Cisco UCS C210 M2 2500 Mailbox Resiliency Microsoft Exchange 2010 Storage Solution

White Paper

June 2012

Contents

Overview

This document provides information on Cisco Systems, Inc. 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 go to http://www.microsoft.com/technet/prodtechnol/exchange/2007/esrp.mspx.

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Cisco Unified Computing System

Today's data center managers are faced with the arduous task of reducing expenses while increasing responsiveness. Finding ways to better address rising data center capital and operations costs has companies pursuing strategies such as infrastructure consolidation and virtualization. Although this continues to offer dramatic increases in server utilization, virtualization alone is not the answer. In fact, the increase in virtual machines is driving the need for more software, networking and storage resources that are increasing costs and adding complexity within the data center. At the same time, companies are looking for architectures and solutions that will allow them to improve their service delivery capabilities. The industry is transitioning away from the rigid, inflexible platforms and moving toward more flexible, integrated, and virtualized environments. Cisco's Unified Computing System (UCS) was designed from the ground up to specifically meet these challenges.

Cisco UCS Solution

Cisco® UCS C-Series Rack-Mount Servers extend unified computing innovations to an industry-standard form factor to help reduce total cost of ownership (TCO) and increase business agility. Designed to operate both in standalone environments and as part of the Cisco Unified Computing System™, the series employs Cisco technology to help customers handle the most challenging workloads. The series incorporates a standards-based unified network fabric and Cisco VN-Link virtualization and protects customer investments with a future migration path to unified computing.

The Cisco UCS C210 M2 General-Purpose Rack-Mount Server is a two-socket, two-rack-unit (2RU) rack-mount server housing up to 16 internal small form-factor (SFF) SAS, SATA or SSD drives for a total of up to 16 terabytes (TB) of storage (Figure 1). The Cisco UCS C210 M2 server is designed to balance performance, density, and efficiency for workloads requiring economical, high-capacity, reliable, internal storage. Based on six-core Intel® Xeon® 5600 series processors, the server is built for applications

including virtualization, network file servers and appliances, storage servers, database servers, and content-delivery servers.

Building on the success of the Cisco UCS C210 M1 General-Purpose Rack-Mount Server, the Cisco UCS C210 M2 server (Figure 1) extends the capabilities of the Cisco Unified Computing System with the next generation of Intel processor technology: Intel® Xeon® 5600 series processors. These powerful processors deliver more cores, threads, and cache, all within a similar power envelope, with even faster payback, greater productivity, and better energy efficiency than preceding models. When put into production, Cisco Unified Computing System and Intel Xeon 5600 series processors together offer further reductions in TCO, increased business agility, and another big leap forward in data center virtualization.

Figure 1. Cisco UCS C210 M2 Rack-Mount Server

The Cisco UCS C210 M2 server extends Cisco's product portfolio to meet the needs of customers that choose to deploy rack-mount servers. The server enables organizations to deploy systems incrementally, using as many or as few servers as needed, on a schedule that best meets the organization's timing and budget.

Designed to operate both in standalone environments and as part of the Cisco Unified Computing System, the server combines high-capacity disk storage and I/O configurations with Cisco innovations, including a unified network fabric and network-aware Cisco VN-Link technology.

The server brings differentiation and value to what has been a commodity market with products not optimized to meet the needs of virtualized data centers. Available from Cisco and its data center network infrastructure (DCNI) partners, the server advances the rack-mount server market with the features outlined in Table 1.

Table 1. Features and Benefits

Feature	Benefit
10-Gbps unified network fabric	• Low-latency, lossless, 10-Gbps Ethernet and industry-standard Fibre Channel over Ethernet (FCoE) fabric

Feature	Benefit
	• Wire-once deployment model in which changing I/O configurations no longer means installing adapters and recabling racks and switches • Fewer interface cards, cables, and upstream network ports to purchase, power, configure, and maintain
Virtualization optimization	• Cisco VN-Link technology, I/O virtualization, and Intel Xeon 5600 series processor features, extending the network directly to virtual machines • Consistent and scalable operational model • Increased security and efficiency with reduced complexity
Unified management* (when integrated into the Cisco Unified Computing System)	• Entire solution managed as a single entity with Cisco UCS Manager, improving operational efficiency and flexibility • Service profiles and templates that implement role- and policy-based management, enabling more effective use of skilled server, network, and storage administrators • Automated provisioning and increased business agility, allowing data center managers to provision applications in minutes rather than days
Six-core Intel Xeon 5600 series processors	• Intelligent performance that automatically adjusts processor performance to meet application demands, increasing performance when needed and achieving substantial energy savings when not • Automated energy efficiency that reduces energy costs by automatically putting the processor and memory in the lowest available power state while still delivering the performance required • Flexible virtualization technology that optimizes performance for virtualized environments, including processor support for migration and direct I/O • With more cores, threads, and cache, in a similar power envelope, the Cisco Unified Computing System and Intel Xeon 5600 series processors together offer further reductions in TCO, increased business agility, and another big leap forward in data center virtualization. • Cisco C-series servers keep pace with Intel Xeon processor innovation by offering the latest series 5600 processors with an increase in processor frequency and improved security features. With the increased clock speed, the Intel Xeon 5600 series based UCS C-Series rack mount servers will offer improved price/performance making UCS servers one of the best values in the industry.
High-capacity, flexible internal storage	• Up to 16 front-accessible, hot-swappable, SFF SAS, SATA or SSD drives for local storage, providing redundancy options and ease of serviceability • Balanced performance and capacity to best meet application needs: • 15,000 RPM SAS drives for highest performance • 10,000 RPM SAS drives for high performance and value • 7200-RPM SATA drives for high capacity and value
RAID 0, 1, 5, 6, 10, 50, and 60 support	A choice of RAID controllers to provide data protection for up to 16 SAS, SATA or SSD drives in PCIe and mezzanine card form factors
Cisco UCS Integrated Management Controller	• Web user interface for server management; remote keyboard, video, and mouse (KVM); virtual media; and administration • Virtual media support for remote KVM and CD and DVD drives as if local • Intelligent Platform Management Interface (IPMI) 2.0 support for out-of-band management through third-party enterprise management systems • Command-line interface (CLI) for server management
Fast-memory support	12 DIMM slots supporting up to 192 GB of 1333-MHz memory for optimal performance

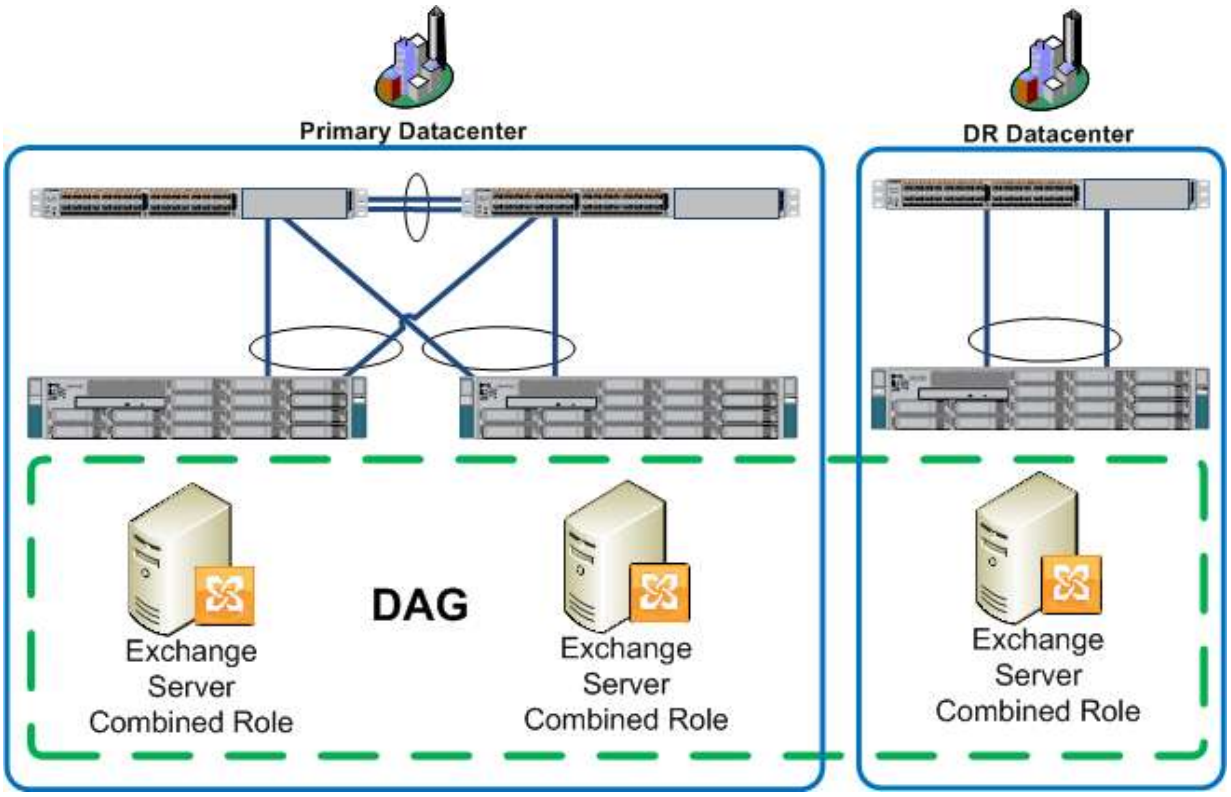
Feature	Benefit
Redundant fans and power supplies	Dual-redundant fans and power supplies for enterprise-class reliability and uptime
5 PCI Express (PCIe) 2.0 slots	• Flexibility, increased performance, and compatibility with industry standards • PCIe 2.0 slots, which double bandwidth over the previous generation and offer more flexibility while maintaining compatibility with PCIe 1 • I/O performance and flexibility with 2 full-height, full-length and 3 full-height half-length x8 PCIe slots, all with x16 connectors
Integrated dual-port Gigabit Ethernet	• Outstanding network I/O performance and increased network efficiency and flexibility. • Increased network availability when configured in failover configurations
Optional optical drive	Direct front-panel read/write access to CD and DVD media

Solution Description

The tested solution (Figure 2) provides a highly available Exchange 2010 deployment for 2500 mailbox users. Each Exchange server runs the combined Mailbox, Client Access Server, and Hub Transport roles on Cisco C210 M2 rack mount servers. The Cisco C210 M2 rack mount servers are efficient, occupying only 2 RU of rack space. The primary datacenter has two Exchange servers in a Data Availability Group. The Data Availability Group uses continuous replication to replicate mailbox database data between member servers. During normal operation each Exchange server runs 1250 active mailboxes.

If one of the two Exchange servers in the primary datacenter needs to be taken offline or fails, the surviving Exchange server is capable of servicing all 2500 mailboxes without noticeable service degradation. The Client Access Server and Hub Transport server roles, which run on each exchange server, are also redundant and are capable of sustaining the entire workload during peak work hours without noticeable service degradation.

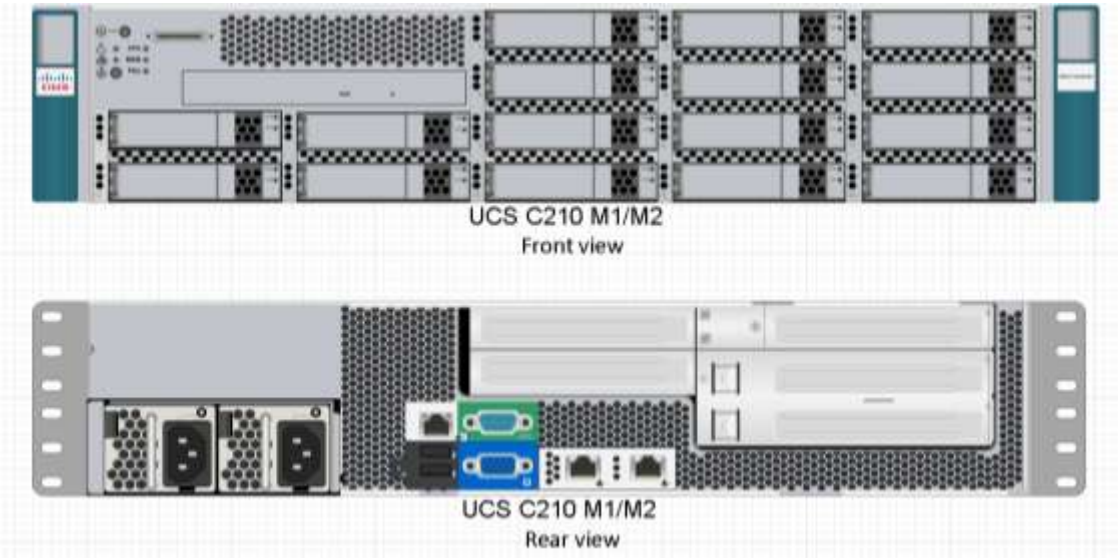
Figure 2. Solution Architecture



The test was conducted on a C210 M2 Cisco UCS Server, firmware version 1.4 (1a), Bios Version: C200 1.4.1.0 (BuildDate 07/13/2011). The server is powered by two (2) 6-Core 12 thread Xeon E5649@2.53Ghz CPUs and contains 48Gb (6 x 8192MB Synchronous DIMMs) 1333mhz RAM. The storage adaptor used to create the RAID 1, and RAID 10 Storage Volumes is an LSI MegaRAID SAS 9261-8i with 512 MB Cache.

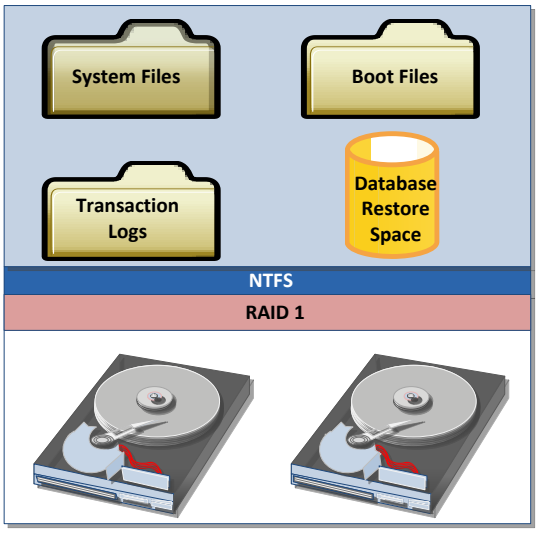
Server Platform	**Cisco UCS C-Series 210 M2 Server**
Firmware	1.4 (1a)
Bios	C200 1.4.1.0(BuildDate 07/13/2011)
RAM	48Gb(6 x 8192MB Synchronous DIMMs) 1333mhz RAM
RAID Adapter	LSI MegaRAID SAS 9261-8i 512MB Cache
CPU	2 6-Core 12 thread Xeon
	E5649@2.53Ghz
Storage	16 Seagate 1TB 7.2K RPM SATA ST91000640NS 2.5” 1 TB Drives

Figure 3. Cisco UCS C210 M1/M2 Front and Back View



The two drive RAID 1 solution for the system drive is illustrated in Figure 3. RAID 1 was created using the RAID controller's WebBios screen which can be accessed during the boot up process using the Ctrl+H keystroke.

Figure 3 RAID 1 Solution

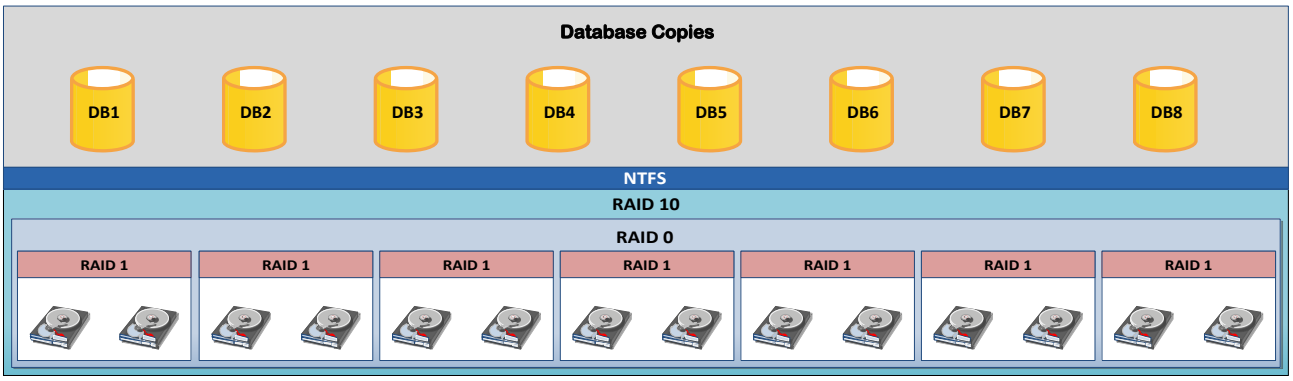


For additional information regarding the RAID Controller configuration and Cisco UCS C210 configuration options, please refer to:

http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/spec_sheet_c17-644230.pdf

The 14 drive RAID 10 solution for the data drive is illustrated in Figure 4. The drives are configured within the controller as 7 spans of mirrors (RAID 1) with a stripe throughout the spans (RAID 0). The result is RAID 10 (1+0) redundancy for the drive that houses the database.

Figure 4. RAID 10 Solution



The following links will aid in visualizing the provided solution:

- http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/data_sheet_c78-587522.html
- http://www.cisco.com/en/US/prod/ps10265/ps10493/ps10516/ucs210_kaon_model_preso.html
- http://www.cisco.com/en/US/products/ps10889/index.html

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
- 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, please refer to Microsoft's Troubleshooting Microsoft Exchange Server Performance http://technet.microsoft.com/en-us/library/dd335215.aspx.

Targeted Customer Profile

This solution is intended for small-to-medium sized organizations:

- 2500 Mailboxes
- One Host attached to storage system
- Mailbox Resiliency = Data Availability Group (DAG)
- Three Database Copies Per Server

- Mailbox quota: 1352 MB per mailbox
- User IO profile: 0.18 IOPS per mailbox
- 24x7 Background Database Maintenance utilized
- Eight Databases per server

Tested Deployment

The following tables summarize the testing environment:

Table 2. Simulated Exchange Configuration

Number of Exchange mailboxes simulated	2500
Number of Database Availability Groups (DAGs)	1
Number of servers/DAG	1
Number of active mailboxes/server	2500
Number of databases/host	8
Number of copies/database	3
Number of mailboxes/database	312
Simulated profile: I/O's per second per mailbox (IOPS, include 20 percent headroom)	.18
Database LUN size	6512.61 GB
Log LUN size	930gb
Total database size for performance testing	3296gb
% storage capacity used by Exchange database**	44.29%=(3296gb/7442gb)

**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.

Table 3. Storage Hardware

Storage Connectivity (Fiber Channel, SAS, SATA, iSCSI)	SATA
Storage model and OS/firmware revision	LSI MegaRAID SAS 9261-8i Firmware Version: 2.12-.133-1322
Storage cache	397MB Cache Memory Size
Number of storage controllers	1
Number of storage ports	8
Maximum bandwidth of storage connectivity to host	N/A
Switch type/model/firmware revision	N/A
HBA model and firmware	LSI 9261-8i MegaRAID SAS HBA Firmware Version: 2.12-.133-1322
Number of HBA's/host	N/A
Host server type	Two (2) 6-Core 12 thread Xeon E5649@2.53Ghz CPUs and contains 48Gb (12 x 8192MB Synchronous DIMMs) 1067mhz RAM
Total number of disks tested in solution	16
Maximum number of spindles can be hosted in the storage	16

Table 4. Storage Software

HBA driver	MEGASAS Storport Driver for Windows 7\Server 2008 R2 for x64 megasas2.sys 4.32.0.64
HBA QueueTarget Setting	N/A
HBA QueueDepth Setting	N/A
Multi-Pathing	N/A
Host OS	Windows 2008R2 Enterprise SP1
ESE.dll file version	14.1.218.12
Replication solution name/version	N/A

Table 5. Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed and firmware revision	Seagate 1TB 7.2K RPM SATA ST91000640NS 2.5” 1 TB Drives
Raw capacity per disk (GB)	931.513
Number of physical disks in test	14
Total raw storage capacity (GB)	13041.182
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	N/A
RAID level	RAID 10
Total formatted capacity	6512.61 GB
Storage capacity utilization	6512.61/13041.182=49.93%
Database capacity utilization	4152/13041.182=31.84%

Table 6. Storage Disk Configuration (Transactional Log Disks)

Disk type, speed and firmware revision	Seagate 1TB 7.2K RPM SATA ST91000640NS 2.5” 1 TB Drives
Raw capacity per disk (GB)	931.513
Number of Spindles in test	1
total raw storage capacity (GB)	931.513
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	N/A
RAID level	RAID 1
Total formatted capacity	930.29 GB

Best Practices

Set up the system using the following table as a guide.

Table 7. Guide for Best Practices

Drive Type	Drive Letter	Raid Type	Format
System Drive	Drive C:	Raid 1	Contains Operating System and Log Files; format as NTFS; 64K disk allocation size

Drive Type	Drive Letter	Raid Type	Format
Data Drive	Drive F:	Raid 10	Format as GPT drive. Contains Database; 64K disk allocation size

The outlined design fulfills the capacity and performance needs for 2500 users, each with a Mailbox limit of 1352 MB. The user profile of 0.18 IOPS per mailbox includes a margin for 20 percent overhead.

Exchange server 2010 is a disk I/O intensive application. Tests were conducted using the Microsoft tool Jetstress 2010, 14.01.0225.017.

Install current firmware and device drivers for all devices in the server, such as network adapters, even if the device will not be used in the configuration. Current Cisco C210 M2 firmware and device drivers for Windows can be found on the UCS Server Firmware ISO and the UCS Drivers ISO. Both can be downloaded from www.cisco.com.

The following practices will help improve the I/O subsystem performance:

- Exchange 2010 is an IO intensive application. Do not share Exchange 2010 storage resources with other applications as performance may be negatively impacted.
- Store the Exchange databases and transaction logs on separate NTFS drive volumes. The Exchange Server 2010 resiliency solution no longer requires separate spindles for log and database files. However, placing the databases on a dedicated NTFS drive and the transaction logs on the system drive allows more space for Exchange databases and enables the deployment of larger mailboxes.
- Windows NTFS allocation unit size for Exchange 2010 database partitions should be set to 64K disk allocation size.
- Exchange Server 2010 storage latencies are related to the number of disks available for a given workload. Windows Performance Monitor may be used to monitor Exchange Server 2010 database counters. Average database read latencies (Avg. Disk sec/Read) should not exceed 20ms.
- Choose Enterprise class SATA disks for storage considerations as storage/design requirements indicate high capacity, moderate performance, and moderate power utilization and SATA storage has very good heat, vibration, and reliability characteristics. The disks used in this test are Seagate Constellation ST91000640N 2.5 inch, 7200 RPM, 1TB SATA drives.
- Windows Server 2008 R2 does not require the use of diskpart.exe to define sector boundary alignment as Window Server 2003 did since the sector boundaries are created automatically. Logical volumes are created using the Windows logical disk manager during the setup phase of the OS installation. Also, using Windows 2008R2 setup, the disk partitions are created with an automatic 1 MB offset (except when the disk capacity is less than 4 GB).
- Format the Database RAID 10 Array as a GPT disk if it is larger than 2TB. In this case, the 14 1TB RAID 10 disks yield approximately 7TB, and a GPT format is recommended.

RAID Controller best practices are to create a 256K strip size on the arrays and then enable read ahead, writeback, direct IO, Drive Cache disable, and Disable BGI parameters. Refer to the following table:

Table 8. RAID Controller Best Practices

Parameter	Value
Strip Size:	256
Access Policy:	RW
Read Policy:	*Ahead*
Write Policy:	*WBack*
IO Policy:	Direct
Drive Cache:	Disable
Disable BGI:	No

Create the System Drive so that it will contain Windows 2008 R2 SP1 Enterprise using RAID 1 (2 spindles) and the Data Drive holding the Jetstress database using RAID 10 (14 spindles). Point the WebBrowser to the UCS C210 Server by entering its IP address and within the Cisco UCS Console, open the KVM, exercise the Ctrl+Alt+Del Macro from the file menu and while the host computer is booting press CTRL+H at the following screen in order to enter the RAID bios menu:

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Press <Ctrl><H> for WebBIOS

A message will then indicate that WebBios will load after post completes.

In the next screen, LSI WebBios, you can set up the RAID Controller drive.

Further RAID adjustments can be made within the OS after installing the LSI Megaraid Utility, now v.9, in Windows 2008 R2 SP1.

For Exchange Server 2010 Mailbox Storage Design, please visit http://technet.microsoft.com/en-us/library/dd346703.aspx.

Backup Strategy

The tests performed for backup are: backup-to-disk (read only) and log replay. The backup-to-disk test measures the read I/O performance by running a checksum on all the databases and log files. This test can help determine the level of database read throughput that can be achieved during backups. The backup speed and throughput achieved will depend upon the backup device used. The log replay test was used to measure the maximum rate at which the log files can be played against the databases. This is used to determine the restore times and the database write throughput that can be achieved during a log recovery.

Contact For Additional Information

To find out more about Cisco Unified Computing, please visit: www.cisco.com/go/ucs.

To learn more about running Microsoft Enterprise Applications on Cisco Unified Computing System, please visit: www.cisco.com/go/microsoft.

Test Results Summary

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

Reliability

A number of tests in the framework will check 24 hour Reliability tests runs. The goal is to verify that the storage can handle high IO load for a long period of time. Both log and database files were analyzed for integrity after the stress test to help ensure that there was no database/log corruption.

The following list provides an overview:

- Any errors reported in the saved eventlog file? **No**
- Any errors reported during the database and log checksum process? **No**
- If backup to disk test is done, any errors reported during the process? **No**
- Any errors during database checksum on the remote storage database? **N/A**

Storage Performance Results

The Primary Storage performance test is designed to exercise the storage simulating maximum sustainable Exchange type of IO for two hours. The test measures the length of time needed for the storage subsystem to respond to an IO under load. The data below is the sum of all of the logical disk I/O's and average of all the logical disks I/O latency in the two hours test duration. Each server is listed separately and the aggregate numbers across all servers are listed as well

Individual Performance Across All Servers Metrics

The sum of I/O's across all servers in the solution including their average latency.

Database I/O	
Database Disks Transfers/sec	651.699
Database Disks Reads/sec	370.981
Database Disks Writes/sec	280.717
Average Database Disk Read Latency (ms)	14.580
Average Database Disk Write Latency (ms)	1.342
Transaction Log I/O	
Log Disks Writes/sec	248.284
Average Log Disk Write Latency (ms)	1.065

Database Backup/Recover Performance

There are two tests 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 through VSS. The following table shows the average rate for a single database file.

MB read/sec per database	30.846
MB read/sec total per server	246.77

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 1 MB in size.

Average time to play one Log file (sec)	2.8426

Conclusion

Our tests, outlined in this document, illustrate the fact that the Cisco UCS C210 M2 system is an excellent platform for provisioning an Exchange Resiliency 2010 Storage Solution. The tests clearly show that 2500 Exchange users have ample resources within a Cisco UCS system containing:

Dual Xeon 6-core 12 thread 5649@2.53Ghz CPUs
48Gb (12 x 8192MB Synchronous DIMMs) 1067mhz RAM
LSI 9261-8i MegaRAID SAS Raid Adapter
16 Seagate 1TB 7.2K RPM ST91000640NS 2.5” 1 TB SATA storage drives

to maintain the IOPs required by a Microsoft Exchange Resiliency solution as well as needed reserve to support continuous and uninterrupted use.

This document was developed by Cisco and reviewed by Microsoft Exchange Product team. The test results/data presented in this document are based on the tests introduced in the ESRP test framework. Customer should not quote the data directly for their pre-deployment 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. Instead, ESRP is focused on producing recommendations from vendors for Exchange application. Therefore, the data presented in this document should not be used for direct comparisons among the solutions.

Appendix A: Stress Testing

Stress Test Result Report

Test Summary

Overall Test Result	**Pass**
Machine Name	EXCHANGE1
Test Description	Create New Config 3 threads, .18 iops, 1352mb mailbox, 2500 users 48gb RAM Test
Test Start Time	5/29/2012 10:12:53 AM
Test End Time	5/30/2012 10:17:44 AM
Collection Start Time	5/29/2012 10:17:24 AM

Collection End Time	5/30/2012 10:17:21 AM
Jetstress Version	14.01.0225.017
ESE Version	14.02.0247.001
Operating System	Windows Server 2008 R2 Enterprise Service Pack 1 (6.1.7601.65536)
Performance Log	C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	613.269
Target Transactional I/O per Second	450
Initial Database Size (bytes)	3568849911808
Final Database Size (bytes)	3594108010496
Database Files (Count)	8

Jetstress System Parameters

Thread Count	3 (per database)
Minimum Database Cache	256.0 MB
Maximum Database Cache	2048.0 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

Instance2536.1 Log path: c:\log1
Database: F:\db1\Jetstress001001.edb

Instance2536.2 Log path: c:\log2
Database: F:\db2\Jetstress002001.edb

Instance2536.3 Log path: c:\log3
Database: F:\db3\Jetstress003001.edb

Instance2536.4 Log path: c:\log4
Database: F:\db4\Jetstress004001.edb

Instance2536.5 Log path: c:\log5
Database: F:\db5\Jetstress005001.edb

Instance2536.6 Log path: c:\log6
Database: F:\db6\Jetstress006001.edb

Instance2536.7 Log path: c:\log7
Database: F:\db7\Jetstress007001.edb

Instance2536.8 Log path: c:\log8
Database: f:\db8\Jetstress008001.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
Instance2536.1	15.332	1.335	43.401	33.224	35274.674	35563.666	0.000	1.139	0.000	28.151	0.000	4633.049
Instance2536.2	14.808	1.354	43.517	33.340	35250.679	35564.863	0.000	1.145	0.000	28.319	0.000	4645.742
Instance2536.3	15.372	1.351	43.554	33.377	35319.407	35560.309	0.000	1.158	0.000	28.297	0.000	4643.700
Instance2536.4	16.297	1.360	43.145	33.000	35277.267	35555.155	0.000	1.170	0.000	28.091	0.000	4636.706
Instance2536.5	17.193	1.366	43.532	33.370	35131.347	35550.476	0.000	1.173	0.000	28.331	0.000	4631.251
Instance2536.6	16.446	1.360	43.340	33.188	35278.988	35552.031	0.000	1.171	0.000	28.204	0.000	4639.940
Instance2536.7	15.340	1.380	43.384	33.223	35267.686	35567.151	0.000	1.159	0.000	28.143	0.000	4645.343
Instance2536.8	14.896	1.381	43.426	33.246	35315.183	35541.813	0.000	1.157	0.000	28.161	0.000	4644.227

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2536.1	26.790	261170.891
Instance2536.2	26.902	261170.996
Instance2536.3	26.362	261170.864
Instance2536.4	25.858	261145.761
Instance2536.5	24.900	261148.443
Instance2536.6	25.457	261179.648
Instance2536.7	26.391	261163.257
Instance2536.8	26.935	261131.667

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance2536.1	1.054	198551.356
Instance2536.2	1.063	201209.482
Instance2536.3	1.062	199583.992
Instance2536.4	1.054	198786.867
Instance2536.5	1.060	200033.054
Instance2536.6	1.057	200490.229
Instance2536.7	1.057	199925.927
Instance2536.8	1.057	199573.541

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
Instance2536.1	15.332	1.335	70.191	33.224	121493.909	35563.666	0.827	1.139	1.054	28.151	198551.356	4633.049
Instance2536.2	14.808	1.354	70.420	33.340	121558.828	35564.863	0.833	1.145	1.063	28.319	201209.482	4645.742

Instance2536.3	15.372	1.351	69.916	33.377	120477.676	35560.309	0.826	1.158	1.062	28.297	199583.992	4643.700
Instance2536.4	16.297	1.360	69.003	33.000	119917.675	35555.155	0.828	1.170	1.054	28.091	198786.867	4636.706
Instance2536.5	17.193	1.366	68.433	33.370	117371.699	35550.476	0.835	1.173	1.060	28.331	200033.054	4631.251
Instance2536.6	16.446	1.360	68.797	33.188	118868.735	35552.031	0.834	1.171	1.057	28.204	200490.229	4639.940
Instance2536.7	15.340	1.380	69.774	33.223	120707.702	35567.151	0.829	1.159	1.057	28.143	199925.927	4645.343
Instance2536.8	14.896	1.381	70.361	33.246	121759.630	35541.813	0.830	1.157	1.057	28.161	199573.541	4644.227

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.081	0.000	8.249
Available MBytes	45116.092	45072.000	45310.000
Free System Page Table Entries	33555545.138	33555538.000	33557578.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	87799566.220	87748608.000	87986176.000
Pool Paged Bytes	113182492.851	112648192.000	116183040.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

5/29/2012 10:12:53 AM -- Jetstress testing begins ...
5/29/2012 10:12:53 AM -- Preparing for testing ...
5/29/2012 10:13:02 AM -- Attaching databases ...
5/29/2012 10:13:02 AM -- Preparations for testing are complete.
5/29/2012 10:13:03 AM -- Starting transaction dispatch ..
5/29/2012 10:13:03 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
5/29/2012 10:13:03 AM -- Database flush thresholds: (start: 20.5 MB, stop: 40.9 MB)
5/29/2012 10:13:11 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
5/29/2012 10:13:11 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
5/29/2012 10:13:21 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
5/29/2012 10:13:21 AM -- Performance logging started (interval: 15000 ms).
5/29/2012 10:13:21 AM -- Attaining prerequisites:
5/29/2012 10:17:24 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1941848000.0 (lower bound: 1932735000.0, upper bound: none)
5/30/2012 10:17:24 AM -- Performance logging has ended.
5/30/2012 10:17:24 AM -- JetInterop batch transaction stats: 222502, 223361, 223068, 222069, 223510, 222601, 222702 and 222837.
5/30/2012 10:17:24 AM -- Dispatching transactions ends.
5/30/2012 10:17:24 AM -- Shutting down databases ...
5/30/2012 10:17:44 AM -- Instance2536.1 (complete), Instance2536.2 (complete), Instance2536.3 (complete), Instance2536.4 (complete), Instance2536.5 (complete), Instance2536.6 (complete), Instance2536.7 (complete) and Instance2536.8 (complete)
5/30/2012 10:17:44 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.blg has 5614 samples.
5/30/2012 10:17:44 AM -- Creating test report ...
5/30/2012 10:18:59 AM -- Instance2536.1 has 15.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.1 has 1.1 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.1 has 1.1 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 14.8 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 1.1 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 1.1 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 15.4 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 16.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 1.2 for I/O Log Reads Average Latency.

5/30/2012 10:18:59 AM -- Instance2536.5 has 17.2 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.5 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.5 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 16.4 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 15.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 14.9 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/30/2012 10:18:59 AM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/30/2012 10:18:59 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.xml has 5598 samples queried.

Appendix B: Performance Testing

Performance Test Result Report

Test Summary

Overall Test Result	**Pass**
Machine Name	EXCHANGE1
Test Description	Create New Config 3 threads, .18 iops, 1352mb mailbox, 2500 users 48gb RAM Test
Test Start Time	5/16/2012 9:37:03 AM
Test End Time	5/16/2012 11:41:44 AM
Collection Start Time	5/16/2012 9:41:25 AM
Collection End Time	5/16/2012 11:41:24 AM
Jetstress Version	14.01.0225.017
ESE Version	14.02.0247.001
Operating System	Windows Server 2008 R2 Enterprise Service Pack 1 (6.1.7601.65536)
Performance Log	C:\Program Files\Exchange Jetstress\Performance_2012_5_16_9_37_21.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	651.699
Target Transactional I/O per Second	450
Initial Database Size (bytes)	3553834303488
Final Database Size (bytes)	3556266999808
Database Files (Count)	8

Jetstress System Parameters

Thread Count	3 (per database)
Minimum Database Cache	256.0 MB
Maximum Database Cache	2048.0 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

Instance3852.1 Log path: c:\log1
Database: F:\db1\Jetstress001001.edb

Instance3852.2 Log path: c:\log2
Database: F:\db2\Jetstress002001.edb

Instance3852.3 Log path: c:\log3
Database: F:\db3\Jetstress003001.edb

Instance3852.4 Log path: c:\log4
Database: F:\db4\Jetstress004001.edb

Instance3852.5 Log path: c:\log5
Database: F:\db5\Jetstress005001.edb

Instance3852.6 Log path: c:\log6
Database: F:\db6\Jetstress006001.edb

Instance3852.7 Log path: c:\log7
Database: F:\db7\Jetstress007001.edb

Instance3852.8 Log path: c:\log8
Database: f:\db8\Jetstress008001.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
Instance3852.1	14.115	1.324	46.309	35.036	34901.856	36404.931	0.000	1.036	0.000	30.772	0.000	4633.090
Instance3852.2	13.560	1.294	46.580	35.266	35037.968	36378.305	0.000	1.046	0.000	30.866	0.000	4648.594
Instance3852.3	16.008	1.353	46.071	34.822	34907.609	36432.698	0.000	1.089	0.000	31.104	0.000	4653.530
Instance3852.4	14.085	1.311	46.918	35.727	34781.188	36460.595	0.000	1.069	0.000	31.573	0.000	4664.550
Instance3852.5	15.197	1.327	46.197	34.801	34916.010	36451.800	0.000	1.075	0.000	30.714	0.000	4657.271
Instance3852.6	15.273	1.354	46.443	35.194	34927.510	36455.343	0.000	1.073	0.000	31.444	0.000	4670.224
Instance3852.7	14.281	1.388	46.124	34.889	34811.357	36423.794	0.000	1.070	0.000	30.946	0.000	4687.627
Instance3852.8	14.122	1.381	46.339	34.982	34725.054	36401.212	0.000	1.065	0.000	30.865	0.000	4677.848

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3852.1	27.918	261158.343
Instance3852.2	28.148	261290.040
Instance3852.3	25.863	261297.587

Instance3852.4	27.723	261247.570
Instance3852.5	26.867	261210.519
Instance3852.6	26.489	261125.447
Instance3852.7	27.456	261242.280
Instance3852.8	27.836	261262.051

Log Replication I/O Performance

MSExchange Database ==> Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance3852.1	1.155	209958.581
Instance3852.2	1.160	207943.076
Instance3852.3	1.170	215483.807
Instance3852.4	1.190	214981.514
Instance3852.5	1.160	214516.361
Instance3852.6	1.183	217492.980
Instance3852.7	1.173	213976.927
Instance3852.8	1.170	211967.754

Total I/O Performance

MSExchange base ==> ances	I/O base ds age ncy c)	I/O base es age ncy c)	I/O base ds/sec	I/O base es/sec	I/O base Reads age Bytes	I/O base es Average s	I/O Log ds age ncy c)	I/O Log es age ncy c)	I/O Log ds/sec	I/O Log es/sec	I/O Log ds Average s	I/O Log es Average s
Instance3852.1	14.115	1.324	74.227	35.036	119999.774	36404.931	0.845	1.036	1.155	30.772	209958.581	4633.090
Instance3852.2	13.560	1.294	74.729	35.266	120260.930	36378.305	0.814	1.046	1.160	30.866	207943.076	4648.594
Instance3852.3	16.008	1.353	71.934	34.822	116304.536	36432.698	0.872	1.089	1.170	31.104	215483.807	4653.530
Instance3852.4	14.085	1.311	74.641	35.727	118893.659	36460.595	0.850	1.069	1.190	31.573	214981.514	4664.550
Instance3852.5	15.197	1.327	73.064	34.801	118128.321	36451.800	0.915	1.075	1.160	30.714	214516.361	4657.271
Instance3852.6	15.273	1.354	72.932	35.194	117082.310	36455.343	0.845	1.073	1.183	31.444	217492.980	4670.224
Instance3852.7	14.281	1.388	73.579	34.889	119302.007	36423.794	0.895	1.070	1.173	30.946	213976.927	4687.627
Instance3852.8	14.122	1.381	74.175	34.982	119737.695	36401.212	0.812	1.065	1.170	30.865	211967.754	4677.848

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.121	0.000	4.660
Available MBytes	45211.280	45206.000	45323.000
Free System Page Table Entries	33555544.375	33555542.000	33555546.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	87109031.724	87093248.000	87179264.000
Pool Paged Bytes	125085113.379	125018112.000	125165568.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

5/16/2012 9:37:03 AM -- Jetstress testing begins ...
5/16/2012 9:37:03 AM -- Preparing for testing ...
5/16/2012 9:37:12 AM -- Attaching databases ...
5/16/2012 9:37:12 AM -- Preparations for testing are complete.
5/16/2012 9:37:12 AM -- Starting transaction dispatch ..
5/16/2012 9:37:12 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
5/16/2012 9:37:12 AM -- Database flush thresholds: (start: 20.5 MB, stop: 40.9 MB)

5/16/2012 9:37:21 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
5/16/2012 9:37:21 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
5/16/2012 9:37:32 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
5/16/2012 9:37:32 AM -- Performance logging started (interval: 15000 ms).
5/16/2012 9:37:32 AM -- Attaining prerequisites:
5/16/2012 9:41:25 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1933160000.0 (lower bound: 1932735000.0, upper bound: none)
5/16/2012 11:41:25 AM -- Performance logging has ended.
5/16/2012 11:41:25 AM -- JetInterop batch transaction stats: 20975, 20966, 20985, 21149, 20968, 21169, 20983 and 20896.
5/16/2012 11:41:26 AM -- Dispatching transactions ends.
5/16/2012 11:41:26 AM -- Shutting down databases ...
5/16/2012 11:41:44 AM -- Instance3852.1 (complete), Instance3852.2 (complete), Instance3852.3 (complete), Instance3852.4 (complete), Instance3852.5 (complete), Instance3852.6 (complete), Instance3852.7 (complete) and Instance3852.8 (complete)
5/16/2012 11:41:44 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_16_9_37_21.blg has 479 samples.
5/16/2012 11:41:44 AM -- Creating test report ...
5/16/2012 11:41:51 AM -- Instance3852.1 has 14.1 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.1 has 1.0 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.1 has 1.0 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.2 has 13.6 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.2 has 1.0 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.2 has 1.0 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.3 has 16.0 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.3 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.3 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.4 has 14.1 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.4 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.4 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.5 has 15.2 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.5 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.5 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.6 has 15.3 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.6 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.6 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.7 has 14.3 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.7 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.7 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.8 has 14.1 for I/O Database Reads Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.8 has 1.1 for I/O Log Writes Average Latency.
5/16/2012 11:41:51 AM -- Instance3852.8 has 1.1 for I/O Log Reads Average Latency.
5/16/2012 11:41:51 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/16/2012 11:41:51 AM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/16/2012 11:41:51 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_16_9_37_21.xml has 463 samples queried.

Appendix C: Streaming Backup Testing

Database backup Test Result Report

Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance2804.1	423377.09	03:46:20	31.17
Instance2804.2	423385.09	03:49:54	30.69
Instance2804.3	423377.09	04:05:46	28.71
Instance2804.4	423393.09	04:06:04	28.68
Instance2804.5	423385.09	03:58:50	29.54
Instance2804.6	423377.09	03:39:08	32.20
Instance2804.7	423369.09	03:25:07	34.40
Instance2804.8	423369.09	03:44:52	31.38

Jetstress System Parameters

Thread Count	3 (per database)
Minimum Database Cache	256.0 MB
Maximum Database Cache	2048.0 MB
Insert Operations	40%
Delete Operations	20%
Replace Operations	5%
Read Operations	35%
Lazy Commits	70%

Database Configuration

Instance2804.1 Log path: c:\log1
Backup path: f:\bak1
Database: F:\db1\Jetstress001001.edb

Instance2804.2 Log path: c:\log2
Backup path: f:\bak2
Database: F:\db2\Jetstress002001.edb

Instance2804.3 Log path: c:\log3
Backup path: f:\bak3
Database: F:\db3\Jetstress003001.edb

Instance2804.4 Log path: c:\log4
Backup path: f:\bak4
Database: F:\db4\Jetstress004001.edb

Instance2804.5 Log path: c:\log5
Backup path: f:\bak5
Database: F:\db5\Jetstress005001.edb

Instance2804.6 Log path: c:\log6
Backup path: f:\bak6

Database: F:\db6\Jetstress006001.edb

Instance2804.7 Log path: c:\log7
Backup path: f:\bak7
Database: F:\db7\Jetstress007001.edb

Instance2804.8 Log path: c:\log8
Backup path: c:\bak8
Database: f:\db8\Jetstress008001.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
Instance2804.1	8.826	0.000	124.416	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.2	13.834	0.000	122.521	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.3	17.156	0.000	114.459	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.4	16.407	0.000	114.141	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.5	14.954	0.000	117.967	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.6	9.791	0.000	128.681	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.7	9.078	0.000	137.536	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance2804.8	9.867	0.000	125.204	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.940	0.532	3.455
Available MBytes	40716.936	37226.000	43721.000
Free System Page Table Entries	33555790.870	33555534.000	33557079.000
Transition Pages RePurposed/sec	58113.461	0.000	70162.089
Pool Nonpaged Bytes	94466031.039	54333440.000	128966656.000
Pool Paged Bytes	3405124457.474	141398016.000	6215434240.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

5/11/2012 10:19:12 AM -- Jetstress testing begins ...
5/11/2012 10:19:12 AM -- Preparing for testing ...
5/11/2012 10:19:21 AM -- Attaching databases ...
5/11/2012 10:19:21 AM -- Preparations for testing are complete.
5/11/2012 10:19:36 AM -- Performance logging started (interval: 30000 ms).
5/11/2012 10:19:36 AM -- Backing up databases ...
5/11/2012 2:25:41 PM -- Performance logging has ended.
5/11/2012 2:25:41 PM -- Instance2804.1 (100% processed), Instance2804.2 (100% processed), Instance2804.3 (100% processed), Instance2804.4 (100% processed), Instance2804.5 (100% processed), Instance2804.6 (100% processed), Instance2804.7 (100% processed) and Instance2804.8 (100% processed)
5/11/2012 2:25:41 PM -- C:\Program Files\Exchange Jetstress\DatabaseBackup_2012_5_11_10_19_21.blg has 483 samples.
5/11/2012 2:25:41 PM -- Creating test report ...

Appendix D: Software Recovery Testing

Microsoft Exchange Jetstress 2010

SoftRecovery Test Result Report

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2740.1	507	1418.822492
Instance2740.2	506	1296.2998768
Instance2740.3	509	1713.4602096
Instance2740.4	508	1429.1653102
Instance2740.5	509	1619.8444451
Instance2740.6	501	1647.1600931
Instance2740.7	506	1298.1562801
Instance2740.8	504	1089.708714

Database Configuration

Instance2740.1 Log path: c:\log1
Database: F:\db1\Jetstress001001.edb

Instance2740.2 Log path: c:\log2
Database: F:\db2\Jetstress002001.edb

Instance2740.3 Log path: c:\log3
Database: F:\db3\Jetstress003001.edb

Instance2740.4 Log path: c:\log4
Database: F:\db4\Jetstress004001.edb

Instance2740.5 Log path: c:\log5
Database: F:\db5\Jetstress005001.edb

Instance2740.6 Log path: c:\log6
Database: F:\db6\Jetstress006001.edb

Instance2740.7 Log path: c:\log7
Database: F:\db7\Jetstress007001.edb

Instance2740.8 Log path: c:\log8
Database: f:\db8\Jetstress008001.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

Instance2740.1	16.627	0.909	294.811	2.138	41482.607	32768.000	4.575	0.000	3.207	0.000	232479.930	0.000
Instance2740.2	14.841	0.877	329.504	2.337	41441.743	32659.497	4.649	0.000	3.504	0.000	231704.650	0.000
Instance2740.3	21.041	0.770	214.842	1.774	42088.596	26460.160	3.807	0.000	2.662	0.000	187798.541	0.000
Instance2740.4	16.198	0.905	298.760	2.131	41385.913	32768.000	4.634	0.000	3.195	0.000	232546.742	0.000
Instance2740.5	18.710	0.921	236.253	1.878	41375.982	31901.122	4.522	0.000	2.818	0.000	223190.830	0.000
Instance2740.6	19.247	0.879	237.881	1.817	41265.385	30976.000	4.403	0.000	2.726	0.000	219250.801	0.000
Instance2740.7	15.262	0.891	325.591	2.341	41373.858	32659.855	4.681	0.004	3.511	0.002	231784.251	1.690
Instance2740.8	13.782	0.877	384.061	2.776	41055.820	32768.000	4.837	0.005	4.164	0.003	232543.793	2.016

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2740.1	22.936	261191.242
Instance2740.2	24.321	261186.054
Instance2740.3	20.869	261368.039
Instance2740.4	23.994	261357.149
Instance2740.5	22.552	261436.144
Instance2740.6	21.103	261065.191
Instance2740.7	23.087	261077.373
Instance2740.8	24.963	260975.086

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
Instance2740.1	16.627	0.909	317.747	2.138	57341.873	32768.000	4.575	0.000	3.207	0.000	232479.930	0.000
Instance2740.2	14.841	0.877	353.825	2.337	56546.327	32659.497	4.649	0.000	3.504	0.000	231704.650	0.000
Instance2740.3	21.041	0.770	235.711	1.774	61502.431	26460.160	3.807	0.000	2.662	0.000	187798.541	0.000
Instance2740.4	16.198	0.905	322.754	2.131	57738.708	32768.000	4.634	0.000	3.195	0.000	232546.742	0.000
Instance2740.5	18.710	0.921	258.805	1.878	60552.027	31901.122	4.522	0.000	2.818	0.000	223190.830	0.000
Instance2740.6	19.247	0.879	258.984	1.817	59175.197	30976.000	4.403	0.000	2.726	0.000	219250.801	0.000
Instance2740.7	15.262	0.891	348.678	2.341	55920.986	32659.855	4.681	0.004	3.511	0.002	231784.251	1.690
Instance2740.8	13.782	0.877	409.024	2.776	54477.404	32768.000	4.837	0.005	4.164	0.003	232543.793	2.016

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	8.094	0.000	21.678
Available MBytes	45264.683	45211.000	47040.000
Free System Page Table Entries	33555543.965	33555543.000	33555544.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	87252797.925	87240704.000	87322624.000
Pool Paged Bytes	124016175.242	123985920.000	124043264.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

5/15/2012 3:41:57 PM -- Jetstress testing begins ...
5/15/2012 3:41:58 PM -- Preparing for testing ...
5/15/2012 3:42:06 PM -- Attaching databases ...
5/15/2012 3:42:06 PM -- Preparations for testing are complete.
5/15/2012 3:42:07 PM -- Starting transaction dispatch ..
5/15/2012 3:42:07 PM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
5/15/2012 3:42:07 PM -- Database flush thresholds: (start: 20.5 MB, stop: 40.9 MB)
5/15/2012 3:42:15 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
5/15/2012 3:42:15 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
5/15/2012 3:42:22 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
5/15/2012 3:42:22 PM -- Performance logging started (interval: 15000 ms).
5/15/2012 3:42:22 PM -- Generating log files ...
5/15/2012 5:49:58 PM -- c:\log1 (101.4% generated), c:\log2 (101.2% generated), c:\log3 (101.8% generated), c:\log4 (101.6% generated), c:\log5 (101.8% generated), c:\log6 (100.2% generated), c:\log7 (101.2% generated) and c:\log8 (100.8% generated)
5/15/2012 5:49:58 PM -- Performance logging has ended.
5/15/2012 5:49:58 PM -- JetInterop batch transaction stats: 22087, 21848, 21974, 22249, 21877, 22037, 21848 and 22092.
5/15/2012 5:49:59 PM -- Dispatching transactions ends.
5/15/2012 5:49:59 PM -- Shutting down databases ...
5/15/2012 5:50:18 PM -- Instance2740.1 (complete), Instance2740.2 (complete), Instance2740.3 (complete), Instance2740.4 (complete), Instance2740.5 (complete), Instance2740.6 (complete), Instance2740.7 (complete) and Instance2740.8 (complete)
5/15/2012 5:50:18 PM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_15_15_42_15.blg has 493 samples.
5/15/2012 5:50:18 PM -- Creating test report ...
5/15/2012 5:50:22 PM -- Instance2740.1 has 17.6 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.1 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.1 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.2 has 16.9 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.2 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.2 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.3 has 17.6 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.3 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.3 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.4 has 16.9 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.4 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.4 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.5 has 17.4 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.5 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.5 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.6 has 17.5 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.6 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.6 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.7 has 17.2 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.7 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.7 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.8 has 17.2 for I/O Database Reads Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.8 has 1.0 for I/O Log Writes Average Latency.
5/15/2012 5:50:22 PM -- Instance2740.8 has 1.0 for I/O Log Reads Average Latency.
5/15/2012 5:50:22 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/15/2012 5:50:22 PM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/15/2012 5:50:22 PM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_15_15_42_15.xml has 492 samples queried.
5/15/2012 5:50:23 PM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_15_15_42_15.html was saved.
5/15/2012 5:50:29 PM -- Performance logging started (interval: 4000 ms).
5/15/2012 5:50:29 PM -- Recovering databases ...
5/15/2012 6:19:02 PM -- Performance logging has ended.
5/15/2012 6:19:02 PM -- Instance2740.1 (1418.822492), Instance2740.2 (1296.2998768), Instance2740.3 (1713.4602096), Instance2740.4 (1429.1653102), Instance2740.5 (1619.8444451), Instance2740.6 (1647.1600931), Instance2740.7 (1298.1562801) and Instance2740.8 (1089.708714)
5/15/2012 6:19:03 PM -- C:\Program Files\Exchange Jetstress\SoftRecovery_2012_5_15_17_50_23.blg has 401

samples.
5/15/2012 6:19:03 PM -- Creating test report ...

Appendix E: Database Checksum

Microsoft Exchange Jetstress 2010

Test Result Report

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
F:\db1\Jetstress001001.edb	13710370	0	0	0	428449 MB/709 sec
F:\db2\Jetstress002001.edb	13711394	0	0	0	428481 MB/583 sec
F:\db3\Jetstress003001.edb	13710626	0	0	0	428457 MB/569 sec
F:\db4\Jetstress004001.edb	13709858	0	0	0	428433 MB/584 sec
F:\db5\Jetstress005001.edb	13711138	0	0	0	428473 MB/597 sec
F:\db6\Jetstress006001.edb	13709858	0	0	0	428433 MB/611 sec
F:\db7\Jetstress007001.edb	13710114	0	0	0	428441 MB/631 sec
f:\db8\Jetstress008001.edb	13710114	0	0	0	428441 MB/990 sec
(Sum)	109683472	0	0	0	3427608 MB/4288 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
F:	0.013	0.000	12767.216	0.000	65536.000
f:	0.011	0.000	17091.822	0.000	65536.000

Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	3.392	1.838	5.478
Available MBytes	47205.043	47175.000	47211.000
Free System Page Table Entries	33555543.454	33555543.000	33555545.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	87869890.270	87834624.000	87949312.000
Pool Paged Bytes	119515760.567	119435264.000	119803904.000

Test Log

5/29/2012 10:12:53 AM -- Jetstress testing begins ...
5/29/2012 10:12:53 AM -- Preparing for testing ...
5/29/2012 10:13:02 AM -- Attaching databases ...
5/29/2012 10:13:02 AM -- Preparations for testing are complete.
5/29/2012 10:13:03 AM -- Starting transaction dispatch ..
5/29/2012 10:13:03 AM -- Database cache settings: (minimum: 256.0 MB, maximum: 2.0 GB)
5/29/2012 10:13:03 AM -- Database flush thresholds: (start: 20.5 MB, stop: 40.9 MB)
5/29/2012 10:13:11 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
5/29/2012 10:13:11 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
5/29/2012 10:13:21 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
5/29/2012 10:13:21 AM -- Performance logging started (interval: 15000 ms).
5/29/2012 10:13:21 AM -- Attaining prerequisites:

5/29/2012 10:17:24 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1941848000.0 (lower bound: 1932735000.0, upper bound: none)
5/30/2012 10:17:24 AM -- Performance logging has ended.
5/30/2012 10:17:24 AM -- JetInterop batch transaction stats: 222502, 223361, 223068, 222069, 223510, 222601, 222702 and 222837.
5/30/2012 10:17:24 AM -- Dispatching transactions ends.
5/30/2012 10:17:24 AM -- Shutting down databases ...
5/30/2012 10:17:44 AM -- Instance2536.1 (complete), Instance2536.2 (complete), Instance2536.3 (complete), Instance2536.4 (complete), Instance2536.5 (complete), Instance2536.6 (complete), Instance2536.7 (complete) and Instance2536.8 (complete)
5/30/2012 10:17:44 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.blg has 5614 samples.
5/30/2012 10:17:44 AM -- Creating test report ...
5/30/2012 10:18:59 AM -- Instance2536.1 has 15.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.1 has 1.1 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.1 has 1.1 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 14.8 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 1.1 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.2 has 1.1 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 15.4 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.3 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 16.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.4 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.5 has 17.2 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.5 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.5 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 16.4 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.6 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 15.3 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.7 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 14.9 for I/O Database Reads Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 1.2 for I/O Log Writes Average Latency.
5/30/2012 10:18:59 AM -- Instance2536.8 has 1.2 for I/O Log Reads Average Latency.
5/30/2012 10:18:59 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
5/30/2012 10:18:59 AM -- The test has 0 Database Page Fault Stalls/sec samples higher than 0.
5/30/2012 10:18:59 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.xml has 5598 samples queried.
5/30/2012 10:18:59 AM -- C:\Program Files\Exchange Jetstress\Performance_2012_5_29_10_13_11.html was saved.
5/30/2012 10:19:00 AM -- Performance logging started (interval: 30000 ms).
5/30/2012 10:19:00 AM -- Verifying database checksums ...
5/30/2012 11:30:29 AM -- F: (100% processed) and f: (100% processed)
5/30/2012 11:30:29 AM -- Performance logging has ended.

5/30/2012 11:30:29 AM -- C:\Program Files\Exchange Jetstress\DBChecksum_2012_5_30_10_18_59.blg has 141 samples.

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