

ESRP Storage Program

EMC CLARiiON AX4-5i (700 User) Storage Solution for Microsoft Exchange Server 2007 SP1

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Overview

This document provides information on the EMC®CLARiiON® AX4-5i 700 User Storage Solution for Microsoft Exchange Server 2007 based on the *Microsoft Exchange Solution Reviewed Program (ESRP) - Storage* program. For any questions or comments regarding the contents of this document, see the “[Contact information](#)” section.

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, copy the following URL into your browser:

<http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.mspx>

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Features

The EMC CLARiiON AX4 is a versatile and cost-effective solution for organizations looking for an alternative to server-based storage. The EMC CLARiiON AX4-5i delivers performance, scalability, and advanced data management features in one easy-to-use storage solution.

Advanced capabilities start with the scalability to meet both the needs of today and the requirements of tomorrow. Single-controller EMC CLARiiON AX4-5i models are a low-cost approach to deploying external storage. They provide an economical storage platform for applications such as backup-to-disk and a variety of data archiving tasks. Dual-controller models offer the superior availability, connectivity, and performance that business-critical data and applications require.

- 12 drives per enclosure
- Scaling up to 60 drives through four expansion enclosures
- Up to 60 TB of capacity
- Storage for up to 64 hosts

With both iSCSI and Fibre Channel (FC) models, the EMC CLARiiON AX4-5i enables organizations to choose the network interconnection that is right for their environments. The EMC CLARiiON AX4-5i iSCSI arrays support cost-effective, shared storage by utilizing widely available IP networking components for direct-attach to a network, using conventional Ethernet switches. EMC CLARiiON AX4-5i arrays, using 4 Gb/s FC connections, utilize low-cost host bus adapters to provide cost-effective, direct-attach configurations with a wide range of SAN switch options to create SANs for up to 64 high-availability servers. Each controller supports two front-end ports: either 4 Gb/s FC or 1 Gb/s iSCSI.

The EMC CLARiiON AX4-5i can be equipped with serial-attached SCSI (SAS) for performance-oriented applications and serial ATA (SATA) drives to deliver the lowest cost per gigabyte and highest capacity per drive. The ability to mix SAS and SATA drives within each enclosure provides the most flexible and economical system configurations for all needs.

The EMC CLARiiON AX4-5i series delivers functionality that releases the benefits of tiered storage. It is the answer to storage consolidation for heterogeneous environments. It supports Windows, Linux, AIX, HP-UX, Solaris, and VMware.

Solution description

The solution described in this document utilizes a single disk enclosure, with a total of four drives. This enables an organization to successfully deploy Microsoft Exchange with an EMC CLARiiON AX4-5i.

The database and log file drives are both configured as EMC two-disk RAID 1_0. In this configuration, organizations can run Microsoft Exchange on the minimum amount of drives for fault tolerance. In addition, an organization has the ability to grow quickly, using the EMC CLARiiON AX4-5i to stripe additional drive sets (in this configuration, two drives at a time) as needed, with no downtime or data loss when space or increased fault tolerance is required.

Sizing and configuring storage for use with the Microsoft Exchange server is an intricate process, driven by many variables and factors that differ from one organization to another.

The method described in this ESRP submission is the *building block* method. When utilizing a low number of disks, organizations can use the building block method to simplify sizing and configuration to ensure the highest performance while staying fault tolerant.

The unit of measure (or building block) is designed to be scalable, based on the I/O and latency requirements of the customer. The building blocks are designed around the Microsoft Exchange database drives in increments, using RAID 1_0 sets that give reproducible and scalable results as incremental building blocks are added.

Figure 1 illustrates the layout of the physical architecture.

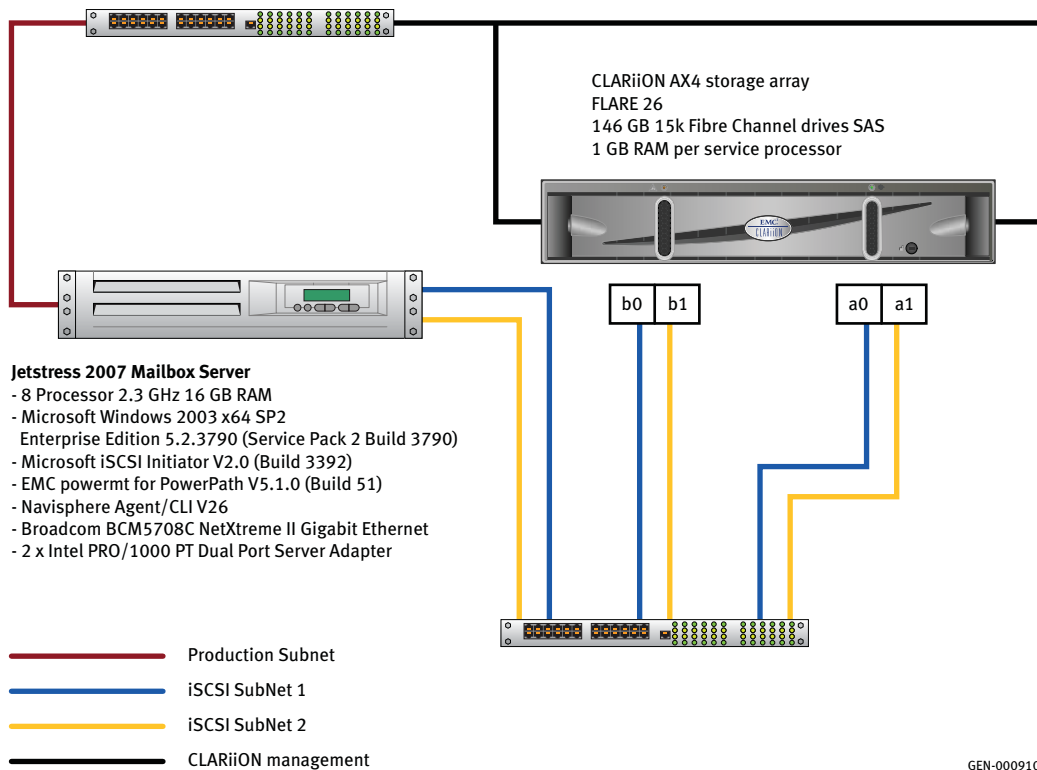


Figure 1 Physical architecture

The Windows Hardware Compatibility List link for the EMC CLARiiON AX4-5i is:

<http://www.windowsservercatalog.com/item.aspx?idItem=53f4f795-0c47-2df1-24b7-690341b1769e>

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 consider when designing a scalable Exchange solution. Other factors that affect the server scalability are:

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

Due to such variables, 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, see Microsoft's *Troubleshooting Microsoft Exchange Server Performance*, available at:

<http://go.microsoft.com/fwlink/?LinkId=23454>

Targeted customer profile

This solution is intended for small and medium-sized businesses hosting 700 Exchange mailboxes. The configuration used for testing is described below:

- One host attached, up to 64 hosts possible
- User I/O profile of .40
- User mailbox size of 130 MB

Tested deployment

The following tables summarize the tested environment.

Simulated Exchange configuration

Table 1 lists the simulated Exchange configuration details.

Table 1 Simulated Exchange configuration

Item	Description
Number of Exchange mailboxes simulated	700
Number of hosts	1
Number of mailboxes/hosts	700
Number of storage groups/host	1
Number of mailbox stores/storage group	1
Number of mailboxes/mailbox store	700
Number of mailbox store LUNs/storage group	1
Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)	.5
Database LUN size	116 GB
Log LUN size	25 GB
Backup LUN size/storage group	N/A
Total database size for performance testing	80 GB
% formatted 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%) may exhibit reduced throughput if the storage capacity utilization is significantly increased beyond what is tested in this paper.

Primary storage hardware

Table 2 lists the hardware used in the environment.

Table 2 Hardware (list of all hardware used for the test)

Item	Description
Storage type (FC, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	http://www.windowsservercatalog.com/item.aspx?idItem=53f4f795-0c47-2df1-24b7-690341b1769e EMC CLARiiON AX4-5i Firmware FLARE® V.26
Storage cache	1 GB
Number of storage controllers	2
Number of storage ports	4
Maximum bandwidth of storage connectivity to host	4 Gb/s
Switch type/model/firmware revision	Dell 5324 V2.0.0.39
HBA model and firmware	Intel PRO/1000 MT Network Connection
Number of HBAs/host	2
Host server type	[01]: EM64T Family 6 Model 15 Stepping 8 GenuineIntel ~2328 MHz [02]: EM64T Family 6 Model 15 Stepping 8 GenuineIntel ~2328 MHz [03]: EM64T Family 6 Model 15 Stepping 8 GenuineIntel ~2328 MHz [04]: EM64T Family 6 Model 15 Stepping 8 GenuineIntel ~2328 MHz Total Physical Memory: 15,743 MB
Total number of disks tested in solution	4
Maximum number of spindles that can be hosted in the storage	60

Primary storage software

Table 3 lists the software used in the environment.

Table 3 Software

Item	Description
HBA driver	c:\windows\system32\drivers\ele5132.sys 9.9.13.0 built by: winDDK 6/19/2007 10:47am 348,568
HBA QueueTarget setting	N/A
HBA QueueDepth setting	N/A
Multipathing	Microsoft iSCSI Initiator version 2.0 Build 3392 EMC powermt for PowerPath [®] Version 5.1.0 (build 51)
Host OS	OS Name: Microsoft Windows Server 2003 Enterprise x64 Edition OS Version: 5.2.3790 Service Pack 1 Build 3790
ESE.dll file version	08.01.0240.005
Replication solution name/version	N/A

Primary storage disk configuration (mailbox store disks)

Table 4 lists the disk configuration (mailbox store disks) for the environment.

Table 4 Disk configuration (mailbox store)

Item	Description
Disk type, speed and firmware revision	146 GB SAS 15k:E50A
Raw capacity per disk (GB)	133 GB
Number of physical disks in test	2
Total raw storage capacity (GB)	266 GB
Disk slice size (GB)	133 GB
Number of disks per LUN	2
RAID level	RAID 1_0

Table 4 Disk configuration (mailbox store) (continued)

Item	Description
Total formatted capacity	116 GB
Storage capacity utilization	50%
Database capacity utilization	30%

Primary storage disk configuration (transactional log disks)

Table 5 lists the disk configuration (transactional log disks) for the environment.

Table 5 Disk configuration

Item	Description
Disk type, speed and firmware revision	146 GB SAS 15k:E50A
Raw capacity per disk (GB)	133 GB
Number of spindles in test	2
Total raw storage capacity (GB)	266 GB
Disk slice size	25
Number of slices per LUN or number of disks per LUN	2
RAID level	RAID 1_0
Total formatted capacity	25 GB

Best practices

Microsoft Exchange Server is a disk-intensive application. It is characterized as a very bursty read/write operation to the database files, with a sequential (mostly 512 byte) write operation to the transaction logs. It is this random, bursty workload—with periods of high peaks—that makes designing a well-performing storage solution with Microsoft Exchange Server a challenge. Different corporate environments have different user and storage requirements, so storage design cannot be based simply on generalizations.

Based on the testing run using an ESRP framework, EMC recommends following these best practices to improve storage performance with Exchange solutions. For Microsoft's Exchange 2007 best practices on storage design, visit:

<http://technet.microsoft.com/en-us/library/bb124518.aspx>

1. Use diskpart (in Microsoft Windows 2003 SP2 x64) to align all disks used with Microsoft Exchange, using a value of 64 for CLARiiON. This aligns all of the Exchange-related NTFS partitions on a 64 KB boundary.
2. Isolate the Microsoft Exchange Database workload from other I/O intensive applications or workloads. This ensures the highest levels of performance for Microsoft Exchange and makes troubleshooting efforts easier in the event of a disk-related Microsoft Exchange performance issue.
3. TcpAckFrequency = 1 for each iSCSI connection. Refer to: <http://support.microsoft.com/kb/328890>
4. Size and configure the environment for spindle performance as a primary consideration, with storage capacity as secondary.
5. Configure iSCSI using PowerPath 5.1.0 utilizing a balanced path approach. Log in with NIC0 into the A0(Spa) and B0(Spb), and NIC1 into B1(Spb) and A1(Spa).
6. Tuning the AX4 storage system parameters is important in obtaining best performance. The following list details the optimal parameters for Exchange:
 - Cache page size of 8 KB
 - Balance read and write caching
 - Read and write cache enabled for all LUNs
 - Read cache minimum of 50–100 MB for prefetch

Test result summary

This section provides a high-level summary of the test data from ESRP, as well as links to the detailed reports that are generated by the ESRP testing framework. The results are located in [“Appendix A: Jetstress results” on page 17](#).

Reliability

A number of the tests in the framework are designed to test reliability over a 24-hour period. The goal of these tests is to verify that the storage can handle a high I/O load for a long period of time while replicating synchronously. Following the stress test, both log and database files are analyzed for integrity to ensure there is no database/log corruption.

- No errors were reported in the event log file for the storage reliability testing.
- No errors were reported for the database and log checksum.
- The backup-to-disk test is not applicable.
- No errors were reported during the database checksum on the remote storage database.

Primary storage performance results

To see the Jetstress performance results (2-hour performance test), review the section [“Microsoft Exchange Server 2007 Jetstress - 2-hour performance” on page 17](#).

Performance testing exercises the storage with maximum sustainable Exchange-type I/O for two hours. The test is used to show how long it takes for the storage to respond to an I/O under load. The data included in the following tables is a sample taken from each of the attached hosts. It is the average of all the logical disks in the two-hour test duration.

Each server is listed separately, and the aggregate numbers across all servers are listed in [“Individual server metrics” on page 14](#).

Individual server metrics

The information in this table includes the sum of I/Os across storage groups and the average latency across all storage groups on a per-server basis.

Database I/O	
Database disks transfers/sec	284.509
Database disks reads/sec	133.767
Database disks writes/sec	150.742
Average database disk read latency (ms)	9
Average database disk write latency (ms)	6
Transaction log I/O	
Log disks writes/sec	101.382
Average log disk write latency (ms)	1

Recovery performance

The SoftRecovery test is to measure the read I/O performance metrics by running a checksum on all the databases and log files.

Log read-only performance

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

Average time to play one log file (sec)	.55
---	-----

Streaming backup/recovery performance

For the version 1.0 release, only streaming backup type is supported for testing in the framework. There are two tests in this section. The first one is to measure the read I/O performance metrics by running checksum on all the databases and log files. The second test is to measure the end-to-end performance when the databases are backed up to disks.

Database read-only performance

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

Server 1

MB read/sec per storage group	58.59
MB read/sec total	58.59

Conclusion

This document has been 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. The customers should not quote the data directly for their predeployment verification. It is still necessary to go through the exercises to validate the storage design for a specific customer environment.

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

Contact information

EMC recommends that you consult with EMC Professional Services to assist with the design and deployment of a similar solution. For information about 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**

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<http://EMC.com>

or to

<http://Powerlink.EMC.com>

Appendix A: Jetstress results

This section provides a high-level summary of the test data from ESRP.

Microsoft Exchange Server 2007 Jetstress - 2-hour performance

Performance test result report

Test summary

Overall Test Result	Pass
Machine Name	8B8MGD1
Test Description	
Test Start Time	5/8/2008 7:42:58 AM
Test End Time	5/8/2008 9:49:13 AM
Jetstress Version	08.01.0283.000
Ese Version	08.01.0240.005
Operating System	Microsoft Windows Server 2003 R2 Service Pack 2 (5.2.3790.131072)
Performance Log	C:\ax4q2\2+2 0_5-0_6 2t\Performance_2008_5_8_7_43_0.blg

Database sizing and throughput

Achieved I/O per Second	284.509
Target I/O per Second	40
Initial database size	78643871744
Final database size	79681961984
Database files (count)	1

Jetstress system parameters

Thread count	2 (per storage group)
Log buffers	9000
Minimum database cache	32.0 MB
Maximum database cache	256.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%
Lazy commits	55%

Disk subsystem performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (V:)	0.009	0.006	133.767	150.742	(n/a)
Log (s:)	0.000	0.001	0.000	101.382	4176.577

Host system performance

Counter	Average	Minimum	Maximum
% Processor Time	0.556	0.039	1.107
Available MBytes	15115.275	15101.000	15128.000
Free System Page Table Entries	16757120.000	16757120.000	16757120.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	69908906.667	69820416.000	69984256.000
Pool Paged Bytes	63428309.333	63381504.000	63946752.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test log

5/8/2008 7:42:58 AM -- Command Line: "C:\PROGRA~1\EXCHAN~1\jetstresscmd.exe" /c "C:\ax4q2\2+2 0_5-0_6 2t\2+2 - 2t.xml"

5/8/2008 7:42:58 AM -- Jetstress testing begins ...

5/8/2008 7:42:58 AM -- Prepare testing begins ...

5/8/2008 7:42:59 AM -- Attaching databases ...

5/8/2008 7:42:59 AM -- Prepare testing ends.

5/8/2008 7:42:59 AM -- Dispatching transactions begins ...

5/8/2008 7:42:59 AM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)

5/8/2008 7:42:59 AM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)

5/8/2008 7:43:00 AM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

5/8/2008 7:43:00 AM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

5/8/2008 7:43:01 AM -- Operation mix: Sessions 2, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.

5/8/2008 7:43:01 AM -- Performance logging begins (interval: 15000 ms).

5/8/2008 7:43:01 AM -- Attaining prerequisites:

5/8/2008 7:49:10 AM -- \MSEExchange Database(JetstressCmd)\Database Cache Size, Last: 241926100.0 (lower bound: 241591900.0, upper bound: none)

5/8/2008 9:49:12 AM -- Performance logging ends.

5/8/2008 9:49:12 AM -- JetInterop batch transaction stats: 40074.

5/8/2008 9:49:13 AM -- Dispatching transactions ends.

5/8/2008 9:49:13 AM -- Shutting down databases ...

5/8/2008 9:49:13 AM -- Instance1628.1 (complete)

5/8/2008 9:49:13 AM -- C:\ax4q2\2+2 0_5-0_6 2t\Performance_2008_5_8_7_43_0.blg has 504 samples.

5/8/2008 9:49:13 AM -- Creating test report ...

5/8/2008 9:49:16 AM -- Volume V: has 0.0090 for Avg. Disk sec/Read.

5/8/2008 9:49:16 AM -- Volume s: has 0.0010 for Avg. Disk sec/Write.

5/8/2008 9:49:16 AM -- Volume s: has 0.0000 for Avg. Disk sec/Read.

5/8/2008 9:49:16 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.

5/8/2008 9:49:16 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/8/2008 9:49:16 AM -- C:\ax4q2\2+2 0_5-0_6 2t\Performance_2008_5_8_7_43_0.xml has 479 samples queried.

Jetstress SoftRecovery

Microsoft Exchange Server Jetstress

SoftRecovery test result report

SoftRecovery statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance3056.1	500	268.515625

Disk subsystem performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (V:)	0.112	0.029	929.223	17.567	(n/a)
Log (s:)	0.001	0.000	61.670	1.380	1706.239

Host system performance

Counter	Average	Minimum	Maximum
% Processor Time	2.146	0.977	8.887
Available MBytes	15184.619	15148.000	15415.000
Free System Page Table Entries	16758236.000	16758236.000	16758236.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	63576889.313	62390272.000	63668224.000
Pool Paged Bytes	41520907.463	41263104.000	41811968.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test log

5/12/2008 9:39:21 PM -- Command Line: "C:\PROGRA~1\EXCHAN~1\jetstresscmd.exe" /c "C:\ax4q2\2+2 0_5-0_6 2t\soft\2+2 - 2t.xml"

5/12/2008 9:39:21 PM -- Jetstress testing begins ...

5/12/2008 9:39:22 PM -- Prepare testing begins ...

5/12/2008 9:39:23 PM -- Attaching databases ...

5/12/2008 9:39:23 PM -- Prepare testing ends.

5/12/2008 9:39:23 PM -- Dispatching transactions begins ...

5/12/2008 9:39:23 PM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)

5/12/2008 9:39:23 PM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)

5/12/2008 9:39:24 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

5/12/2008 9:39:24 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

5/12/2008 9:39:25 PM -- Operation mix: Sessions 2, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.

5/12/2008 9:39:25 PM -- Performance logging begins (interval: 15000 ms).

5/12/2008 9:39:25 PM -- Generating log files ...

5/12/2008 10:22:48 PM -- s:\ (100.2% generated)

5/12/2008 10:22:49 PM -- Performance logging ends.

5/12/2008 10:22:49 PM -- JetInterop batch transaction stats: 14262.

5/12/2008 10:22:50 PM -- Dispatching transactions ends.

5/12/2008 10:22:50 PM -- Shutting down databases ...

5/12/2008 10:22:50 PM -- Instance3056.1 (complete)

5/12/2008 10:22:50 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.blg has 173 samples.

5/12/2008 10:22:50 PM -- Creating test report ...

5/12/2008 10:22:50 PM -- Volume V: has 0.0089 for Avg. Disk sec/Read.

5/12/2008 10:22:50 PM -- Volume s: has 0.0010 for Avg. Disk sec/Write.

5/12/2008 10:22:50 PM -- Volume s: has 0.0000 for Avg. Disk sec/Read.

5/12/2008 10:22:50 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

5/12/2008 10:22:50 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/12/2008 10:22:51 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.xml has 172 samples queried.

5/12/2008 10:22:51 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.html is saved.

5/12/2008 10:22:51 PM -- Performance logging begins (interval: 2000 ms).

5/12/2008 10:22:51 PM -- Recovering databases ...

5/12/2008 10:27:21 PM -- Performance logging ends.

5/12/2008 10:27:21 PM -- Instance3056.1 (268.515625)

5/12/2008 10:27:21 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\SoftRecovery_2008_5_12_22_22_51.blg has 134 samples.

5/12/2008 10:27:21 PM -- Creating test report ...

Microsoft Exchange Server 2007 Jetstress

Soft recovery test result report

Test summary

Overall Test Result	Pass
Machine Name	8B8MGD1
Test Description	
Test Start Time	5/12/2008 9:39:22 PM
Test End Time	5/12/2008 10:22:50 PM
Jetstress Version	08.01.0283.000
Ese Version	08.01.0240.005
Operating System	Microsoft Windows Server 2003 R2 Service Pack 2 (5.2.3790.131072)
Performance Log	C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.blg

Database sizing and throughput

Achieved I/O per Second	286.108
Target I/O per Second	40
Initial database size	78643871744
Final database size	79021359104
Database files (count)	1

Jetstress system parameters

Thread count	2 (per storage group)
Log buffers	9000
Minimum database cache	32.0 MB
Maximum database cache	256.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%
Lazy commits	55%

Disk subsystem performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (V:)	0.009	0.006	133.608	152.500	(n/a)
Log (s:)	0.000	0.001	0.000	105.623	4199.944

Host subsystem performance

Counter	Average	Minimum	Maximum
% Processor Time	0.323	0.052	0.807
Available MBytes	15127.559	15105.000	15351.000
Free System Page Table Entries	16757120.000	16757120.000	16757120.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	70353735.111	70197248.000	70443008.000
Pool Paged Bytes	64449009.778	64393216.000	65540096.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test log

5/12/2008 9:39:21 PM -- Command Line: "C:\PROGRA~1\EXCHAN~1\jetstresscmd.exe" /c "C:\ax4q2\2+2 0_5-0_6 2t\soft\2+2 - 2t.xml"

5/12/2008 9:39:21 PM -- Jetstress testing begins ...

5/12/2008 9:39:22 PM -- Prepare testing begins ...

5/12/2008 9:39:23 PM -- Attaching databases ...

5/12/2008 9:39:23 PM -- Prepare testing ends.

5/12/2008 9:39:23 PM -- Dispatching transactions begins ...

5/12/2008 9:39:23 PM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)

5/12/2008 9:39:23 PM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)

5/12/2008 9:39:24 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.05 seconds/read).

5/12/2008 9:39:24 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.05 seconds/write).

5/12/2008 9:39:25 PM -- Operation mix: Sessions 2, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.

5/12/2008 9:39:25 PM -- Performance logging begins (interval: 15000 ms).

5/12/2008 9:39:25 PM -- Generating log files ...

5/12/2008 10:22:48 PM -- s:\ (100.2% generated)

5/12/2008 10:22:49 PM -- Performance logging ends.

5/12/2008 10:22:49 PM -- JetInterop batch transaction stats: 14262.

5/12/2008 10:22:50 PM -- Dispatching transactions ends.

5/12/2008 10:22:50 PM -- Shutting down databases ...

5/12/2008 10:22:50 PM -- Instance3056.1 (complete)

5/12/2008 10:22:50 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.blg has 173 samples.

5/12/2008 10:22:50 PM -- Creating test report ...

5/12/2008 10:22:50 PM -- Volume V: has 0.0089 for Avg. Disk sec/Read.

5/12/2008 10:22:50 PM -- Volume s: has 0.0010 for Avg. Disk sec/Write.

5/12/2008 10:22:50 PM -- Volume s: has 0.0000 for Avg. Disk sec/Read.

5/12/2008 10:22:50 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.

5/12/2008 10:22:50 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/12/2008 10:22:51 PM -- C:\ax4q2\2+2 0_5-0_6 2t\soft\Performance_2008_5_12_21_39_24.xml has 172 samples queried.

Microsoft Exchange Server 2007 Jetstress - 24-hour stress

Stress test result report

Test summary

Overall Test Result	Pass
Machine Name	8B8MGD1
Test Description	
Test Start Time	5/14/2008 6:41:30 PM
Test End Time	5/15/2008 6:47:16 PM
Jetstress Version	08.01.0283.000
Ese Version	08.01.0240.005
Operating System	Microsoft Windows Server 2003 R2 Service Pack 2 (5.2.3790.131072)
Performance Log	C:\ax4q2\2+2 0_5-0_6 2t\stress\Stress_2008_5_14_18_41_33.blg

Database sizing and throughput

Achieved I/O per Second	277.063
Target I/O per Second	40
Initial database size	78643871744
Final database size	88334811136
Database files (count)	1

Jetstress system parameters

Thread count	2 (per storage group)
Log buffers	9000
Minimum database cache	32.0 MB
Maximum database cache	256.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%
Lazy commits	55%

Disk subsystem performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (V:)	0.009	0.006	136.553	140.510	(n/a)
Log (s:)	0.000	0.001	0.000	89.669	4337.499

Host system performance

Counter	Average	Minimum	Maximum
% Processor Time	0.627	0.013	2.266
Available MBytes	15146.085	15133.000	15168.000
Free System Page Table Entries	16758446.000	16758446.000	16758446.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	66886308.978	66813952.000	67014656.000
Pool Paged Bytes	43782595.556	43630592.000	44392448.000
Database Page Fault Stalls/sec	0.001	0.000	1.067

Test log

5/14/2008 6:41:30 PM -- Command Line: "C:\PROGRA~1\EXCHAN~1\jetstresscmd.exe" /c "C:\ax4q2\2+2 0_5-0_6 2t\stress\2+2 - 2t.xml"

5/14/2008 6:41:30 PM -- Jetstress testing begins ...

5/14/2008 6:41:30 PM -- Prepare testing begins ...

5/14/2008 6:41:32 PM -- Attaching databases ...

5/14/2008 6:41:32 PM -- Prepare testing ends.

5/14/2008 6:41:32 PM -- Dispatching transactions begins ...

5/14/2008 6:41:32 PM -- Database cache settings: (minimum: 32.0 MB, maximum: 256.0 MB)

5/14/2008 6:41:32 PM -- Database flush thresholds: (start: 2.6 MB, stop: 5.1 MB)

5/14/2008 6:41:33 PM -- Database read latency thresholds: (average: 0.02 seconds/read, maximum: 0.1 seconds/read).

5/14/2008 6:41:33 PM -- Log write latency thresholds: (average: 0.01 seconds/write, maximum: 0.1 seconds/write).

5/14/2008 6:41:34 PM -- Operation mix: Sessions 2, Inserts 40%, Deletes 30%, Replaces 5%, Reads 25%, Lazy Commits 55%.

5/14/2008 6:41:34 PM -- Performance logging begins (interval: 15000 ms).

5/14/2008 6:41:34 PM -- Attaining prerequisites:

5/14/2008 6:47:14 PM -- \MSExchange Database(JetstressCmd)\Database Cache Size, Last: 242368500.0 (lower bound: 241591900.0, upper bound: none)

5/15/2008 6:47:16 PM -- Performance logging ends.

5/15/2008 6:47:16 PM -- JetInterop batch transaction stats: 400379.

5/15/2008 6:47:16 PM -- Dispatching transactions ends.

5/15/2008 6:47:16 PM -- Shutting down databases ...

5/15/2008 6:47:16 PM -- Instance2764.1 (complete)

5/15/2008 6:47:16 PM -- C:\ax4q2\2+2 0_5-0_6 2t\stress\Stress_2008_5_14_18_41_33.blg has 5782 samples.

5/15/2008 6:47:16 PM -- Creating test report ...

5/15/2008 6:48:04 PM -- Volume V: has 0.0094 for Avg. Disk sec/Read.

5/15/2008 6:48:04 PM -- Volume s: has 0.0010 for Avg. Disk sec/Write.

5/15/2008 6:48:04 PM -- Volume s: has 0.0000 for Avg. Disk sec/Read.

5/15/2008 6:48:04 PM -- Test has 1.06691943699111 Maximum Database Page Fault Stalls/sec.

5/15/2008 6:48:04 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/15/2008 6:48:04 PM -- C:\ax4q2\2+2 0_5-0_6 2t\stress\Stress_2008_5_14_18_41_33.xml has 5759 samples queried.

JetStress streaming backup

Microsoft Exchange Server Jetstress streaming backup test result report

Streaming backup statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance1732.1	109252.90	00:31:04	58.59

Jetstress system parameters

Thread count	2 (per storage group)
Log buffers	9000
Minimum database cache	32.0 MB
Maximum database cache	256.0 MB
Insert operations	40%
Delete operations	30%
Replace operations	5%
Read operations	25%
Lazy commits	55%

Disk subsystem performance Disk subsystem performance

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Write
Database (h:)	0.002	2.96558704453441E-05	468.880	0.013	(n/a)
Log (g:)	0.000	9.17148640832851E-05	0.000	0.011	97.425

Host system performance

Counter	Average	Minimum	Maximum
% Processor Time	4.821	4.010	5.599
Available MBytes	15399.677	15388.000	15403.000
Free System Page Table Entries	16757986.000	16757986.000	16757986.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	63607477.677	63594496.000	63713280.000
Pool Paged Bytes	45675057.548	45408256.000	46829568.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test log

8/1/2008 9:21:30 AM -- Command Line: "C:\PROGRA~1\EXCHAN~1\jetstresscmd.exe" /c "C:\ax4q2\2+2_0_5-0_6 2t\nobu\2+2 - 2t.xml"

8/1/2008 9:21:30 AM -- Jetstress testing begins ...

8/1/2008 9:21:30 AM -- Prepare testing begins ...

8/1/2008 9:21:32 AM -- Attaching databases ...

8/1/2008 9:21:32 AM -- Prepare testing ends.

8/1/2008 9:21:34 AM -- Performance logging begins (interval: 7500 ms).

8/1/2008 9:21:34 AM -- Streaming backup databases ...

8/1/2008 9:52:39 AM -- Performance logging ends.

8/1/2008 9:52:39 AM -- Instance1732.1 (100% processed)

8/1/2008 9:52:39 AM -- C:\ax4q2\2+2_0_5-0_6 2t\nobu\StreamingBackup_2008_8_1_9_21_32.blg has 248 samples.

8/1/2008 9:52:39 AM -- Creating test report ...

Appendix B: Mailbox count configurations

Based on the performance of the test and approximate achieved 180 IOPS and a simulated profile of .40, the possible range of mailbox configurations is from 100 users with a 900 MB mailbox, up to 700 users with a 130 MB mailbox.

Table 6 displays the small- to medium-sized customer types suitable for this solution.

Table 6 **Range of mailbox configurations**

Configuration	Host	Profile	User mailbox size
100 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	900 MB
200 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	450 MB
300 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	300 MB
400 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	200 MB
500 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	180 MB
600 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	150 MB
700 mailboxes	One host attached; up to 64 hosts possible	User I/O profile .40	130 MB