



NetApp FAS2220 1,000-Mailbox Exchange 2010 Mailbox Resiliency Storage Solution

**Tested with: ESRP-Storage Version 3.0
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Content

Overview	3
Disclaimer.....	3
Features	3
Solution Description	5
Targeted Customer Profile	8
Tested Deployment	8
Simulated Exchange Configuration	8
Storage Hardware	9
Storage Software	9
Storage Disk Configuration (Mailbox Store Disks).....	10
Storage Disk Configuration (Transactional Log Disks Utilizing Same Disks as Mailbox Store Database)	10
Best Practices.....	10
Mailbox Resiliency	11
Backup strategy	11
Contact for Additional Information.....	11
Test Result Summary	12
Reliability	12
Storage Performance Results	12
Database Backup/Recovery Performance	13
Database Read-Only Performance	13
Transaction Log Recovery/Replay Performance	13
Conclusion	13
Appendix A – Test Results	14
24-Hour Stress/Reliability Test Results	14
2-Hour Performance Test Results	17
Database Backup Test Results.....	19
Soft Recovery Test Results	20

Overview

This document provides information on a NetApp® FAS2220 iSCSI mailbox resiliency 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 for Additional Information](#).

*The ESRP–Storage Program was developed by Microsoft Corporation to provide a common storage testing framework for vendors to provide information on its storage solutions for Microsoft Exchange Server software. For more details on the Microsoft ESRP–Storage Program, please click <http://technet.microsoft.com/en-us/exchange/ff182054.aspx>.

Disclaimer

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The information contained in this document represents the current view of NetApp on the issues discussed as of the date of publication. Due to changing market conditions, it should not be interpreted to be a commitment on the part of NetApp, and NetApp cannot guarantee the accuracy of any information presented after the date of publication.

Features

This document describes the testing of a 1,000-mailbox resiliency (2-copy) database availability group (DAG) configuration for Exchange Server 2010 with a NetApp FAS2220 storage system. The FAS2220 is the newest member of NetApp's FAS2200 entry-level product family. Leveraging the NetApp Unified Storage Architecture and industry-leading storage efficiency features, the FAS2220 provides midsize businesses or departments/remote offices of distributed enterprises with three to seven times the performance of the FAS2020 system, which it replaced. The FAS2220 can be used as primary or secondary storage. The FAS2220 comes in a 2U form factor with room for 12 internal SAS or SATA drives, dual independent hot swappable controllers, and dual hot swappable power supplies. Additional expansion options include SAS or SATA shelves connected through SAS interfaces that are built in to the two controllers for a total maximum capacity of 60 drives.

The FAS2220 introduces a new feature of Data ONTAP® software: Flash Pools. Flash Pools allow customers to leverage the power of flash technology

to accelerate key business applications, reduce the amount of storage they need to purchase, and reduce expenses such as power and cooling. Flash Pools are supported on the new FAS2220, as well as the recently released FAS2240 system.

The FAS2220 is also simple to deploy and manage. OnCommand® System Manager cuts set-up time to under one hour, and no storage expertise is required to keep your storage infrastructure in line with business requirements. The FAS2220 ships with Data ONTAP Essentials, a powerful set of standard software including a wealth of integrated data protection, efficiency, and management software, such as:

- Thin provisioning helps avoid the costly overprovisioning and time-consuming reconfiguration that is typical with other storage solutions.
- Deduplication enables you to store only one copy of each unique data object, substantially reducing capacity requirements.

Customers can also easily expand data management capabilities as their needs grow by adding optional software features that provide enterprise-proven capabilities for automated provisioning and restoration; simple, efficient disaster recovery; automated application; and virtual machine-aware backup, recovery, and cloning.

For the purposes of this tested Exchange deployment, various NetApp best practice recommendations for an Exchange deployment were followed. The FAS2220 being tested used standard NetApp features such as Snapshot™ and RAID-DP® technologies, FlexVol® flexible volumes, and SnapDrive® technology.

Snapshot technology provides in-place, logical backups of an entire Exchange environment, usually in seconds, regardless of whether the data being backed up is several megabytes or hundreds of terabytes. Additionally, NetApp Snapshot technology causes virtually no loss of performance following Snapshot copy creation and use going forward.

RAID-DP is a high-performance implementation of RAID 6 that provides double parity across the disk subsystem and protects against the failure of up to two disks per RAID group. Calculations have shown double parity RAID offers over 160 times the protection against data loss than RAID 10 and almost 4,000 times the protection against data loss than RAID 5. The performance results listed in this report were produced with RAID-DP enabled.

FlexVol volumes enable the creation of logical storage volumes across a large pool of disk drives known as an aggregate. FlexVol volumes provide three core advantages for workloads such as Microsoft Exchange:

1. Using FlexVol volumes, the capacity and performance bandwidth of a large collection of fast drives can be made available to all volumes. Even very small FlexVol volumes have the performance benefit of a very large number of drives.
2. A large number of volumes may be created, all with independent Snapshot copy schedules, mirroring events, and so on.
3. All FlexVol volumes can be managed independently, while receiving the maximum I/O benefit of a much larger pool of drives.

SnapDrive for Windows[®] offers a rich set of capabilities that virtualizes and enhances storage management for Microsoft Windows environments. SnapDrive is tightly integrated with NTFS to provide a layer of abstraction between application data and physical storage associated with that data.

For this ESRP testing environment, NetApp SnapManager[®] for Microsoft Exchange (SME) was not required. SnapManager for Exchange is an Exchange software backup and recovery management solution that integrates NetApp Snapshot backups with Microsoft Exchange Server via the Microsoft standard and approved Volume Shadow Copy Services (VSS) snapshot interface. NetApp highly recommends SnapManager for Exchange as part of a production Exchange deployment.

For this ESRP testing environment, a single DAG containing two mailbox servers was used. The detailed DAG architecture is specified in the next section.

Solution Description

This section outlines the Exchange 2010 mailbox resiliency solution NetApp used to run the ESRP tests.

Storage:

- A pair of FAS2220 storage controllers
- Data ONTAP 8.1.1X27 operating in 7-Mode
- SAS, 600GB 10K RPM drives
- Link to FAS2220 Windows Server[®] Catalog listing:
<http://windowsservercatalog.com/item.aspx?idItem=d8f70616-a405-0a98-05b9-e80209512e01&bCatID=1511>

Switches:

- Two Cisco Catalyst[®] 4948 Ethernet switches

Figure 1 depicts the DAG architecture and the topology of the Exchange 2010 mailbox resiliency solution using the NetApp FAS2220 storage system. The FAS2220 system consists of two storage controllers: FAS2220-3 and FAS2220-4. The first Exchange data copy (active copy) is on the FAS2220-3. The second Exchange data copy (passive copy) is on the FAS2220-4.

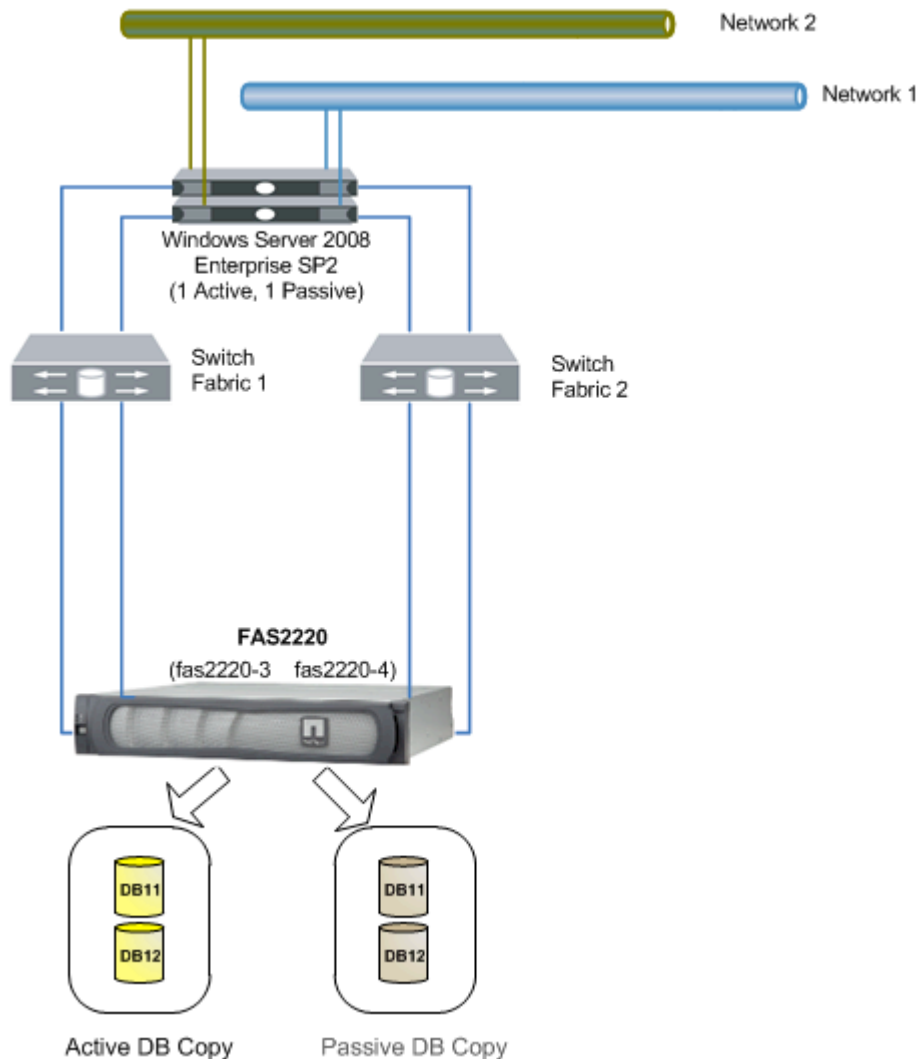


Figure 1) Topology and DAG architecture of the FAS2220 mailbox resiliency ESRP testing.

Only the primary copy storage is described below. The secondary copy storage (shown grayed out in Figure 1) is configured identically (from the host on down to the spindle, including brand, model, firmware, drivers, and so on).

The FAS2220-3 storage controller was configured with one aggregate for both database and log files. Four FlexVol flexible volumes, two for the DB LUNs and the other two for the log LUNs, were created for the active server. The details about the placement of aggregates, volumes, and LUNs are enumerated in the table following.

For a Mailbox Resiliency configuration, databases and log files can be placed on the same set of disk drives (see <http://technet.microsoft.com/en-us/library/ee832792.aspx>). Therefore, all four LUNs are placed on the same aggregate, aggr0.

Controller Name	Aggregate	Volume	LUN	RAID Type	Number of Data Drives	Number of Parity Drives	Size of LUNs
FAS2220-3	aggr0	db1_fv	DB1	RAID-DP	5	2	1.05TB
		log1_fv	LOG1				14GB
		db2_fv	DB2				1.05TB
		log2_fv	LOG2				14GB

The DAG configuration is as follows:

- Two mailbox servers: 3650-4 and 3650-5
- 500 mailboxes per database
- Two active databases total (1,000 active mailboxes): DB1 and DB2 hosted on 3650-4
- Two passive databases total (shown in gray in Figure 1): hosted by 3650-5; the passive database is on a separate aggregate and on the separate but identical storage controller: FAS2220-4
- Using NetApp RAID-DP
- Two copies of databases

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, server physical 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 of 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, please refer to Microsoft's "Troubleshooting Microsoft Exchange Server Performance," available at <http://go.microsoft.com/fwlink/?LinkId=23454>.

Targeted Customer Profile

This solution is designed for a small enterprise Exchange environment. The target customer would typically be one looking for a scalable, reliable, high-performance, and highly available Exchange storage solution. The solution tested is designed for:

- 1,000 mailboxes
- 2 servers (1 tested)
- 0.100 IOPS (0.120 tested for additional 20% head room)
- 2000MB mailboxes
- Maintaining ample controller head room available for storage infrastructure activities such as data replication and disk reconstructs
- 24/7 background database maintenance (BDM)
- Mailbox Resiliency (2-copy)

Tested Deployment

The following tables summarize the testing environment.

Simulated Exchange Configuration

Number of Exchange mailboxes simulated	1,000
Number of Database Availability Groups (DAGs)	1
Number of servers/DAG	2
Number of active mailboxes/server	1,000
Number of databases/host	2
Number of copies/database	2
Number of mailboxes/database	500
Simulated profile: I/Os per second per mailbox (IOPS include 20% head room)	0.120 IOPs per mailbox (0.10 IOPs plus 20% head room added)
Database LUN size	1070GB
Log LUN size	14GB

Total database size for performance testing	1953GB
% storage capacity used by Exchange database**	91%

**Storage performance characteristics change based on the percentage utilization of the individual disks. Tests that use a small percentage of the storage (~25%) may exhibit reduced throughput if the storage capacity utilization is significantly increased beyond what is tested in this paper.

Storage Hardware

Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	iSCSI
Storage model and OS/firmware revision	FAS2220 Data ONTAP 8.1.1 7-Mode
Storage cache	4GB per controller
Number of storage controllers	2 (1 tested)
Number of storage ports	2 per controller
Maximum bandwidth of storage connectivity to host	4Gbps (4 x 1Gb/sec per port)
Switch type/model/firmware revision	Cisco Catalyst 4948 Version 12.2(20) EWA
HBA model and firmware	Microsoft iSCSI Software Initiator Broadcom BCM5708C NetXtreme II GigE
Number of HBAs/host	2 per host
Host server type	IBM x3650, 4 x 3.6 GHz CPU, 18GB RAM
Total number of disks tested in solution	7
Maximum number of spindles can be hosted in the storage	60

Storage Software

HBA driver	Broadcom BCM5708C NetXtreme II GigE Version 3.7.19.0
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	Data ONTAP DSM 3.5 for Windows MPIO
Host OS	Windows Server 2008 Enterprise SP2
ESE.dll file version	14.00.0639.019
Replication solution name/version	N/A

Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed, and firmware revision	SAS 600GB 10K RPM – FW NA00
Raw capacity per disk (GB)	600GB
Number of physical disks in test	7
Total raw storage capacity (GB)	4200GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	One aggregate consisting of one 7-disk RAID-DP group per controller
Raid level	RAID-DP
Total formatted capacity	2140GB
Storage capacity utilization	51%
Database capacity utilization	47%

Storage Disk Configuration (Transactional Log Disks Utilizing Same Disks as Mailbox Store Database)

Disk type, speed, and firmware revision	SAS 600GB 10K RPM – FW NA00
Raw capacity per disk (GB)	600GB
Number of spindles in test	7
Total raw storage capacity (GB)	4200GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	One aggregate consisting of one 7-disk RAID-DP group per controller
Raid level	RAID-DP
Total formatted capacity	28GB

Best Practices

Exchange Server is a disk-sensitive application. Based on the testing run using the ESRP framework, NetApp recommends the following to improve storage performance.

For Exchange 2010 best practices on storage design, please visit <http://technet.microsoft.com/en-us/library/dd346703.aspx>.

Sizing

Performance, stability, disaster recovery procedures, and general Exchange maintenance all benefit from proper Exchange sizing. NetApp has studied the I/O patterns of Exchange systems running on NetApp storage. When a customer approaches NetApp for an Exchange storage solution, NetApp leverages this knowledge and expertise to properly size the storage

specifically to the customer's environment. Several factors are taken into consideration in this process, including but not limited to:

- Number of mailboxes
- Mailbox size
- IOPS per mailbox
- Storage platform type
- Physical drive type
- Backup retention time

Layout

Another key consideration for Exchange Server 2010 is the layout of the databases, volumes, and LUNs. NetApp storage solutions can take full advantage of the performance benefits of aggregates and flexible volumes. And following proper layout guidelines is essential for a high-performing, low-latency Exchange solution. Consult with your NetApp Exchange specialist about proper layout to enable your Exchange deployment on NetApp storage to perform optimally in your environment.

Mailbox Resiliency

For this ESRP submission, we followed these NetApp Exchange best practices.

- Use dedicated FlexVol volumes for databases.
- Use dedicated FlexVol volumes for transaction logs.
- Use SnapDrive to provision LUNs. This reduces the complexity of LUN provisioning and additionally means that diskpart is not required or recommended, since SnapDrive provides correct LUN sector alignment.
- Spindle counts for databases and log files are derived from consulting with NetApp Exchange specialists. Further information on Exchange sizing is available from your local NetApp Exchange specialist.

Backup strategy

N/A.

Contact for Additional Information

[Link to appropriate storage specs on netapp.com](#)

[Data ONTAP software](#)

[FlexVol and FlexClone® technologies](#)

[SnapDrive software](#)

[SnapManager for Exchange software](#)

[NetApp RAID-DP](#)

Test Result Summary

This section provides a high-level summary of the test data from ESRP and the link to the detailed html reports that are generated by the ESRP testing framework. Please click on the underlined headings below to view the html report for each test.

Reliability

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

The following list provides an overview (clicking on the underlined word will show the html report after the reliability tests run).

- No errors were reported in any of the event logs collected for the reliability tests.
- No errors were reported during the [database](#) and [log](#) checksum process.

Storage [Performance Results](#)

The Primary Storage performance testing is designed to exercise the storage with the maximum sustainable Exchange type of I/O for two 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 the logical disk I/Os and the average of all the logical disks I/O latency in the two-hour test duration. Each server is listed separately and the aggregate numbers across all servers are listed as well.

Individual Server Metrics:

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

Host 3650-4

Database I/O	
Database Disks Transfers/sec	185.74
Database Disks Reads/sec	113.14
Database Disks Writes/sec	72.60
Average Database Disk Read Latency (ms)	14.96
Average Database Disk Write Latency (ms)	1.02
Transaction Log I/O	
Log Disks Writes/sec	61.96
Average Log Disk Write Latency (ms)	0.99

Aggregate Performance Across All Servers Metrics:

This is the sum of I/Os across servers in the solution and the average latency across servers in the solution. In this case, there is only one active server in the solution: 3650-4.

Database Backup/Recovery Performance

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

Database Read-Only Performance

This test measures the maximum rate at which databases can be backed up via VSS. The following table shows the average rate for a single database file.

Host 3650-4

MB read/sec per database	32.875
MB read/sec total per server	65.750

Transaction Log Recovery/Replay Performance

This test measures 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 1MB in size.

Host 3650-4

Average time to play one log file (sec)	3.599
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Conclusion

This document demonstrates that the NetApp FAS2220 is a high-performance, highly reliable, and high-efficiency storage system capable of supporting 1,000 Exchange 2010 users at 0.120 IOPs per user and a 2000MB mailbox size in the Mailbox Resiliency configuration. Moreover, the tested solution has a large IOPS head room since it achieved 40% more IOPS than the target IOPS.

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

NetApp offers its customers complete sizing information for Exchange Server deployments through its systems engineers. Contact your local NetApp sales office for additional information.

Appendix A – Test Results

This section includes representative test results from the active server under test: 3650-4.

24-Hour Stress/Reliability Test Results

Microsoft Exchange Server **Jetstress** - DBChecksum

Test Result Report (from server 3650-4)

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
E:\db\Jetstress001001.edb	32100674	0	0	0	1003146 MB/25030 sec
F:\db\Jetstress002001.edb	32101698	0	0	0	1003178 MB/19324 sec
(Sum)	64202372	0	0	0	2006324 MB/25028 sec

Disk Subsystem Performance (of checksum)

LogicalDisk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
E:	0.148	0.000	641.161	0.000	65536.000
F:	0.134	0.000	831.173	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	14.296	5.703	19.956
Available MBytes	15325.667	15217.000	15487.000
Free System Page Table Entries	33560444.871	33559815.000	33560607.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	83810264.710	83521536.000	84008960.000
Pool Paged Bytes	245499216.422	244248576.000	246308864.000

Test Log

```

4/23/2012 8:06:51 AM -- Jetstress testing begins ...
4/23/2012 8:06:51 AM -- Preparing for testing ...
4/23/2012 8:06:53 AM -- Attaching databases ...
4/23/2012 8:06:53 AM -- Preparations for testing are complete.
4/23/2012 8:06:53 AM -- Starting transaction dispatch ..
4/23/2012 8:06:53 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/23/2012 8:06:53 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/23/2012 8:06:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
4/23/2012 8:06:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum:

```

200 msec/write).
 4/23/2012 8:06:58 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 4/23/2012 8:06:58 AM -- Performance logging started (interval: 15000 ms).
 4/23/2012 8:06:58 AM -- Attaining prerequisites:
 4/23/2012 8:13:19 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 484425700.0 (lower bound: 483183800.0, upper bound: none)
 4/24/2012 8:13:19 AM -- Performance logging has ended.
 4/24/2012 8:13:19 AM -- JetInterop batch transaction stats: 236944 and 238008.
 4/24/2012 8:13:20 AM -- Dispatching transactions ends.
 4/24/2012 8:13:20 AM -- Shutting down databases ...
 4/24/2012 8:13:21 AM -- Instance37680.1 (complete) and Instance37680.2 (complete)
 4/24/2012 8:13:21 AM -- C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.blg has 5780 samples.
 4/24/2012 8:13:21 AM -- Creating test report ...
 4/24/2012 8:14:00 AM -- Instance37680.1 has 15.7 for I/O Database Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.1 has 1.1 for I/O Log Writes Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.1 has 1.1 for I/O Log Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 15.2 for I/O Database Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 1.1 for I/O Log Writes Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 1.1 for I/O Log Reads Average Latency.
 4/24/2012 8:14:00 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/24/2012 8:14:00 AM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/24/2012 8:14:00 AM -- C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.xml has 5754 samples queried.
 4/24/2012 8:14:01 AM -- C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.html was saved.
 4/24/2012 8:14:02 AM -- Performance logging started (interval: 30000 ms).
 4/24/2012 8:14:02 AM -- Verifying database checksums ...
 4/24/2012 3:11:10 PM -- E: (100% processed) and F: (100% processed)
 4/24/2012 3:11:10 PM -- Performance logging has ended.
 4/24/2012 3:11:10 PM -- C:\Program Files\Exchange Jetstress\results\DBChecksum_2012_4_24_8_14_1.blg has 834 samples.

Microsoft Exchange Server **Jetstress** - Stress

Stress Test Result Report (from server 3650-4)

Test Summary

Overall Test Result	Pass
Machine Name	3650-4
Test Description	
Test Start Time	4/23/2012 8:06:51 AM
Test End Time	4/24/2012 8:13:21 AM
Collection Start Time	4/23/2012 8:13:19 AM
Collection End Time	4/24/2012 8:13:11 AM
Jetstress Version	14.01.0225.017
ESE Version	14.01.0322.000
Operating System	Windows Server (R) 2008 Enterprise Service Pack 2 (6.0.6002.131072)
Performance Log	C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	177.375
Target Transactional I/O per Second	120
Initial Database Size (bytes)	2097156325376
Final Database Size (bytes)	2103783325696
Database Files (Count)	2

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 2

Database Configuration

Instance37680.1 Log path: G:\log
 Database: E:\db\Jetstress001001.edb

Instance37680.2 Log path: H:\log
 Database: F:\db\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance37680.1	15.735	1.094	54.091	34.303	34581.086	36242.571	0.000	1.100	0.000	30.284	0.000	4602.047
Instance37680.2	15.225	1.082	54.414	34.567	34637.757	36223.806	0.000	1.100	0.000	30.546	0.000	4610.223

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance37680.1	36.318	261739.990
Instance37680.2	37.584	261749.956

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance37680.1	0.565	203316.561
Instance37680.2	0.571	205227.616

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
Instance37680.1	15.735	1.094	90.409	34.303	125832.326	36242.571	9.110	1.100	0.565	30.284	203316.561	4602.047
Instance37680.2	15.225	1.082	91.998	34.567	127419.824	36223.806	8.653	1.100	0.571	30.546	205227.616	4610.223

Total I/O Performance

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.918	3.253	17.510
Available MBytes	14826.521	14675.000	14995.000
Free System Page Table Entries	33560299.086	33559506.000	33560715.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	81522922.159	80748544.000	82411520.000
Pool Paged Bytes	242155092.963	240934912.000	323309568.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/23/2012 8:06:51 AM -- Jetstress testing begins ...
 4/23/2012 8:06:51 AM -- Preparing for testing ...
 4/23/2012 8:06:53 AM -- Attaching databases ...
 4/23/2012 8:06:53 AM -- Preparations for testing are complete.
 4/23/2012 8:06:53 AM -- Starting transaction dispatch ..
 4/23/2012 8:06:53 AM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
 4/23/2012 8:06:53 AM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
 4/23/2012 8:06:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
 4/23/2012 8:06:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
 4/23/2012 8:06:58 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 4/23/2012 8:06:58 AM -- Performance logging started (interval: 15000 ms).
 4/23/2012 8:06:58 AM -- Attaining prerequisites:
 4/23/2012 8:13:19 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 484425700.0 (lower bound: 483183800.0, upper bound: none)
 4/24/2012 8:13:19 AM -- Performance logging has ended.
 4/24/2012 8:13:19 AM -- JetInterop batch transaction stats: 236944 and 238008.
 4/24/2012 8:13:20 AM -- Dispatching transactions ends.
 4/24/2012 8:13:20 AM -- Shutting down databases ...
 4/24/2012 8:13:21 AM -- Instance37680.1 (complete) and Instance37680.2 (complete)
 4/24/2012 8:13:21 AM -- [C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.blg](#) has 5780 samples.
 4/24/2012 8:13:21 AM -- Creating test report ...
 4/24/2012 8:14:00 AM -- Instance37680.1 has 15.7 for I/O Database Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.1 has 1.1 for I/O Log Writes Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.1 has 1.1 for I/O Log Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 15.2 for I/O Database Reads Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 1.1 for I/O Log Writes Average Latency.
 4/24/2012 8:14:00 AM -- Instance37680.2 has 1.1 for I/O Log Reads Average Latency.
 4/24/2012 8:14:00 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/24/2012 8:14:00 AM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/24/2012 8:14:00 AM -- [C:\Program Files\Exchange Jetstress\results\Stress_2012_4_23_8_6_56.xml](#) has 5754 samples queried.

2-Hour Performance Test Results

Microsoft Exchange Server **Jetstress** - Performance

Performance Test Result Report (from server 3650-4)

Test Summary

Overall Test Result	Pass
Machine Name	3650-4
Test Description	
Test Start Time	4/25/2012 3:29:30 PM
Test End Time	4/25/2012 5:35:12 PM
Collection Start Time	4/25/2012 3:35:11 PM
Collection End Time	4/25/2012 5:35:00 PM
Jetstress Version	14.01.0225.017
ESE Version	14.01.0322.000
Operating System	Windows Server (R) 2008 Enterprise Service Pack 2 (6.0.6002.131072)
Performance Log	C:\Program Files\Exchange Jetstress\results\Performance_2012_4_25_15_29_35.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	185.738
Target Transactional I/O per Second	120

Initial Database Size (bytes) 2103783325696
Final Database Size (bytes) 2104362139648
Database Files (Count) 2

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 MB
Insert Operations 40%
Delete Operations 20%
Replace Operations 5%
Read Operations 35%
Lazy Commits 70%
Run Background Database Maintenance True
Number of Copies per Database 2

Database Configuration

Instance4760.1 Log path: G:\log
 Database: E:\db\Jetstress001001.edb

Instance4760.2 Log path: H:\log
 Database: F:\db\Jetstress002001.edb

Transactional I/O Performance

MSEXchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/sec	I/O Database Writes/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/sec	I/O Log Writes/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance4760.1	15.079	1.021	56.901	36.476	34488.842	35483.416	0.000	0.984	0.000	31.003	0.000	4570.83
Instance4760.2	14.842	1.021	56.235	36.127	34385.964	35597.450	0.000	0.994	0.000	30.957	0.000	4591.07

Background Database Maintenance I/O Performance

MSEXchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance4760.1	37.186	261742.003
Instance4760.2	37.581	261770.143

Log Replication I/O Performance

MSEXchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance4760.1	0.573	204896.981
Instance4760.2	0.578	203903.294

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
Instance4760.1	15.079	1.021	94.087	36.476	124306.364	35483.416	8.659	0.984	0.573	31.003	204896.981	4570.83
Instance4760.2	14.842	1.021	93.816	36.127	125472.708	35597.450	9.108	0.994	0.578	30.957	203903.294	4591.07

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	5.330	3.363	8.922
Available MBytes	15681.223	15597.000	15831.000
Free System Page Table Entries	33559386.854	33559181.000	33559627.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	56538250.956	56258560.000	56680448.000
Pool Paged Bytes	180751520.334	180346880.000	180969472.000

Database Page Fault Stalls/sec | 0.000 | 0.000 | 0.000 |

Test Log

4/25/2012 3:29:30 PM -- Jetstress testing begins ...
 4/25/2012 3:29:30 PM -- Preparing for testing ...
 4/25/2012 3:29:33 PM -- Attaching databases ...
 4/25/2012 3:29:33 PM -- Preparations for testing are complete.
 4/25/2012 3:29:33 PM -- Starting transaction dispatch ..
 4/25/2012 3:29:33 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
 4/25/2012 3:29:33 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
 4/25/2012 3:29:35 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
 4/25/2012 3:29:35 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
 4/25/2012 3:29:39 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
 4/25/2012 3:29:39 PM -- Performance logging started (interval: 15000 ms).
 4/25/2012 3:29:39 PM -- Attaining prerequisites:
 4/25/2012 3:35:11 PM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 485232600.0 (lower bound: 483183800.0, upper bound: none)
 4/25/2012 5:35:11 PM -- Performance logging has ended.
 4/25/2012 5:35:11 PM -- JetInterop batch transaction stats: 20809 and 20753.
 4/25/2012 5:35:11 PM -- Dispatching transactions ends.
 4/25/2012 5:35:11 PM -- Shutting down databases ...
 4/25/2012 5:35:12 PM -- Instance4760.1 (complete) and Instance4760.2 (complete)
 4/25/2012 5:35:12 PM -- [C:\Program Files\Exchange Jetstress\results\Performance_2012_4_25_15_29_35.blg](#) has 501 samples.
 4/25/2012 5:35:12 PM -- Creating test report ...
 4/25/2012 5:35:16 PM -- Instance4760.1 has 15.1 for I/O Database Reads Average Latency.
 4/25/2012 5:35:16 PM -- Instance4760.1 has 1.0 for I/O Log Writes Average Latency.
 4/25/2012 5:35:16 PM -- Instance4760.1 has 1.0 for I/O Log Reads Average Latency.
 4/25/2012 5:35:16 PM -- Instance4760.2 has 14.8 for I/O Database Reads Average Latency.
 4/25/2012 5:35:16 PM -- Instance4760.2 has 1.0 for I/O Log Writes Average Latency.
 4/25/2012 5:35:16 PM -- Instance4760.2 has 1.0 for I/O Log Reads Average Latency.
 4/25/2012 5:35:16 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/25/2012 5:35:16 PM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/25/2012 5:35:16 PM -- [C:\Program Files\Exchange Jetstress\results\Performance_2012_4_25_15_29_35.xml](#) has 478 samples queried.

Database Backup Test Results

Microsoft Exchange Server Jetstress – Database Backup

Database Backup Test Result Report (from server 3650-4)

Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance4256.1	1003410.09	08:35:15	32.46
Instance4256.2	1003450.09	08:22:18	33.29

Jetstress System Parameters

Thread Count 3 (per database)
Minimum Database Cache 64.0 MB
Maximum Database Cache 512.0 MB
Insert Operations 40%
Delete Operations 20%

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

Database Configuration

Instance4256.1 Log path: G:\log
 Database: E:\db\Jetstress001001.edb

Instance4256.2 Log path: H:\log
 Database: F:\db\Jetstress002001.edb

Transactional I/O Performance

MExchange 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
Instance4256.1	11.043	0.000	129.809	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance4256.2	10.662	0.000	133.179	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	12.263	6.008	14.867
Available MBytes	15933.080	15817.000	16097.000
Free System Page Table Entries	33559755.599	33559324.000	33559873.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	59159979.495	59031552.000	59424768.000
Pool Paged Bytes	184143860.070	183046144.000	264155136.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/26/2012 11:58:58 AM -- Jetstress testing begins ...
 4/26/2012 11:58:58 AM -- Preparing for testing ...
 4/26/2012 11:59:00 AM -- Attaching databases ...
 4/26/2012 11:59:00 AM -- Preparations for testing are complete.
 4/26/2012 11:59:04 AM -- Performance logging started (interval: 30000 ms).
 4/26/2012 11:59:04 AM -- Backing up databases ...
 4/26/2012 8:34:19 PM -- Performance logging has ended.
 4/26/2012 8:34:19 PM -- Instance4256.1 (100% processed) and Instance4256.2 (100% processed)
 4/26/2012 8:34:19 PM -- [C:\Program Files\Exchange Jetstress\results\DatabaseBackup_2012_4_26_11_59_0.blg](#) has 1030 samples.
 4/26/2012 8:34:19 PM -- Creating test report ...

Soft Recovery Test Results

Microsoft Exchange Server Jetstress – Soft Recovery

SoftRecovery Test Result Report (from server 3650-4)

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance9568.1	501	1823.567
Instance9568.2	508	1807.816

Database Configuration

Instance9568.1 Log path: G:\log
 Database: E:\db\Jetstress001001.edb

Instance9568.2 Log path: H:\log
 Database: F:\db\Jetstress002001.edb

Transactional I/O Performance

MSExchange Database ==> Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s	I/O Database Writes/s	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s	I/O Log Writes/s	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance9568.1	28.461	0.499	216.171	1.642	43636.835	18791.814	4.874	0.000	2.463	0.000	131577.748	0.000
Instance9568.2	26.783	0.536	223.049	1.683	44234.916	19412.668	5.040	0.001	2.527	0.007	136255.673	1.140

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance9568.1	35.934	261816.304
Instance9568.2	40.298	261805.403

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/s	I/O Database Writes/s	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s	I/O Log Writes/s	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance9568.1	28.461	0.499	252.105	1.642	74735.395	18791.814	4.874	0.000	2.463	0.000	131577.748	0.000
Instance9568.2	26.783	0.536	263.347	1.683	77528.060	19412.668	5.040	0.001	2.527	0.007	136255.673	1.140

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	8.565	1.869	32.899
Available MBytes	15321.311	15234.000	15812.000
Free System Page Table Entries	33559688.428	33559410.000	33559847.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	60975868.044	60887040.000	61161472.000
Pool Paged Bytes	185152030.517	184184832.000	185372672.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/27/2012 7:52:55 PM -- Jetstress testing begins ...
4/27/2012 7:52:55 PM -- Preparing for testing ...
4/27/2012 7:52:57 PM -- Attaching databases ...
4/27/2012 7:52:57 PM -- Preparations for testing are complete.
4/27/2012 7:52:57 PM -- Starting transaction dispatch ..
4/27/2012 7:52:57 PM -- Database cache settings: (minimum: 64.0 MB, maximum: 512.0 MB)
4/27/2012 7:52:57 PM -- Database flush thresholds: (start: 5.1 MB, stop: 10.2 MB)
4/27/2012 7:52:59 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/27/2012 7:52:59 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/27/2012 7:53:01 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/27/2012 7:53:01 PM -- Performance logging started (interval: 15000 ms).
4/27/2012 7:53:01 PM -- Generating log files ...
4/27/2012 9:31:49 PM -- G:\log (100.2% generated) and H:\log (101.6% generated)
4/27/2012 9:31:49 PM -- Performance logging has ended.
4/27/2012 9:31:49 PM -- JetInterop batch transaction stats: 21651 and 21929.
4/27/2012 9:31:49 PM -- Dispatching transactions ends.
4/27/2012 9:31:49 PM -- Shutting down databases ...
4/27/2012 9:31:50 PM -- Instance9568.1 (complete) and Instance9568.2 (complete)
4/27/2012 9:31:50 PM -- C:\Program Files\Exchange Jetstress\results\Performance_2012_4_27_19_52_59.blg has 394 samples.
4/27/2012 9:31:50 PM -- Creating test report ...

4/27/2012 9:31:53 PM -- Instance9568.1 has 15.5 for I/O Database Reads Average Latency.
4/27/2012 9:31:53 PM -- Instance9568.1 has 0.9 for I/O Log Writes Average Latency.
4/27/2012 9:31:53 PM -- Instance9568.1 has 0.9 for I/O Log Reads Average Latency.
4/27/2012 9:31:53 PM -- Instance9568.2 has 15.4 for I/O Database Reads Average Latency.
4/27/2012 9:31:53 PM -- Instance9568.2 has 0.9 for I/O Log Writes Average Latency.
4/27/2012 9:31:53 PM -- Instance9568.2 has 0.9 for I/O Log Reads Average Latency.
4/27/2012 9:31:53 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/27/2012 9:31:53 PM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
4/27/2012 9:31:53 PM -- C:\Program Files\Exchange Jetstress\results\Performance_2012_4_27_19_52_59.xml has 393 samples queried.
4/27/2012 9:31:53 PM -- C:\Program Files\Exchange Jetstress\results\Performance_2012_4_27_19_52_59.html was saved.
4/27/2012 9:31:55 PM -- Performance logging started (interval: 2000 ms).
4/27/2012 9:31:55 PM -- Recovering databases ...
4/27/2012 10:02:18 PM -- Performance logging has ended.
4/27/2012 10:02:18 PM -- Instance9568.1 (1823.567) and Instance9568.2 (1807.816)
4/27/2012 10:02:18 PM -- C:\Program Files\Exchange Jetstress\results\SoftRecovery_2012_4_27_21_31_53.blg has 906 samples.
4/27/2012 10:02:18 PM -- Creating test report ...

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