52 PM -- Jetstress testing begins ...
 3/25/2010 9:15:52 PM -- Prepare testing begins ...
 3/25/2010 9:15:57 PM -- Attaching databases ...
 3/25/2010 9:15:57 PM -- Prepare testing ends.
 3/25/2010 9:15:57 PM -- Dispatching transactions begins ...
 3/25/2010 9:15:57 PM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)
 3/25/2010 9:15:57 PM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)
 3/25/2010 9:16:03 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
 3/25/2010 9:16:03 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
 3/25/2010 9:16:07 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 3/25/2010 9:16:07 PM -- Performance logging begins (interval: 15000 ms).
 3/25/2010 9:16:07 PM -- Attaining prerequisites:
 3/25/2010 9:18:46 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 728727600.0 (lower bound: 724775700.0, upper bound: none)
 3/26/2010 9:18:46 PM -- Performance logging ends.
 3/26/2010 9:18:46 PM -- JetInterop batch transaction stats: 251129, 251071, and 251287.
 3/26/2010 9:18:46 PM -- Dispatching transactions ends.
 3/26/2010 9:18:46 PM -- Shutting down databases ...
 3/26/2010 9:18:54 PM -- Instance2992.1 (complete), Instance2992.2 (complete), and Instance2992.3 (complete)
 3/26/2010 9:18:54 PM -- Performance logging begins (interval: 30000 ms).
 3/26/2010 9:18:54 PM -- Verifying database checksums ...
 3/27/2010 3:04:09 AM -- G: (100% processed), F: (100% processed), and I: (100% processed)
 3/27/2010 3:04:09 AM -- Performance logging ends.
 3/27/2010 3:04:09 AM -- C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_26_21_18_54.blg has 690 samples.
 3/27/2010 3:04:12 AM -- C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_26_21_18_54.html is saved.
 3/27/2010 3:04:12 AM -- Verifying log checksums ...
 3/27/2010 3:04:13 AM -- J:\ (7 log(s) processed), H:\ (6 log(s) processed), and E:\ (7 log(s) processed)
 3/27/2010 3:04:13 AM -- C:\Program Files\Exchange Jetstress\Results\Stress_2010_3_25_21_16_3.blg has 5767 samples.
 3/27/2010 3:04:13 AM -- Creating test report ...
 3/27/2010 3:04:36 AM -- Instance2992.1 has 13.4 for I/O Database Reads Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.1 has 3.3 for I/O Log Writes Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.1 has 3.3 for I/O Log Reads Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.2 has 12.9 for I/O Database Reads Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.2 has 3.2 for I/O Log Writes Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.2 has 3.2 for I/O Log Reads Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.3 has 13.0 for I/O Database Reads Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.3 has 3.3 for I/O Log Writes Average Latency.
 3/27/2010 3:04:36 AM -- Instance2992.3 has 3.3 for I/O Log Reads Average Latency.
 3/27/2010 3:04:36 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 3/27/2010 3:04:36 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 3/27/2010 3:04:36 AM -- C:\Program Files\Exchange Jetstress\Results\Stress_2010_3_25_21_16_3.xml has 5756 samples queried.

Stress test report – Checksum statistics

Microsoft Exchange Server Jetstress

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
G:\db1\Jetstress001001.edb	36833874	0	0	0	1151058 MBytes / 20713 sec
F:\db2\Jetstress002001.edb	36833874	0	0	0	1151058 MBytes / 19805 sec
I:\db3\Jetstress003001.edb	36834642	0	0	0	1151082 MBytes / 19831 sec
(Sum)	110502390	0	0	0	3453199 MBytes / 20714 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
G:	0.057	0.000	889.448	0.000	65536.000
F:	0.060	0.000	930.062	0.000	65536.000
I:	0.060	0.000	928.090	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	18.451	8.758	28.769
Available MBytes	30420.678	30377.000	30435.000
Free System Page Table Entries	33555575.980	33555501.000	33556037.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	52677949.588	52355072.000	53145600.000
Pool Paged Bytes	81900926.887	80588800.000	108535808.000

Test Log 3/25/2010 9:15:52 PM -- Jetstress testing begins ...

3/25/2010 9:15:52 PM -- Prepare testing begins ...

3/25/2010 9:15:57 PM -- Attaching databases ...

3/25/2010 9:15:57 PM -- Prepare testing ends.

3/25/2010 9:15:57 PM -- Dispatching transactions begins ...

3/25/2010 9:15:57 PM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)

3/25/2010 9:15:57 PM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)

3/25/2010 9:16:03 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

3/25/2010 9:16:03 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

3/25/2010 9:16:07 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%,

Reads 35%, Lazy Commits 70%.
 3/25/2010 9:16:07 PM -- Performance logging begins (interval: 15000 ms).
 3/25/2010 9:16:07 PM -- Attaining prerequisites:
 3/25/2010 9:18:46 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 728727600.0 (lower bound: 724775700.0, upper bound: none)
 3/26/2010 9:18:46 PM -- Performance logging ends.
 3/26/2010 9:18:46 PM -- JetInterop batch transaction stats: 251129, 251071, and 251287.
 3/26/2010 9:18:46 PM -- Dispatching transactions ends.
 3/26/2010 9:18:46 PM -- Shutting down databases ...
 3/26/2010 9:18:54 PM -- Instance2992.1 (complete), Instance2992.2 (complete), and Instance2992.3 (complete)
 3/26/2010 9:18:54 PM -- Performance logging begins (interval: 30000 ms).
 3/26/2010 9:18:54 PM -- Verifying database checksums ...
 3/27/2010 3:04:09 AM -- G: (100% processed), F: (100% processed), and I: (100% processed)
 3/27/2010 3:04:09 AM -- Performance logging ends.
 3/27/2010 3:04:09 AM -- C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_26_21_18_54.blg has 690 samples.

Appendix B: Performance Test Results

Microsoft Exchange Server *Jetstress*

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 3/22/2010 6:15:21 AM

Test End Time 3/22/2010 8:18:10 AM

Jetstress Version 14.00.0639.012

Ese Version 14.00.0639.019

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange Jetstress\Performance_2010_3_22_6_15_31.blg
C:\Program Files\Exchange Jetstress\DBChecksum_2010_3_22_8_18_10.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 367.957

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 3607780589568

Final Database Size (bytes) 3609089212416

Database Files (Count) 3

Jetstress System Parameters

Thread Count 3 (per database)

Minimum Database Cache 96.0 MB
Maximum Database Cache 768.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 3

Database Configuration

Instance2188.1 Log Path: J:\
 Database: G:\db1\Jetstress001001.edb

Instance2188.2 Log Path: H:\
 Database: F:\db2\Jetstress002001.edb

Instance2188.3 Log Path: E:\
 Database: I:\db3\Jetstress003001.edb

Transactional I/O Performance

MSExchange Database Instances	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database Average Latency (msec)	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database 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
Instance2188.1	12.957	6.189	86.337	36.046	33990.317	41772.250	0.000	2.784	0.000	35.677	0.000	5611.919
Instance2188.2	12.720	5.944	86.329	36.312	33925.020	41750.782	0.000	2.751	0.000	35.745	0.000	5622.104
Instance2188.3	12.808	5.832	86.585	36.347	33919.791	41784.334	0.000	2.645	0.000	35.855	0.000	5586.122

Background Database Maintenance I/O Performance

MSExchange Database Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2188.1	27.976	261915.728
Instance2188.2	28.456	261914.764
Instance2188.3	28.277	261953.471

Log Replication I/O Performance

MSExchange Database Instances	I/O Log Reads /sec	I/O Log Reads Average Bytes
Instance2188.1	1.646	231101.414

Instance2188.2	1.648	229644.594
Instance2188.3	1.646	230127.716

Total I/O Performance

MSExchange Database ==> Instances	I/O Data base Reads	I/O Data base Writes	I/O Database Reads /sec	I/O Database Writes /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 /sec	I/O Log Writes /sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2188.1	12.953	6.189	114.313	36.046	89770.000	41772.250	6.064	2.784	1.646	35.677	231101.414	5611.919
Instance 2188.2	12.720	5.944	114.785	36.312	90446.099	41750.782	5.888	2.751	1.648	35.745	229644.594	5622.104
Instance 2188.3	12.808	5.832	114.862	36.347	90057.397	41784.334	6.236	2.645	1.646	35.855	230127.716	5586.122

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.214	2.080	9.127
Available MBytes	29973.067	29967.000	29999.000
Free System Page Table Entries	33555726.244	33555474.000	33556039.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	49591982.230	49541120.000	49803264.000
Pool Paged Bytes	76205746.505	75862016.000	78753792.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 3/22/2010 6:15:21 AM -- Jetstress testing begins ...
3/22/2010 6:15:21 AM -- Prepare testing begins ...
3/22/2010 6:15:26 AM -- Attaching databases ...
3/22/2010 6:15:26 AM -- Prepare testing ends.
3/22/2010 6:15:26 AM -- Dispatching transactions begins ...
3/22/2010 6:15:26 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)
3/22/2010 6:15:26 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)
3/22/2010 6:15:31 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 50 msec/read).
3/22/2010 6:15:31 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 50 msec/write).
3/22/2010 6:15:35 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
3/22/2010 6:15:35 AM -- Performance logging begins (interval: 15000 ms).
3/22/2010 6:15:35 AM -- Attaining prerequisites:
3/22/2010 6:18:06 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 725860400.0 (lower bound: 724775700.0, upper bound: none)
3/22/2010 8:18:06 AM -- Performance logging ends.
3/22/2010 8:18:06 AM -- JetInterop batch transaction stats: 25071, 25078, and 25073.
3/22/2010 8:18:07 AM -- Dispatching transactions ends.
3/22/2010 8:18:07 AM -- Shutting down databases ...
3/22/2010 8:18:10 AM -- Instance2188.1 (complete), Instance2188.2 (complete), and

Instance2188.3 (complete)
 3/22/2010 8:18:11 AM -- Performance logging begins (interval: 30000 ms).
 3/22/2010 8:18:11 AM -- Verifying database checksums ...
 3/22/2010 1:56:40 PM -- G: (100% processed), F: (100% processed), and I: (100% processed)
 3/22/2010 1:56:40 PM -- Performance logging ends.
 3/22/2010 1:56:40 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum 2010 3 22 8 18 10.blg](#) has 676 samples.
 3/22/2010 1:56:43 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum 2010 3 22 8 18 10.html](#) is saved.
 3/22/2010 1:56:43 PM -- Verifying log checksums ...
 3/22/2010 1:56:44 PM -- J:\ (6 log(s) processed), H:\ (7 log(s) processed), and E:\ (7 log(s) processed)
 3/22/2010 1:56:44 PM -- [C:\Program Files\Exchange Jetstress\Performance 2010 3 22 6 15 31.blg](#) has 489 samples.
 3/22/2010 1:56:44 PM -- Creating test report ...
 3/22/2010 1:56:46 PM -- Instance2188.1 has 13.0 for I/O Database Reads Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.1 has 2.8 for I/O Log Writes Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.1 has 2.8 for I/O Log Reads Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.2 has 12.7 for I/O Database Reads Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.2 has 2.8 for I/O Log Writes Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.2 has 2.8 for I/O Log Reads Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.3 has 12.8 for I/O Database Reads Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.3 has 2.6 for I/O Log Writes Average Latency.
 3/22/2010 1:56:46 PM -- Instance2188.3 has 2.6 for I/O Log Reads Average Latency.
 3/22/2010 1:56:46 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 3/22/2010 1:56:46 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 3/22/2010 1:56:46 PM -- [C:\Program Files\Exchange Jetstress\Performance 2010 3 22 6 15 31.xml](#) has 478 samples queried.

Performance test report – Checksum statistics

Microsoft Exchange Server Jetstress

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
G:\db1\Jetstress001001.edb	36713554	0	0	0	1147298 MBytes / 20307 sec
F:\db2\Jetstress002001.edb	36713554	0	0	0	1147298 MBytes / 19817 sec
I:\db3\Jetstress003001.edb	36713554	0	0	0	1147298 MBytes / 20053 sec
(Sum)	110140662	0	0	0	3441895 MBytes / 20308 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
G:	0.056	0.000	903.539	0.000	65536.000
F:	0.061	0.000	926.645	0.000	65536.000
I:	0.060	0.000	915.831	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	17.550	8.745	22.142
Available MBytes	30759.186	30709.000	30769.000
Free System Page Table Entries	33555680.516	33555503.000	33556037.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	50638666.225	50487296.000	51261440.000
Pool Paged Bytes	76855283.882	76529664.000	80539648.000

Test Log 3/22/2010 6:15:21 AM -- Jetstress testing begins ...
 3/22/2010 6:15:21 AM -- Prepare testing begins ...
 3/22/2010 6:15:26 AM -- Attaching databases ...
 3/22/2010 6:15:26 AM -- Prepare testing ends.
 3/22/2010 6:15:26 AM -- Dispatching transactions begins ...
 3/22/2010 6:15:26 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)
 3/22/2010 6:15:26 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)
 3/22/2010 6:15:31 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 50 msec/read).
 3/22/2010 6:15:31 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 50 msec/write).
 3/22/2010 6:15:35 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 3/22/2010 6:15:35 AM -- Performance logging begins (interval: 15000 ms).
 3/22/2010 6:15:35 AM -- Attaining prerequisites:
 3/22/2010 6:18:06 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 725860400.0 (lower bound: 724775700.0, upper bound: none)
 3/22/2010 8:18:06 AM -- Performance logging ends.
 3/22/2010 8:18:06 AM -- JetInterop batch transaction stats: 25071, 25078, and 25073.
 3/22/2010 8:18:07 AM -- Dispatching transactions ends.
 3/22/2010 8:18:07 AM -- Shutting down databases ...
 3/22/2010 8:18:10 AM -- Instance2188.1 (complete), Instance2188.2 (complete), and Instance2188.3 (complete)
 3/22/2010 8:18:11 AM -- Performance logging begins (interval: 30000 ms).
 3/22/2010 8:18:11 AM -- Verifying database checksums ...
 3/22/2010 1:56:40 PM -- G: (100% processed), F: (100% processed), and I: (100% processed)
 3/22/2010 1:56:40 PM -- Performance logging ends.
 3/22/2010 1:56:40 PM -- [C:\Program Files\Exchange Jetstress\DBChecksum_2010_3_22_8_18_10.blg](#) has 676 samples.

Appendix C: Maximum Solution IOPS Test Results

The storage configuration illustrated in [Figure 1](#) is the EMC recommended configuration for a 1,500 Exchange user workload with 0.15 IOPS per user. The results shown in [Figure 1](#) illustrate that this configuration achieved excellent results, with considerable room for growth.

Often the observed user workload in customer environments is greater than expected. For example, the use of BlackBerry 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 3 to 9 without modifying any of the other components. The achieved IOPS increased from 367 to 746 with a 103 percent increase. While 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.

Microsoft Exchange Server *Jetstress*

Performance Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 3/25/2010 12:01:14 AM

Test End Time 3/25/2010 2:03:37 AM

Jetstress Version 14.00.0639.012

Ese Version 14.00.0639.019

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log C:\Program Files\Exchange Jetstress\Results\Performance_2010_3_25_0_1_24.blg
C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_25_2_3_37.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second 746.183

Capacity Percentage 100%
Throughput Percentage 100%
Initial Database Size (bytes) 3607780589568
Final Database Size (bytes) 3610263617536
Database Files (Count) 3

Jetstress System Parameters

Thread Count 9 (per database)
Minimum Database Cache 96.0 MB
Maximum Database Cache 768.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 3

Database Configuration

Instance2304.1 Log Path: J:\
 Database: G:\db1\Jetstress001001.edb

Instance2304.2 Log Path: H:\
 Database: F:\db2\Jetstress002001.edb

Instance2304.3 Log Path: E:\
 Database: I:\db3\Jetstress003001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Reads /sec	I/O Database Writes /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 /sec	I/O Log Writes /sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2304.1	19.759	13.468	174.793	72.511	33169.279	40877.015	0.000	5.023	0.000	54.060	0.000	6986.245
Instance2304.2	19.268	11.633	176.430	73.633	33182.717	40824.997	0.000	4.745	0.000	55.192	0.000	6910.258
Instance2304.3	19.179	10.767	175.788	73.028	33195.076	40867.780	0.000	4.987	0.000	54.500	0.000	6985.245

Background Database Maintenance I/O Performance

MSExchange Database ==>	Database Maintenance IO	Database Maintenance IO Reads
-------------------------	-------------------------	-------------------------------

Instances	Reads/sec	Average Bytes
Instance2304.1	25.632	261926.295
Instance2304.2	25.633	261926.471
Instance2304.3	25.594	261910.033

Log Replication I/O Performance

MSEExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2304.1	3.145	232572.402
Instance2304.2	3.177	232560.369
Instance2304.3	3.170	232565.193

Total I/O Performance

MSEExchange Database ==> Instances	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/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/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2304.1	19.759	13.468	200.426	72.511	62425.030	40877.015	7.463	5.023	3.145	54.060	232572.402	6986.245
Instance 2304.2	19.268	11.633	202.063	73.633	62200.062	40824.997	7.374	4.745	3.177	55.192	232560.369	6910.258
Instance 2304.3	19.179	10.767	201.382	73.028	62262.518	40867.780	7.592	4.987	3.170	54.500	232565.193	6985.245

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.882	4.289	11.881
Available MBytes	29902.300	29874.000	29950.000
Free System Page Table Entries	33555793.569	33555469.000	33556037.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	51206766.933	50384896.000	51699712.000
Pool Paged Bytes	84084241.067	80781312.000	110108672.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 3/25/2010 12:01:14 AM -- Jetstress testing begins ...

3/25/2010 12:01:14 AM -- Prepare testing begins ...

3/25/2010 12:01:19 AM -- Attaching databases ...

3/25/2010 12:01:19 AM -- Prepare testing ends.

3/25/2010 12:01:19 AM -- Dispatching transactions begins ...

3/25/2010 12:01:19 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)

3/25/2010 12:01:19 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)

3/25/2010 12:01:24 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 50 msec/read).

3/25/2010 12:01:24 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 50 msec/write).

3/25/2010 12:01:28 AM -- Operation mix: Sessions 9, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

3/25/2010 12:01:28 AM -- Performance logging begins (interval: 15000 ms).

3/25/2010 12:01:28 AM -- Attaining prerequisites:

3/25/2010 12:03:34 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 726175700.0 (lower bound: 724775700.0, upper bound: none)

3/25/2010 2:03:35 AM -- Performance logging ends.

3/25/2010 2:03:35 AM -- JetInterop batch transaction stats: 47091, 47502, and 47595.

3/25/2010 2:03:35 AM -- Dispatching transactions ends.

3/25/2010 2:03:35 AM -- Shutting down databases ...

3/25/2010 2:03:37 AM -- Instance2304.1 (complete), Instance2304.2 (complete), and Instance2304.3 (complete)

3/25/2010 2:03:38 AM -- Performance logging begins (interval: 30000 ms).

3/25/2010 2:03:38 AM -- Verifying database checksums ...

3/25/2010 7:49:25 AM -- G: (100% processed), F: (100% processed), and I: (100% processed)

3/25/2010 7:49:25 AM -- Performance logging ends.

3/25/2010 7:49:25 AM -- [C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_25_2_3_37.blg](#) has 691 samples.

3/25/2010 7:49:28 AM -- [C:\Program Files\Exchange Jetstress\Results\DBChecksum_2010_3_25_2_3_37.html](#) is saved.

3/25/2010 7:49:28 AM -- Verifying log checksums ...

3/25/2010 7:49:29 AM -- J:\ (11 log(s) processed), H:\ (11 log(s) processed), and E:\ (11 log(s) processed)

3/25/2010 7:49:29 AM -- [C:\Program Files\Exchange Jetstress\Results\Performance_2010_3_25_0_1_24.blg](#) has 488 samples.

3/25/2010 7:49:29 AM -- Creating test report ...

3/25/2010 7:49:32 AM -- Instance2304.1 has 19.8 for I/O Database Reads Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.1 has 5.0 for I/O Log Writes Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.1 has 5.0 for I/O Log Reads Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.2 has 19.3 for I/O Database Reads Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.2 has 4.7 for I/O Log Writes Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.2 has 4.7 for I/O Log Reads Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.3 has 19.2 for I/O Database Reads Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.3 has 5.0 for I/O Log Writes Average Latency.

3/25/2010 7:49:32 AM -- Instance2304.3 has 5.0 for I/O Log Reads Average Latency.

3/25/2010 7:49:32 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.

3/25/2010 7:49:32 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

3/25/2010 7:49:32 AM -- [C:\Program Files\Exchange Jetstress\Results\Performance_2010_3_25_0_1_24.xml](#) has 479 samples queried.

Maximum Solution Test Report – Checksum statistics

Microsoft Exchange Server **Jetstress**

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
G:\db1\Jetstress001001.edb	36725330	0	0	0	1147666 MBytes / 20746 sec
F:\db2\Jetstress002001.edb	36725586	0	0	0	1147674

					MBytes / 19853 sec
I:\db3\Jetstress003001.edb	36725586	0	0	0	1147674
					MBytes / 19897 sec
(Sum)	110176502	0	0	0	3443015
					MBytes / 20746 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
G:	0.057	0.000	885.159	0.000	65535.923
F:	0.061	0.000	925.100	0.000	65535.924
I:	0.060	0.000	922.653	0.000	65535.930

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	17.297	7.692	21.700
Available MBytes	30683.171	30576.000	30693.000
Free System Page Table Entries	33555749.389	33555501.000	33556039.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	52150621.731	51818496.000	52887552.000
Pool Paged Bytes	84151662.032	80404480.000	179376128.000

Test Log 3/25/2010 12:01:14 AM -- Jetstress testing begins ...
3/25/2010 12:01:14 AM -- Prepare testing begins ...
3/25/2010 12:01:19 AM -- Attaching databases ...
3/25/2010 12:01:19 AM -- Prepare testing ends.
3/25/2010 12:01:19 AM -- Dispatching transactions begins ...
3/25/2010 12:01:19 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)
3/25/2010 12:01:19 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)
3/25/2010 12:01:24 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 50 msec/read).
3/25/2010 12:01:24 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 50 msec/write).
3/25/2010 12:01:28 AM -- Operation mix: Sessions 9, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
3/25/2010 12:01:28 AM -- Performance logging begins (interval: 15000 ms).
3/25/2010 12:01:28 AM -- Attaining prerequisites:
3/25/2010 12:03:34 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 726175700.0 (lower bound: 724775700.0, upper bound: none)
3/25/2010 2:03:35 AM -- Performance logging ends.
3/25/2010 2:03:35 AM -- JetInterop batch transaction stats: 47091, 47502, and 47595.
3/25/2010 2:03:35 AM -- Dispatching transactions ends.
3/25/2010 2:03:35 AM -- Shutting down databases ...
3/25/2010 2:03:37 AM -- Instance2304.1 (complete), Instance2304.2 (complete), and Instance2304.3 (complete)
3/25/2010 2:03:38 AM -- Performance logging begins (interval: 30000 ms).
3/25/2010 2:03:38 AM -- Verifying database checksums ...
3/25/2010 7:49:25 AM -- G: (100% processed), F: (100% processed), and I: (100% processed)
3/25/2010 7:49:25 AM -- Performance logging ends.

Appendix D: SoftRecovery Test Results

Microsoft Exchange Server *Jetstress*

SoftRecovery Test Result Report

SoftRecovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2616.1	504	1419.1134087
Instance2616.2	504	1429.1911379
Instance2616.3	500	1358.3818301

Database Configuration

Instance2616.1 Log Path: J:\
Database: G:\db1\Jetstress001001.edb

Instance2616.2 Log Path: H:\
Database: F:\db2\Jetstress002001.edb

Instance2616.3 Log Path: E:\
Database: I:\db3\Jetstress003001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Data base Reads /sec	I/O Data base Writes /sec	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database Average Bytes	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Average Bytes	I/O Log Average Bytes
Instance 2616.1	148.584	44.822	149.705	2.132	54969.168	16663.273	10.887	0.005	3.201	0.011	109419.914	1.455
Instance 2616.2	146.991	46.055	153.328	2.110	54463.557	16152.588	8.693	0.000	3.170	0.000	103849.112	0.000
Instance 2616.3	148.306	51.509	155.480	2.207	53202.328	17236.065	12.889	0.004	3.316	0.002	111393.711	0.761

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2616.1	8.781	262036.140
Instance2616.2	8.578	262072.000
Instance2616.3	8.443	261789.263

Total I/O Performance

MSExchange Database ==> Instances	I/O Database Reads	I/O Database Writes	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database Average Bytes	I/O Log Reads	I/O Log Writes	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Average Bytes	I/O Log Average Bytes
Instance 2616.1	148.584	44.822	158.486	2.132	66441.480	16663.273	10.887	0.005	3.201	0.011	109419.914	1.455
Instance 2616.2	146.991	46.055	161.907	2.110	65463.072	16152.588	8.693	0.000	3.170	0.000	103849.112	0.000
Instance 2616.3	148.306	51.509	163.922	2.207	63945.292	17236.065	12.889	0.004	3.316	0.002	111393.711	0.761

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.612	0.000	10.964
Available MBytes	30032.219	29899.000	30704.000
Free System Page Table Entries	33555524.017	33555509.000	33556037.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	50403833.501	48652288.000	50745344.000
Pool Paged Bytes	73841682.776	69599232.000	772953344.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 3/23/2010 4:41:17 AM -- Jetstress testing begins ...

3/23/2010 4:41:17 AM -- Prepare testing begins ...

3/23/2010 4:41:22 AM -- Attaching databases ...

3/23/2010 4:41:22 AM -- Prepare testing ends.

3/23/2010 4:42:41 AM -- Jetstress testing begins ...

3/23/2010 4:42:41 AM -- Prepare testing begins ...

3/23/2010 4:42:46 AM -- Attaching databases ...

3/23/2010 4:42:46 AM -- Prepare testing ends.

3/23/2010 4:42:46 AM -- Dispatching transactions begins ...

3/23/2010 4:42:46 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)

3/23/2010 4:42:46 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)

3/23/2010 4:42:50 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 50 msec/read).

3/23/2010 4:42:50 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 50 msec/write).

3/23/2010 4:42:53 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

3/23/2010 4:42:53 AM -- Performance logging begins (interval: 15000 ms).

3/23/2010 4:42:53 AM -- Generating log files ...

3/23/2010 6:11:36 AM -- J:\ (101.0% generated), H:\ (101.0% generated), and E:\ (100.2% generated)

3/23/2010 6:11:36 AM -- Performance logging ends.

3/23/2010 6:11:36 AM -- JetInterop batch transaction stats: 18758, 18668, and 18620.

3/23/2010 6:11:36 AM -- Dispatching transactions ends.

3/23/2010 6:11:36 AM -- Shutting down databases ...
 3/23/2010 6:11:40 AM -- Instance2616.1 (complete), Instance2616.2 (complete), and Instance2616.3 (complete)
 3/23/2010 6:11:40 AM -- [C:\Program Files\Exchange Jetstress\Performance_2010_3_23_4_42_50.blg](#) has 354 samples.
 3/23/2010 6:11:40 AM -- Creating test report ...
 3/23/2010 6:11:42 AM -- Instance2616.1 has 13.2 for I/O Database Reads Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.1 has 2.5 for I/O Log Writes Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.1 has 2.5 for I/O Log Reads Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.2 has 13.0 for I/O Database Reads Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.2 has 2.5 for I/O Log Writes Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.2 has 2.5 for I/O Log Reads Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.3 has 13.1 for I/O Database Reads Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.3 has 2.5 for I/O Log Writes Average Latency.
 3/23/2010 6:11:42 AM -- Instance2616.3 has 2.5 for I/O Log Reads Average Latency.
 3/23/2010 6:11:42 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 3/23/2010 6:11:42 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 3/23/2010 6:11:42 AM -- [C:\Program Files\Exchange Jetstress\Performance_2010_3_23_4_42_50.xml](#) has 353 samples queried.
 3/23/2010 6:11:42 AM -- [C:\Program Files\Exchange Jetstress\Performance_2010_3_23_4_42_50.html](#) is saved.
 3/23/2010 6:11:45 AM -- Performance logging begins (interval: 2000 ms).
 3/23/2010 6:11:45 AM -- Recovering databases ...
 3/23/2010 6:35:34 AM -- Performance logging ends.
 3/23/2010 6:35:34 AM -- Instance2616.1 (1419.1134087), Instance2616.2 (1429.1911379), and Instance2616.3 (1358.3818301)
 3/23/2010 6:35:34 AM -- [C:\Program Files\Exchange Jetstress\SoftRecovery_2010_3_23_6_11_42.blg](#) has 709 samples.
 3/23/2010 6:35:34 AM -- Creating test report ...

SoftRecovery Test Report – Test Results

Microsoft Exchange Server Jetstress

SoftRecovery Test Result Report

Test Summary

Overall Test Result **Pass**

Machine Name RTPSOL395

Test Description

Test Start Time 3/23/2010 4:42:41 AM

Test End Time 3/23/2010 6:11:40 AM

Jetstress Version 14.00.0639.012

Ese Version 14.00.0639.019

Operating System Windows Server 2008 R2 Enterprise (6.1.7600.0)

Performance Log [C:\Program Files\Exchange Jetstress\Performance_2010_3_23_4_42_50.blg](#)

Database Sizing and Throughput

Achieved Transactional I/O per Second 369.712

Capacity Percentage 100%

Throughput Percentage 100%

Initial Database Size (bytes) 3607780589568
Final Database Size (bytes) 3608753668096
Database Files (Count) 3

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 96.0 MB
Maximum Database Cache 768.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%

Database Configuration

Instance2616.1 Log Path: J:\
 Database: G:\db1\Jetstress001001.edb

Instance2616.2 Log Path: H:\
 Database: F:\db2\Jetstress002001.edb

Instance2616.3 Log Path: E:\
 Database: I:\db3\Jetstress003001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Reads /sec	I/O Database Writes /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 /sec	I/O Log Writes /sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance2616.1	13.209	6.4655	87.225	35.951	32769.057	41503.431	0.000	2.512	0.000	36.943	0.000	5636.187
Instance2616.2	13.044	5.6967	87.427	36.254	32768.884	41573.180	0.000	2.548	0.000	36.698	0.000	5665.251
Instance2616.3	13.124	4.8039	86.929	35.926	32768.712	41574.016	0.000	2.545	0.000	36.560	0.000	5624.096

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.615	1.586	8.399
Available MBytes	30036.384	30018.000	30694.000
Free System Page Table Entries	33555997.144	33555509.000	33556039.000
Transition Pages RePurposed/sec	0.000	0.000	0.000

Pool Nonpaged Bytes	47926324.068	47538176.000	48365568.000
Pool Paged Bytes	69201364.610	68886528.000	71819264.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 3/23/2010 4:41:17 AM -- Jetstress testing begins ...
3/23/2010 4:41:17 AM -- Prepare testing begins ...
3/23/2010 4:41:22 AM -- Attaching databases ...
3/23/2010 4:41:22 AM -- Prepare testing ends.
3/23/2010 4:42:41 AM -- Jetstress testing begins ...
3/23/2010 4:42:41 AM -- Prepare testing begins ...
3/23/2010 4:42:46 AM -- Attaching databases ...
3/23/2010 4:42:46 AM -- Prepare testing ends.
3/23/2010 4:42:46 AM -- Dispatching transactions begins ...
3/23/2010 4:42:46 AM -- Database cache settings: (minimum: 96.0 MB, maximum: 768.0 MB)
3/23/2010 4:42:46 AM -- Database flush thresholds: (start: 7.7 MB, stop: 15.3 MB)
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3/23/2010 4:42:53 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
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3/23/2010 4:42:53 AM -- Generating log files ...
3/23/2010 6:11:36 AM -- J:\ (101.0% generated), H:\ (101.0% generated), and E:\ (100.2% generated)
3/23/2010 6:11:36 AM -- Performance logging ends.
3/23/2010 6:11:36 AM -- JetInterop batch transaction stats: 18758, 18668, and 18620.
3/23/2010 6:11:36 AM -- Dispatching transactions ends.
3/23/2010 6:11:36 AM -- Shutting down databases ...
3/23/2010 6:11:40 AM -- Instance2616.1 (complete), Instance2616.2 (complete), and Instance2616.3 (complete)
3/23/2010 6:11:40 AM -- C:\Program Files\Exchange\Jetstress\Performance_2010_3_23_4_42_50.blg has 354 samples.
3/23/2010 6:11:40 AM -- Creating test report ...
3/23/2010 6:11:42 AM -- Instance2616.1 has 13.2 for I/O Database Reads Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.1 has 2.5 for I/O Log Writes Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.1 has 2.5 for I/O Log Reads Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.2 has 13.0 for I/O Database Reads Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.2 has 2.5 for I/O Log Writes Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.2 has 2.5 for I/O Log Reads Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.3 has 13.1 for I/O Database Reads Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.3 has 2.5 for I/O Log Writes Average Latency.
3/23/2010 6:11:42 AM -- Instance2616.3 has 2.5 for I/O Log Reads Average Latency.
3/23/2010 6:11:42 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
3/23/2010 6:11:42 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
3/23/2010 6:11:42 AM -- C:\Program Files\Exchange\Jetstress\Performance_2010_3_23_4_42_50.xml has 353 samples queried.