

Hitachi Adaptable Modular Storage 2100 Dynamically Provisioned 9,440 User Exchange 2010 Mailbox Resiliency Storage Solution

Tested with: ESRP – Storage Version 3.0

Test Date: April 2010

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Overview

This document provides information on a Hitachi Adaptable Modular Storage 2100 Resiliency storage solution using Hitachi Dynamic Provisioning software for Microsoft® Exchange Server 2010, based on the Microsoft Exchange Solution Reviewed Program (ESRP) – Storage program. For more information about the contents of this document or Hitachi Data Systems best practice recommendations for Microsoft Exchange Server 2010 storage design, see Hitachi Data Systems [Microsoft Exchange Solutions Web page](#).

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 information about the Microsoft ESRP – Storage program, see [TechNet's overview of the program](#).

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Features

The purpose of this testing was to measure the ESRP 3.0 results on a Microsoft Exchange 2010 environment with 9,440 users and 4 servers. This testing used the Hitachi Adaptable Modular Storage 2100 storage system using Hitachi Dynamic Provisioning software in a two-pool RAID-5 configuration (one for databases and one for logs) in a resiliency configuration. These results help answer questions about the kind of performance capabilities to expect with a large-scale Exchange deployment on the 2100.

This solution includes Exchange 2010 Mailbox Resiliency by using the new Database Availability Group (DAG) feature. This tested configuration uses four DAGs, each containing two database copies and two servers. The test configuration was capable of supporting 9,440 users with a 0.18 IOPS per user profile and user mailbox size of 3GB. A 2100 with 117 450GB 15K RPM SAS disks, 8GB of cache and 4Gbit/s paths was used for these tests. Testing used four Sun Fire 4270 servers with 32GB of RAM, two quad-core Intel E5540 2.53GHz CPUs, eight Emulex 4Gbit/s Fibre Channel adapters, and Windows Server 2008 R2 Enterprise.

The Hitachi Adaptable Modular Storage 2100 is a medium-sized, high-performance, highly reliable midrange storage system that can scale to 120 disks while maintaining 99.999% availability. It is highly suitable for a variety of applications and host platforms and is modular in scale. With the option of in-system and cross-system replication functionality, the 2100 is fully capable of being used as the core underlying storage platform for high-performance Exchange Server 2010 architectures.

Solution Description

Deploying Microsoft Exchange Server 2010 requires careful consideration of all aspects of the solution architecture. Host servers need to be configured so that they are robust enough to handle the required Exchange load. The storage solution must be designed to provide the necessary performance while also being reliable and easy to administer. Of course, an effective backup and recovery plan should be incorporated into the solution as well. The aim of this solution report is to provide a tested configuration that utilizes the 2100 to meet the needs of a large Exchange Server deployment.

This solution uses Hitachi Dynamic Provisioning software, which is enabled on the 2100 via a license key. In the most basic sense, Hitachi Dynamic Provisioning software is similar to the use of a host-based logical volume manager (LVM), but with several additional features available within the 2100 and without the need to install software on the host or incur host processing overhead. Hitachi Dynamic Provisioning software is a superior solution. Hitachi Dynamic Provisioning software provides for one or more pools of wide striping across many RAID groups within a 2100. One or more Dynamic Provisioning virtual volumes (DP-VOLs) of a user-specified logical size (with no initial physical space allocated) are created against each pool.

Primarily, Hitachi Dynamic Provisioning software is deployed to avoid the routine issue of hot spots that occur on logical units (LUs) from individual RAID groups when the host workload exceeds the IOPS or throughput capacity of that RAID group. By using many RAID groups as members of a striped Dynamic Provisioning pool underneath the virtual or logical volumes seen by the hosts, a host workload is distributed across many RAID groups, which provides a smoothing effect that dramatically reduces hot spots and results in fewer mailbox moves for the Exchange administrator.

Hitachi Dynamic Provisioning software also carries the side benefit of thin provisioning, where physical space is only assigned from the pool to the DP-VOL as needed using 1GB chunks, up to the logical size specified for each DP-VOL. A pool can also be dynamically expanded by adding more RAID groups without disruption or requiring downtime. Upon expansion a Pool can easily be rebalanced so that the data and workload is wide striped evenly across the current and newly added RAID groups make up the pool.

High availability is also a part of this solution with the use of the new DAG feature, which is the base component of the high availability and site resilience framework built into Microsoft Exchange Server 2010. A DAG is a group of up to 16 mailbox servers that host a set of databases and logs and uses continuous replication to provide automatic database-level recovery from failures that affect individual servers or databases.

Any server in a DAG can host a copy of a mailbox database from any other server in the DAG. When a server is added to a DAG, it monitors and works with the other servers in the DAG to provide automatic recovery delivering a robust, highly available Exchange solution without the administrative complexities of traditional failover clustering. For more information about the DAG feature in Exchange Server 2010, see <http://technet.microsoft.com/en-us/library/dd979799.aspx>.

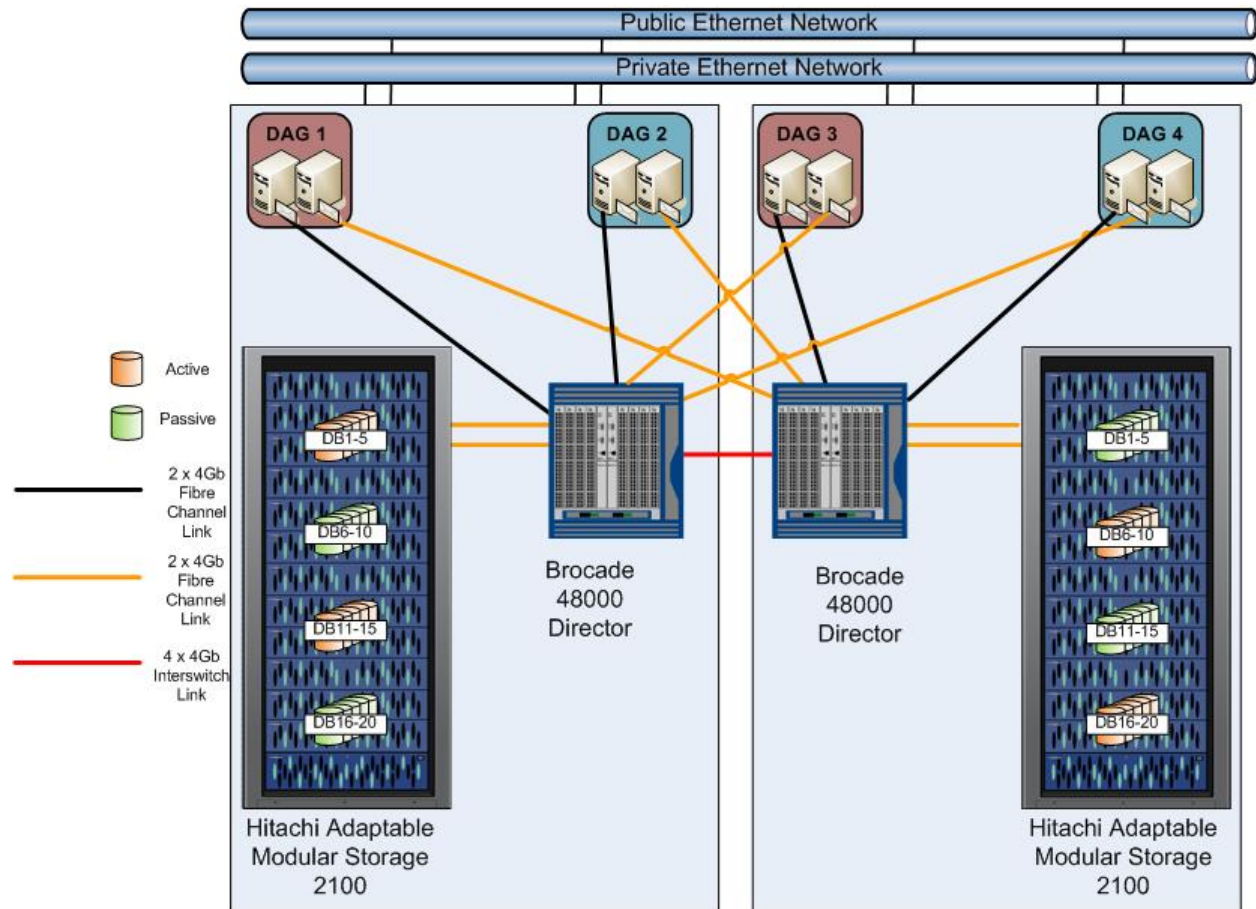
This solution includes two copies of each Exchange database using four DAGs, each configured with two servers that host active mailboxes in five databases. To target the 9,440-user resiliency solution, a Hitachi Adaptable Modular Storage 2100 configured with 117 disks (120 is the maximum) and four servers, each configured with 2,360 mailboxes, were used to host the 20 active databases and the simulated database copies for the tests.

Each DAG contained two copies of every database; a local, active copy on a server connected to the primary 2100 and the passive copy on another server connected to a second 2100. This recommended configuration can support both high-availability and disaster-recovery scenarios when the active and passive database copies are allocated among both DAG members and dispersed across both 2100

storage systems. Each simulated DAG server node in this solution maintains a mirrored configuration and possess adequate capacity and performance capabilities to support the second set of replicated databases.

Figure 1 illustrates the two systems that make up the recommended DAG configuration that was simulated.

Figure 1. Recommended Database Availability Group Configuration

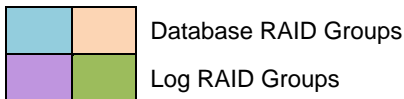


This solution enables organizations to consolidate Exchange Server 2010 DAG deployments on two 2100 storage systems. Using identical hardware and software configurations guarantees that an active database and its replicated copy do not share storage paths, disk spindles or storage controllers, making it a very reliable, high-performing, highly available Exchange Server 2010 solution that is cost effective and easy to manage. This helps ensure that performance and service levels related to storage are maintained regardless of which server is hosting the active database. If further protection is needed in a production environment, additional Exchange Server 2010 mailbox servers can be easily added to support these failover scenarios.

Table 1 illustrates how the 2100 storage system's disks were organized into RAID groups for use by either databases or logs. Each set of colored disks represents a RAID-5 (8D+1P) group. Except for RKA-0 (with 15 internal SAS disks), each RKA is an external disk enclosure with 15 SAS disks.

Table 1. Adaptable Modular Storage 2100 RAID Groups by RKA Tray Layout

<i>Drive Slot</i>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RKA 7	11	11	11	12	12	12	12	12	12	12	12	12			
RKA 6	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11
RKA 5	8	8	8	8	8	8	9	9	9	9	9	9	9	9	9
RKA 4	6	6	6	7	7	7	7	7	7	7	7	7	8	8	8
RKA 3	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6
RKA 2	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4
RKA 1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3
RKA 0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1



Two Dynamic Provisioning pools were created, one for the databases and the other for the logs. The database pool was created from 11 RAID-5 (8D+1P) groups and the log pool was created from two RAID-5 (8D+1P) groups. From the database pool, 20 DP-VOLs (each specified to have a 1,750GB size limit) were created for 20 databases (five per server). From the log pool, two DP-VOLs (each specified to have a size limit of 175GB) were created for 20 logs (five per server).

Table 2 outlines the port layout for the primary storage and servers. An identical configuration is deployed on the replicated storage and servers for this solution.

Table 2. Adaptable Modular Storage 2100 Port to Server Layout

<i>Server</i>	<i>Primary Path</i>	<i>Secondary Path</i>
SUN149	0A	1A
SUN150	0B	1B
SUN151	1A	0A
SUN152	1B	0B

Table 3 outlines the port layout with the database DP-VOL assignments for the primary storage and servers. An identical configuration is deployed on the replicated storage and servers for this solution.

Table 3. Adaptable Modular Storage 2100 Port to Database DP-VOL Layout

<i>Port</i>	<i>Database</i>	<i>DP-VOL</i>
0A	1-5	0-4
0B	6-10	5-9
1A	11-15	10-14
1B	16-20	15-19

Table 4 outlines the port layout with the log DP-VOL assignments for the primary storage and servers. An identical configuration is deployed on the replicated storage and servers for this solution.

Table 4. Adaptable Modular Storage 2100 Port to Log DP-VOL Layout

<i>Port</i>	<i>Log</i>	<i>DP-VOL</i>
0A	1-5	20-24
0B	6-10	25-29
1A	11-15	30-34
1B	16-20	35-39

Table 5 provides the detailed specifications for the storage configuration which uses RAID-5 (8D+1P) groups and 450GB 15K disks. Dynamic Provisioning pool 0 is dedicated for the databases and Dynamic Provisioning pool 1 is dedicated for the logs.

Table 5. Adaptable Modular Storage 2100 Configuration Details

<i>Host</i>	<i>Pool</i>	<i>Port</i>	<i>DP-VOL</i>	<i>Size GB)</i>	<i>Description</i>
Sun149	0	0A/1A	0-4	1750	Databases 1-5
Sun150	0	0B/1B	5-9	1750	Databases 6-10
Sun151	0	1A/0A	10-14	1750	Databases 11-15
Sun152	0	1B/0B	15-19	1750	Databases 16-20
Sun149	1	0A/1A	20-24	175	Logs 1-5
Sun150	1	0B/1B	25-29	175	Logs 6-10
Sun151	1	1A/0A	30-34	175	Logs 11-15
Sun152	1	1B/0B	35-39	175	Logs 16-20

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. These factors also affect server scalability:

- 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

These factors are all beyond the scope of the ESRP – Storage program. Therefore, the number of mailboxes hosted per server as part of the tested configuration might not necessarily be viable for some customer deployments.

For more information about identifying and addressing performance bottlenecks in an Exchange system, see Microsoft's [Troubleshooting Microsoft Exchange Server Performance](#).

Targeted Customer Profile

This solution is designed for medium to large organizations that plan to consolidate their Exchange Server 2010 storage on high-performance, high-reliability storage systems. This configuration is designed to support 9,440 Exchange users with the following specifications:

- Eight Exchange servers (four tested, simulating eight for the database copies)
- Two Adaptable Modular Storage 2100 storage systems (one tested)
- 0.15 IOPS per user (0.18 tested for 20 percent growth)
- 3GB mailbox size
- Mailbox resiliency provides high availability and used as primary data protection mechanism.
- Adaptable Modular Storage RAID protection against physical failure or loss.
- 24x7 background database maintenance enabled

Tested Deployment

The following tables summarize the testing environment.

Table 6. Simulated Exchange Configuration

<i>Number of Exchange mailboxes simulated</i>	9,440
<i>Number of database availability groups (DAGs)</i>	4
<i>Number of servers per DAG</i>	2
<i>Number of active mailboxes per server</i>	2,360
<i>Number of databases per host</i>	5
<i>Number of copies per database</i>	2
<i>Number of mailboxes per database</i>	472
<i>Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)</i>	0.18
<i>Database LU size</i>	1750GB
<i>Log LU size</i>	175GB
<i>Total database size for performance testing</i>	28,320GB
<i>% storage capacity used by Exchange database**</i>	80.7%

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

Table 7. Primary Storage Hardware

Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	Fibre Channel
Storage model and OS/firmware revision	1 Hitachi Adaptable Modular Storage 2100 Firmware: 0890/B-X WHQL listing: Hitachi Adaptable Modular Storage 2100
Storage cache	8GB
Number of storage controllers	2
Number of storage ports	4
Maximum bandwidth of storage connectivity to host	16Gb/s (4 x 4Gbit/s ports)
Switch type/model/firmware revision	Brocade 5320, Fabric OS v6.3.0b
HBA model and firmware	Emulex LPe11002, FW:2.82A3
Number of HBAs per host	2 dual-ported HBA per host, 1 4Gbit/s port used per HBA
Host server type	Sun Fire 4270 2 2.54GHz quad-core Intel Xeon CPUs, 32GB memory
Total number of disks tested in solution	117
Maximum number of spindles can be hosted in the storage	120

Table 8. Primary Storage Software

HBA Driver	STOR Miniport 7.2.0.12
HBA QueueTarget Setting	0
HBA QueueDepth Setting	32
Multipathing	Hitachi Dynamic Link Manager v6.2.0
Host OS	Microsoft Windows Server 2008 R2 Enterprise
ESE.dll file version	14.00.0639.019
Replication solution name/version	N/A

Table 9. Primary Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed and firmware revision	SAS Disk 450GB 15K 4C57
Raw capacity per disk (GB)	450GB
Number of physical disks in test	99 (Dynamic Provisioning pool)
Total raw storage capacity (GB)	44,550GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	N/A
RAID level	RAID-5 (8+1) at storage level
Total formatted capacity	35,112GB (Dynamic Provisioning database pool)
Storage capacity utilization	78.8%
Database capacity utilization	78.6%

Table 10. Primary Storage Disk Configuration (Transaction Log Disks)

Disk type, speed and firmware revision	SAS Disk 450GB 15K 4C57
Raw capacity per disk (GB)	450GB
Number of spindles in test	18 (Dynamic Provisioning pool)
Total raw storage capacity (GB)	8,100GB
Disk slice size (GB)	N/A
Number of slices per LU or number of disks per LU	N/A
RAID level	RAID-5 (8+1) at storage level
Total formatted capacity	6,384GB

Replication Configuration

The following tables summarize the replication environment.

Table 11. Replicated Configuration

Replication mechanism	Exchange Server 2010 Database Availability Group (DAG)
Number of links	2
Simulated link distance	N/A
Link type	IP
Link bandwidth	GigE (1Gbps)

Table 12. Replicated Storage Hardware

Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	Fibre Channel
Storage model and OS/firmware revision	1 Hitachi Adaptable Modular Storage 2100 Firmware: 0890/B-X WHQL listing: Hitachi Adaptable Modular Storage 2100
Storage cache	8GB
Number of storage controllers	2
Number of storage ports	4
Maximum bandwidth of storage connectivity to host	16Gb/s (4 x 4Gbit/s ports)
Switch type/model/firmware revision	Brocade 5320, Fabric OS v6.3.0b
HBA model and firmware	Emulex LPe11002, FW:2.82A3
Number of HBAs per host	2 dual-ported HBA per host, 1 4Gbit/s port used per HBA
Host server type	Sun Fire 4270 2 2.54GHz quad-core Intel Xeon CPUs, 32GB memory
Total number of disks tested in solution	117
Maximum number of spindles can be hosted in the storage	120

Table 13. Replicated Storage Software

HBA Driver	STOR Miniport 7.2.0.12
HBA QueueTarget Setting	0
HBA QueueDepth Setting	32
Multipathing	Hitachi Dynamic Link Manager v6.2.0
Host OS	Microsoft Windows Server 2008 R2 Enterprise
ESE.dll file version	14.00.0639.019
Replication solution name/version	Exchange Server 2010 Database Availability Group (DAG)

Table 14. Replicated Storage Disk Configuration (Mailbox Store Disks)

Disk type, speed and firmware revision	SAS Disk 450GB 15K 4C57
Raw capacity per disk (GB)	450GB
Number of physical disks in test	99 (Dynamic Provisioning pool)
Total raw storage capacity (GB)	44,550GB
Disk slice size (GB)	N/A
Number of slices per LUN or number of disks per LUN	N/A
RAID level	RAID-5 (8+1) at storage level
Total formatted capacity	35,112GB (Dynamic Provisioning database pool)
Storage capacity utilization	78.8%
Database capacity utilization	78.6%

Table 15. Replicated Storage Disk Configuration (Transaction Log Disks)

Disk type, speed and firmware revision	SAS Disk 450GB 15K 4C57
Raw capacity per disk (GB)	450GB
Number of spindles in test	18 (Dynamic Provisioning pool)
Total raw storage capacity (GB)	8,100GB
Disk slice size (GB)	N/A
Number of slices per LU or number of disks per LU	N/A
RAID level	RAID-5 (8+1) at storage level
Total formatted capacity	6,384GB

Best Practices

Microsoft Exchange Server 2010 is a disk-intensive application. It presents two distinct workload patterns to the storage, with 32KB random read/write operations to the databases, and sequential write operations of varying size (between 512 bytes up to the log buffer size) to the transaction logs. For this reason, designing an optimal storage configuration can prove challenging in practice. Based on the testing run using the ESRP framework, Hitachi Data Systems recommends these best practices to improve the performance of the Hitachi Adaptable Modular Storage 2100 running Exchange 2010.

For more information about Exchange 2010 best practices for storage design, see the Microsoft TechNet article "[Mailbox Server Storage Design](#)."

Storage – Mailbox Resiliency

1. When formatting a newly partitioned LU, Hitachi Data Systems recommends setting the ALU to 64K and 4K respectively for the database and log files.
2. Disk alignment is no longer required when using Microsoft Windows Server 2008.
3. Keep the Exchange workload isolated from other applications. Mixing another I/O intensive application whose workload differs from Exchange can cause the performance for both applications to degrade.
4. Use Hitachi Dynamic Link Manager multipathing software to provide fault tolerance and high availability for host connectivity.

5. Use Hitachi Dynamic Provisioning software to simplify storage management of the Exchange database and log volumes.
6. Due to the difference in I/O patterns, isolate the Exchange database from the log groups. Create a dedicated Dynamic Provisioning pool for the databases and a separate pool for the logs.
7. Hitachi Data Systems recommends RAID-5 or RAID-1+0 groups for both the database pools and for the log pool. Use of RAID-1+0 allows more writes at a lower response time under heavier loads. RAID-1+0 also supports a shorter RAID group rebuild time on failure of a disk.
8. The Log LUs should be at least 10 percent of the size of the database LUs.
9. LU concatenation is not recommended.
10. Hitachi Data Systems recommends implementing Mailbox Resiliency using the Exchange Server 2010 Database Availability Group feature.
11. Ensure that each Database Availability Groups maintains at least two database copies to provide high availability.
12. Isolate active databases and their replicated copies in separate Dynamic Provisioning pools or ensure that they are located on a separate 2100.
13. Use fewer, larger LUs for Exchange 2010 databases (up to 2TB) with Background Database Maintenance (24x7) enabled.
14. Size storage solutions for Exchange based primarily on performance criteria. The number of disks, RAID level and percent utilization of each disk directly affect the level of achievable performance. Factor in capacity requirements only after performance is addressed.
15. Disk size is unrelated to performance with regards to IOPS or throughput rates. Disk size is related to the usable capacity of all of the LUs from a RAID group, which is a choice users make.
16. The number of spindles, coupled with the RAID level, determines the physical IOPS capacity of the RAID group and all of its LUs. If the disk has too few spindles, the response times grow to large values very quickly.
17. For more information about RAID-5 drive failure and rebuild, see Appendix A.

Storage-based Replication

N/A

Backup Strategy

N/A

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 ESRP testing framework.

Reliability

A number of tests in the framework check reliability spanning a 24-hour window. The goal is to verify the storage can handle high I/O load for a long period of time. Following these stress tests, both log and database files are analyzed for integrity to ensure that no database or log corruption occurs.

- No errors were reported in the event log file for the storage reliability testing
- No errors were reported for the [database](#) and [log](#) checksum process
- Backup to disk test is N/A
- Database checksum on the remote storage database is N/A

Storage [Performance](#) Results

Primary storage performance testing exercises the storage with maximum sustainable Exchange type of I/O for two hours. The test shows how long it takes for the storage to respond to an I/O under load. The following data is the sum of all of the logical disk I/Os and average of all the logical disks I/O latency in the two-hour test duration.

Individual Server Metrics

Individual server metrics show the sum of I/Os across database and the average latency across all databases on a per-server basis.

Table 16. Individual Server Metrics for Exchange Server (SUN149)

Database I/O	
<i>Database disk transfers per second</i>	1065
<i>Database disk reads per second</i>	671
<i>Database disk writes per second</i>	394
<i>Average database disk read latency (ms)</i>	11.5
<i>Average database disk write latency (ms)</i>	3.1
Transaction Log I/O	
<i>Log disk writes per second</i>	327
<i>Average log disk write latency (ms)</i>	1.1

Table 17. Individual Server Metrics for Exchange Server (SUN150)

Database I/O	
<i>Database disk transfers per second</i>	1105
<i>Database disk reads per second</i>	696
<i>Database disk writes per second</i>	409
<i>Average database disk read latency (ms)</i>	11.4
<i>Average database disk write latency (ms)</i>	3.2
Transaction Log I/O	
<i>Log disk writes per second</i>	338
<i>Average log disk write latency (ms)</i>	1.0

Table 18. Individual Server Metrics for Exchange Server (SUN151)

Database I/O	
<i>Database disk transfers per second</i>	1088
<i>Database disk reads per second</i>	685
<i>Database disk writes per second</i>	403
<i>Average database disk read latency (ms)</i>	11.5
<i>Average database disk write latency (ms)</i>	3.2
Transaction Log I/O	
<i>Log disk writes per second</i>	334
<i>Average log disk write latency (ms)</i>	1.1

Table 19. Individual Server Metrics for Exchange Server (SUN152)

Database I/O	
<i>Database disk transfers per second</i>	1087
<i>Database disk reads per second</i>	685
<i>Database disk writes per second</i>	402
<i>Average database disk read latency (ms)</i>	11.6
<i>Average database disk write latency (ms)</i>	3.5
Transaction Log I/O	
<i>Log disk writes per second</i>	333
<i>Average log disk write latency (ms)</i>	1.0

Aggregate Performance Across All Servers Metrics

The aggregate performance across all server metrics shows the sum of I/Os across all servers in the solution and the average latency across all servers in the solution.

Table 20. Aggregate Performance for Exchange Server 2010

Database I/O	
<i>Database disk transfers per second</i>	4345
<i>Database disk reads per second</i>	2737
<i>Database disk writes per second</i>	1608
<i>Average database disk read latency (ms)</i>	11.5
<i>Average database disk write latency (ms)</i>	3.2
Transaction Log I/O	
<i>Log disk writes per second</i>	1332
<i>Average log disk write latency (ms)</i>	1.1

Database Backup and Recovery Performance

This section has two tests: The first measures the sequential read rate of the database files and the second measures 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 tables show the average rate for a single database file.

Table 21. Database Read-only Performance

<i>MB read per second per database</i>	41
<i>MB read per second total per server</i>	205

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 Database. Each log file was 1MB in size.

Table 22. Transaction Log Recovery/Replay Performance

<i>Average time to play one log file (sec)</i>	1.10
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Conclusion

This document details a tested and robust Exchange Server 2010 Resiliency solution capable of supporting 9,440 users with a 0.18 IOPS per user profile and user mailbox size of 3GB using four DAGs each configured with two server nodes. A Hitachi Adaptable Modular Storage 2100, with 8GB of cache and four 4Gbit/s Fibre Channel host paths, using Hitachi Dynamic Provisioning (with two pools) and 117 450GB 15K RPM SAS disks in a RAID-5 configuration, was used for these tests. Testing confirmed that the 2100 is more than capable of delivering the IOPS and capacity requirements needed to support the active and replicated databases for 9,440 Exchange mailboxes configured with the specified user profile, while maintaining additional headroom to support peak throughput.

The solution outlined in this document does not include data protection components, such as VSS snapshot or clone backups, and relies on the built-in Mailbox Resiliency features of Exchange Server 2010 coupled with Adaptable Modular Storage RAID technology to provide high-availability and protection from logical and physical failures. Adding additional protection requirements might affect performance and capacity requirements of the underlying storage configuration, and as such needs to be factored into the storage design accordingly.

For more information about planning Exchange Server 2010 storage architectures for the Hitachi Adaptable Modular Storage 2000 family, see <http://www.hds.com/assets/pdf/hitachi-ams-2000-family.pdf>.

This document is developed by Hitachi Data Systems and reviewed by Microsoft Exchange Product team. The test results and data presented in this document are based on the tests introduced in the ESRP test framework. Do not quote the data directly for pre-deployment verification. It is still necessary to validate the storage design for a specific customer environment.

The ESRP program is not designed to be a benchmarking program; tests do not generate the maximum throughput for a given solution. Rather, it is focused on producing recommendations from vendors for Exchange application. Thus, do not use the data presented in this document for direct comparisons among the solutions.

Appendix A — RAID-5 Drive Failure and Rebuild

These ESRP tests used RAID-5 (8D+1P) rather than RAID-6 (for example, 4D+2P) or RAID-1+0 (for example, 4D+4D). RAID-5 is a much more capacity-efficient RAID level than the others, losing only 12.5 percent of the usable space (using 8D+1P) instead of 33 percent (4D+2P) or 50 percent (4D+4D). One downside with the use of parity RAID instead of mirrored and striped (RAID-1+0) is that for *writes*, the internal disk write penalty is higher. For SAS or Fibre Channel disks, RAID-5 requires four physical disk I/Os on the backend for every host write, whereas RAID-1+0 consumes two physical I/Os. RAID-6 requires six physical I/Os for each host write.

The other downside is the RAID group rebuild time after a sudden disk failure. The Hitachi Adaptable Modular Storage 2000 family is always scanning the storage system looking for *soft fails*, because excessive soft fails often predict a hard failure. If the number of soft fails exceeds the failure threshold in a 24-hour period (user parameter driven), the 2000 family storage system first executes a disk-to-disk copy to a global hot spare (thus avoiding a RAID-5 or RAID-6 rebuild), and then marks the disk as *failed* and replaces it.

If hard fail does occur, for RAID-1+0, the contents of the good disk are mirrored onto a spare disk (these 'hot spares' are user defined to be in several disk enclosures on a storage system). For RAID-5 and RAID-6, all disks in the RAID group must be read to recreate the missing data and parity that was on the failed disk onto the spare disk. This rebuild mode is called *Corrective Copy*. An associated array setting called *[Drive] Restore Options* determines how aggressive the rebuild operation is in the face of ongoing host I/Os. This setting has three levels: aggressive, moderate and background.

Lab tests show that, on a RAID-6 group using Fibre Channel disks (the only sample available), and an *aggressive* Restore Option setting, a RAID-6 (8D+2P) group Corrective Copy operation requires about 30 minutes to complete in the absence of host workloads on LUs from that RAID group. In the presence of sustained 100 percent sequential write workloads to LUs from that RAID Group, this rebuild time increased to 18 hours. The host performance on a LU from that RAID group was measured at 154MB/s (normal state) and 95MB/s (Corrective Copy state). Had this been RAID-5, the Corrective Copy times would have been reduced.

Appendix B — Test Reports

This appendix contains Jetstress test results for one of the servers used in testing this storage solution. These test results are representative of the results obtained for all of the servers tested.

Performance Test Result: SUN149

Test Summary

Overall Test Result	Pass
Machine Name	SUN149
Test Description	
Test Start Time	4/14/2010 1:19:57 AM
Test End Time	4/14/2010 3:37:52 AM
Collection Start Time	4/14/2010 1:21:36 AM
Collection End Time	4/14/2010 3:21:26 AM
Jetstress Version	14.01.0043.000
Ese Version	14.00.0639.019
Operating System	Windows Server 2008 R2 Enterprise (6.1.7600.0)
Performance Log	C:\ESRP RAID 5 3GB\Performance Test\final\Performance_2010_4_14_1_20_8.blg C:\ESRP RAID 5 3GB\Performance Test\final\DBChecksum_2010_4_14_3_37_52.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	1065.999
Target Transactional I/O per Second	424.8
Initial Database Size (bytes)	7608902942720
Final Database Size (bytes)	7612434546688
Database Files (Count)	5

Jetstress System Parameters

Thread Count	7 (per database)
Minimum Database Cache	160.0 MB
Maximum Database Cache	1280.0 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

Instance3632.1	Log Path: C:\alogluns\log1 Database: C:\asgluns\sg1\Jetstress001001.edb
Instance3632.2	Log Path: C:\alogluns\log2 Database: C:\asgluns\sg2\Jetstress002001.edb
Instance3632.3	Log Path: C:\alogluns\log3 Database: C:\asgluns\sg3\Jetstress003001.edb
Instance3632.4	Log Path: C:\alogluns\log4 Database: C:\asgluns\sg4\Jetstress004001.edb
Instance3632.5	Log Path: C:\alogluns\log5 Database: C:\asgluns\sg5\Jetstress005001.edb

Transactional I/O Performance

MSExchange Database => Instance	I/O Data base Reads /sec	I/O Data base Writes /sec	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database 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
Instance 3632.1	12.388	4.192	132.685	77.888	33803.232	35863.151	0.000	1.318	0.000	64.926	0.000	4761.285
Instance 3632.2	10.996	3.194	134.498	78.997	33833.807	35840.978	0.000	1.032	0.000	64.862	0.000	4771.404
Instance 3632.3	11.671	3.571	135.061	79.434	33714.037	35825.805	0.000	1.286	0.000	65.880	0.000	4734.202
Instance 3632.4	10.996	2.373	134.590	79.187	33763.024	35808.812	0.000	1.030	0.000	65.247	0.000	4795.445
Instance 3632.5	11.717	2.610	134.592	79.067	33751.313	35828.298	0.000	1.237	0.000	65.803	0.000	4746.263

Background Database Maintenance I/O Performance

MSExchange Database => Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3632.1	29.228	261868.611
Instance3632.2	29.113	261847.425
Instance3632.3	28.853	261860.676
Instance3632.4	29.156	261871.619
Instance3632.5	28.833	261905.831

Log Replication I/O Performance

MSExchange Database => Instances	I/O Log Reads/sec	I/O Log Reads Average Bytes
Instance3632.1	1.256	232517.785
Instance3632.2	1.262	232563.353
Instance3632.3	1.266	232554.551
Instance3632.4	1.275	232561.778
Instance3632.5	1.270	232562.110

Total I/O Performance

MSExchange Database => Instance s	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Database Reads/s/sec	I/O Database Writes/s/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 3632.1	12.388	4.192	161.913	77.888	74973.042	35863.151	5.833	1.318	1.256	64.926	232517.785	4761285
Instance 3632.2	10.996	3.194	163.611	78.997	74406.468	35840.978	2.199	1.032	1.262	64.862	232563.353	4771404
Instance 3632.3	11.671	3.571	163.913	79.434	73873.469	35825.805	5.926	1.286	1.266	65.880	232554.551	4734202
Instance 3632.4	10.996	2.373	163.746	79.187	74378.951	35808.812	2.113	1.030	1.275	65.247	232561.778	4795445
Instance 3632.5	11.717	2.610	163.425	79.067	74004.724	35828.298	5.744	1.237	1.270	65.803	232562.110	4746263

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.176	0.000	3.082
Available MBytes	29429.382	29415.000	29462.000
Free System Page Table Entries	33555130.994	33555130.000	33555131.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	72623037.729	72609792.000	72736768.000
Pool Paged Bytes	117451440.367	117403648.000	117506048.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/14/2010 1:19:57 AM -- Jetstress testing begins ...
4/14/2010 1:19:57 AM -- Prepare testing begins ...
4/14/2010 1:20:03 AM -- Attaching databases ...
4/14/2010 1:20:03 AM -- Prepare testing ends.
4/14/2010 1:20:03 AM -- Dispatching transactions begins ...
4/14/2010 1:20:03 AM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)
4/14/2010 1:20:03 AM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)
4/14/2010 1:20:08 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/14/2010 1:20:08 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/14/2010 1:20:15 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/14/2010 1:20:15 AM -- Performance logging begins (interval: 15000 ms).
4/14/2010 1:20:15 AM -- Attaining prerequisites:
4/14/2010 1:21:36 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1215570000.0 (lower bound: 1207960000.0, upper bound: none)
4/14/2010 3:21:37 AM -- Performance logging ends.
4/14/2010 3:37:50 AM -- JetInterop batch transaction stats: 50255, 50356, 50557, 50536 and 50665.
4/14/2010 3:37:50 AM -- Dispatching transactions ends.
4/14/2010 3:37:50 AM -- Shutting down databases ...
4/14/2010 3:37:52 AM -- Instance3632.1 (complete), Instance3632.2 (complete), Instance3632.3 (complete), Instance3632.4 (complete) and Instance3632.5 (complete)
4/14/2010 3:37:53 AM -- Performance logging begins (interval: 30000 ms).
4/14/2010 3:37:53 AM -- Verifying database checksums ...
4/14/2010 11:59:44 AM -- C:\asgluns\sg1 (100% processed), C:\asgluns\sg2 (100% processed), C:\asgluns\sg3 (100% processed), C:\asgluns\sg4 (100% processed) and C:\asgluns\sg5 (100% processed)
4/14/2010 11:59:44 AM -- Performance logging ends.
4/14/2010 11:59:44 AM -- C:\ESRP RAID 5 3GB\Performance Test\final\DBChecksum_2010_4_14_3_37_52.blg has 1002 samples.
4/14/2010 11:59:49 AM -- C:\ESRP RAID 5 3GB\Performance Test\final\DBChecksum_2010_4_14_3_37_52.html is saved.
4/14/2010 11:59:49 AM -- Verifying log checksums ...
4/14/2010 11:59:49 AM -- C:\alogluns\log1 (12 log(s) processed), C:\alogluns\log2 (13 log(s) processed), C:\alogluns\log3 (13 log(s) processed), C:\alogluns\log4 (12 log(s) processed) and C:\alogluns\log5 (13 log(s) processed)
4/14/2010 11:59:49 AM -- C:\ESRP RAID 5 3GB\Performance Test\final\Performance_2010_4_14_1_20_8.blg has 484 samples.
4/14/2010 11:59:49 AM -- Creating test report ...
4/14/2010 11:59:52 AM -- Instance3632.1 has 12.4 for I/O Database Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.1 has 1.3 for I/O Log Writes Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.1 has 1.3 for I/O Log Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.2 has 11.0 for I/O Database Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.2 has 1.0 for I/O Log Writes Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.2 has 1.0 for I/O Log Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.3 has 11.7 for I/O Database Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.3 has 1.3 for I/O Log Writes Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.3 has 1.3 for I/O Log Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.4 has 11.0 for I/O Database Reads Average Latency.
4/14/2010 11:59:52 AM -- Instance3632.4 has 1.0 for I/O Log Writes Average

Latency.
 4/14/2010 11:59:52 AM -- Instance3632.4 has 1.0 for I/O Log Reads Average Latency.
 4/14/2010 11:59:52 AM -- Instance3632.5 has 11.7 for I/O Database Reads Average Latency.
 4/14/2010 11:59:52 AM -- Instance3632.5 has 1.2 for I/O Log Writes Average Latency.
 4/14/2010 11:59:52 AM -- Instance3632.5 has 1.2 for I/O Log Reads Average Latency.
 4/14/2010 11:59:52 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/14/2010 11:59:52 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/14/2010 11:59:52 AM -- C:\ESRP RAID 5 3GB\Performance Test\final\Performance_2010_4_14_1_20_8.xml has 478 samples queried.

Performance Test Database Checksums Result: SUN149

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
C:\asgluns\sg1\Jetstress001001.edb	46462562	0	0	0	1451955 MBytes / 30058 sec
C:\asgluns\sg2\Jetstress002001.edb	46462562	0	0	0	1451955 MBytes / 22504 sec
C:\asgluns\sg3\Jetstress003001.edb	46462562	0	0	0	1451955 MBytes / 29686 sec
C:\asgluns\sg4\Jetstress004001.edb	46462818	0	0	0	1451963 MBytes / 22504 sec
C:\asgluns\sg5\Jetstress005001.edb	46462562	0	0	0	1451955 MBytes / 30110 sec
(Sum)	232313066	0	0	0	7259783 MBytes / 30110 sec

Disk Subsystem Performance of Checksum

Logical Disk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
C:\asgluns\sg1	0.069	0.000	772.638	0.000	65536.000
C:\asgluns\sg2	0.054	0.000	1031.832	0.000	65536.000
C:\asgluns\sg3	0.069	0.000	780.424	0.000	65536.000
C:\asgluns\sg4	0.054	0.000	1031.467	0.000	65536.000
C:\asgluns\sg5	0.068	0.000	769.924	0.000	65536.000

Memory System Performance of Checksum

Counter	Average	Minimum	Maximum
% Processor Time	1.445	0.000	4.281
Available MBytes	30783.261	30766.000	30800.000
Free System Page Table Entries	33555124.277	33555122.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	73028229.876	72896512.000	73400320.000
Pool Paged Bytes	117411496.623	116789248.000	117596160.000

Test Log

4/14/2010 1:19:57 AM -- Jetstress testing begins ...
4/14/2010 1:19:57 AM -- Prepare testing begins ...
4/14/2010 1:20:03 AM -- Attaching databases ...
4/14/2010 1:20:03 AM -- Prepare testing ends.
4/14/2010 1:20:03 AM -- Dispatching transactions begins ...
4/14/2010 1:20:03 AM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)
4/14/2010 1:20:03 AM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)
4/14/2010 1:20:08 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/14/2010 1:20:08 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/14/2010 1:20:15 AM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/14/2010 1:20:15 AM -- Performance logging begins (interval: 15000 ms).
4/14/2010 1:20:15 AM -- Attaining prerequisites:
4/14/2010 1:21:36 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1215570000.0 (lower bound: 1207960000.0, upper bound: none)
4/14/2010 3:21:37 AM -- Performance logging ends.
4/14/2010 3:37:50 AM -- JetInterop batch transaction stats: 50255, 50356, 50557, 50536 and 50665.
4/14/2010 3:37:50 AM -- Dispatching transactions ends.
4/14/2010 3:37:50 AM -- Shutting down databases ...
4/14/2010 3:37:52 AM -- Instance3632.1 (complete), Instance3632.2 (complete), Instance3632.3 (complete), Instance3632.4 (complete) and Instance3632.5 (complete)
4/14/2010 3:37:53 AM -- Performance logging begins (interval: 30000 ms).
4/14/2010 3:37:53 AM -- Verifying database checksums ...
4/14/2010 11:59:44 AM -- C:\asgluns\sg1 (100% processed), C:\asgluns\sg2 (100% processed), C:\asgluns\sg3 (100% processed), C:\asgluns\sg4 (100% processed) and C:\asgluns\sg5 (100% processed)
4/14/2010 11:59:44 AM -- Performance logging ends.
4/14/2010 11:59:44 AM -- C:\ESRP RAID 5 3GB\Performance Test\final\DBChecksum_2010_4_14_3_37_52.blg has 1002 samples.

Stress Test Database Performance Result: SUN149

Test Summary

Overall Test Result	Pass
Machine Name	SUN149
Test Description	
Test Start Time	4/15/2010 10:59:21 PM
Test End Time	4/17/2010 12:00:08 AM
Collection Start Time	4/15/2010 11:01:03 PM
Collection End Time	4/16/2010 11:00:49 PM
Jetstress Version	14.01.0043.000
Ese Version	14.00.0639.019
Operating System	Windows Server 2008 R2 Enterprise (6.1.7600.0)
Performance Log	C:\ESRP RAID 5 3GB\Stress Test\Stress_2010_4_15_22_59_32.blg C:\ESRP RAID 5 3GB\Stress Test\DBChecksum_2010_4_17_0_0_8.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	1021.987
Target Transactional I/O per Second	424.8
Initial Database Size (bytes)	7650216837120
Final Database Size (bytes)	7686740836352
Database Files (Count)	5

Jetstress System Parameters

Thread Count	7 (per database)
Minimum Database Cache	160.0 MB
Maximum Database Cache	1280.0 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

Instance3632.1	Log Path: C:\alogluns\log1 Database: C:\asgluns\sg1\Jetstress001001.edb
Instance3632.2	Log Path: C:\alogluns\log2 Database: C:\asgluns\sg2\Jetstress002001.edb
Instance3632.3	Log Path: C:\alogluns\log3 Database: C:\asgluns\sg3\Jetstress003001.edb
Instance3632.4	Log Path: C:\alogluns\log4 Database: C:\asgluns\sg4\Jetstress004001.edb
Instance3632.5	Log Path: C:\alogluns\log5 Database: C:\asgluns\sg5\Jetstress005001.edb

Transactional I/O Performance

MSExchange Database => Instance	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Database Reads /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
Instance 3632.1	12.719	4.003	127.723	76.389	34357.279	34992.996	0.000	1.910	0.000	61.269	0.000	4758.485
Instance 3632.2	12.005	3.225	128.115	76.632	34494.038	34976.667	0.000	0.776	0.000	62.215	0.000	4699.124
Instance 3632.3	10.648	3.814	127.619	76.459	34816.128	34991.729	0.000	1.854	0.000	60.778	0.000	4805.818
Instance 3632.4	10.679	3.152	128.144	76.755	34879.006	34975.797	0.000	0.762	0.000	62.429	0.000	4689.519
Instance 3632.5	10.629	2.296	127.711	76.440	34816.424	34979.141	0.000	1.850	0.000	60.630	0.000	4793.387

Background Database Maintenance I/O Performance

MSExchange Database => Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance3632.1	28.548	261874.334
Instance3632.2	27.901	261870.269
Instance3632.3	29.922	261874.103
Instance3632.4	29.835	261857.970
Instance3632.5	29.915	261839.033

Log Replication I/O Performance

<i>MSExchange Database ==> Instances</i>	<i>I/O Log Reads/sec</i>	<i>I/O Log Reads Average Bytes</i>
Instance3632.1	1.185	231983.842
Instance3632.2	1.187	231712.541
Instance3632.3	1.188	231984.441
Instance3632.4	1.189	231832.595
Instance3632.5	1.182	231973.275

Total I/O Performance

<i>MSExchange Database ==> Instance s</i>	<i>I/O Data base Reads Average Latency (msec)</i>	<i>I/O Data base Writes Average Latency (msec)</i>	<i>I/O Database Reads/s/sec</i>	<i>I/O Database Writes/s/sec</i>	<i>I/O Database Reads Average Bytes</i>	<i>I/O Database Writes Average Bytes</i>	<i>I/O Log Reads Average Latency (msec)</i>	<i>I/O Log Writes Average Latency (msec)</i>	<i>I/O Log Reads/s/sec</i>	<i>I/O Log Writes/s/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
Instance 3632.1	12.719	4.003	156.271	76.389	75920.956	34992.996	6.979	1.910	1.185	61.269	231983.842	4758.485
Instance 3632.2	12.005	3.225	156.016	76.632	75156.529	34976.667	1.645	0.776	1.187	62.215	231712.541	4699.124
Instance 3632.3	10.648	3.814	157.540	76.459	77941.363	34991.729	8.009	1.854	1.188	60.778	231984.441	4805.818
Instance 3632.4	10.679	3.152	157.978	76.755	77744.610	34975.797	1.667	0.762	1.189	62.429	231832.595	4689.519
Instance 3632.5	10.629	2.296	157.626	76.440	77901.421	34979.141	8.839	1.850	1.182	60.630	231973.275	4793.387

Host System Performance

<i>Counter</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>
% Processor Time	1.196	0.000	4.789
Available MBytes	29383.020	29342.000	29457.000
Free System Page Table Entries	33555130.980	33555123.000	33555131.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	72771441.911	72761344.000	72859648.000
Pool Paged Bytes	119643570.991	118099968.000	121831424.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/15/2010 10:59:21 PM -- Jetstress testing begins ...
4/15/2010 10:59:21 PM -- Prepare testing begins ...
4/15/2010 10:59:26 PM -- Attaching databases ...
4/15/2010 10:59:26 PM -- Prepare testing ends.
4/15/2010 10:59:26 PM -- Dispatching transactions begins ...
4/15/2010 10:59:26 PM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)
4/15/2010 10:59:26 PM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)
4/15/2010 10:59:32 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
4/15/2010 10:59:32 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
4/15/2010 10:59:38 PM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/15/2010 10:59:38 PM -- Performance logging begins (interval: 15000 ms).
4/15/2010 10:59:38 PM -- Attaining prerequisites:
4/15/2010 11:01:03 PM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1218908000.0 (lower bound: 1207960000.0, upper bound: none)
4/16/2010 11:01:03 PM -- Performance logging ends.
4/17/2010 12:00:01 AM -- JetInterop batch transaction stats: 517059, 517853, 517620, 517670 and 517076.
4/17/2010 12:00:01 AM -- Dispatching transactions ends.
4/17/2010 12:00:01 AM -- Shutting down databases ...
4/17/2010 12:00:08 AM -- Instance3632.1 (complete), Instance3632.2 (complete), Instance3632.3 (complete), Instance3632.4 (complete) and Instance3632.5 (complete)
4/17/2010 12:00:09 AM -- Performance logging begins (interval: 30000 ms).
4/17/2010 12:00:09 AM -- Verifying database checksums ...
4/17/2010 7:20:21 AM -- C:\asgluns\sg1 (100% processed), C:\asgluns\sg2 (100% processed), C:\asgluns\sg3 (100% processed), C:\asgluns\sg4 (100% processed) and C:\asgluns\sg5 (100% processed)
4/17/2010 7:20:21 AM -- Performance logging ends.
4/17/2010 7:20:21 AM -- C:\ESRP RAID 5 3GB\Stress Test\DBChecksum_2010_4_17_0_0_8.blg has 879 samples.
4/17/2010 7:20:24 AM -- C:\ESRP RAID 5 3GB\Stress Test\DBChecksum_2010_4_17_0_0_8.html is saved.
4/17/2010 7:20:24 AM -- Verifying log checksums ...
4/17/2010 7:20:26 AM -- C:\alogluns\log1 (11 log(s) processed), C:\alogluns\log2 (12 log(s) processed), C:\alogluns\log3 (11 log(s) processed), C:\alogluns\log4 (12 log(s) processed) and C:\alogluns\log5 (11 log(s) processed)
4/17/2010 7:20:26 AM -- C:\ESRP RAID 5 3GB\Stress Test\Stress_2010_4_15_22_59_32.blg has 5756 samples.
4/17/2010 7:20:26 AM -- Creating test report ...
4/17/2010 7:20:52 AM -- Instance3632.1 has 12.7 for I/O Database Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.1 has 1.9 for I/O Log Writes Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.1 has 1.9 for I/O Log Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.2 has 12.0 for I/O Database Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.2 has 0.8 for I/O Log Writes Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.2 has 0.8 for I/O Log Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.3 has 10.6 for I/O Database Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.3 has 1.9 for I/O Log Writes Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.3 has 1.9 for I/O Log Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.4 has 10.7 for I/O Database Reads Average Latency.
4/17/2010 7:20:52 AM -- Instance3632.4 has 0.8 for I/O Log Writes Average

Latency.
 4/17/2010 7:20:52 AM -- Instance3632.4 has 0.8 for I/O Log Reads Average Latency.
 4/17/2010 7:20:52 AM -- Instance3632.5 has 10.6 for I/O Database Reads Average Latency.
 4/17/2010 7:20:52 AM -- Instance3632.5 has 1.9 for I/O Log Writes Average Latency.
 4/17/2010 7:20:52 AM -- Instance3632.5 has 1.9 for I/O Log Reads Average Latency.
 4/17/2010 7:20:52 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/17/2010 7:20:52 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/17/2010 7:20:52 AM -- C:\ESRP RAID 5 3GB\Stress Test\Stress_2010_4_15_22_59_32.xml has 5750 samples queried.

Stress Test Database Checksums Result: SUN149

Checksum Statistics - All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
C:\asgluns\sg1\Jetstress001001.edb	46916706	0	0	0	1466147 MBytes / 24903 sec
C:\asgluns\sg2\Jetstress002001.edb	46915938	0	0	0	1466123 MBytes / 26411 sec
C:\asgluns\sg3\Jetstress003001.edb	46916706	0	0	0	1466147 MBytes / 23339 sec
C:\asgluns\sg4\Jetstress004001.edb	46917218	0	0	0	1466163 MBytes / 23413 sec
C:\asgluns\sg5\Jetstress005001.edb	46914146	0	0	0	1466067 MBytes / 23444 sec
(Sum)	234580714	0	0	0	7330647 MBytes / 26411 sec

Disk Subsystem Performance of Checksum

Logical Disk	Avg. Disk sec/Read	Avg. Disk sec/Write	Disk Reads/sec	Disk Writes/sec	Avg. Disk Bytes/Read
C:\asgluns\sg1	0.063	0.000	939.646	0.000	65536.000
C:\asgluns\sg2	0.062	0.000	884.649	0.000	65536.000
C:\asgluns\sg3	0.056	0.000	1004.956	0.000	65536.000
C:\asgluns\sg4	0.056	0.000	1001.863	0.000	65536.000
C:\asgluns\sg5	0.055	0.000	1000.236	0.000	65536.000

Memory System Performance of Checksum

Counter	Average	Minimum	Maximum
% Processor Time	1.627	0.000	4.216
Available MBytes	30742.635	30720.000	30762.000
Free System Page Table Entries	33555130.589	33555123.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	73122383.800	73011200.000	73248768.000
Pool Paged Bytes	119206945.784	118022144.000	121802752.000

Test Log

4/15/2010 10:59:21 PM -- Jetstress testing begins ...
4/15/2010 10:59:21 PM -- Prepare testing begins ...
4/15/2010 10:59:26 PM -- Attaching databases ...
4/15/2010 10:59:26 PM -- Prepare testing ends.
4/15/2010 10:59:26 PM -- Dispatching transactions begins ...
4/15/2010 10:59:26 PM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)
4/15/2010 10:59:26 PM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)
4/15/2010 10:59:32 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).
4/15/2010 10:59:32 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).
4/15/2010 10:59:38 PM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/15/2010 10:59:38 PM -- Performance logging begins (interval: 15000 ms).
4/15/2010 10:59:38 PM -- Attaining prerequisites:
4/15/2010 11:01:03 PM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 1218908000.0 (lower bound: 1207960000.0, upper bound: none)
4/16/2010 11:01:03 PM -- Performance logging ends.
4/17/2010 12:00:01 AM -- JetInterop batch transaction stats: 517059, 517853, 517620, 517670 and 517076.
4/17/2010 12:00:01 AM -- Dispatching transactions ends.
4/17/2010 12:00:01 AM -- Shutting down databases ...
4/17/2010 12:00:08 AM -- Instance3632.1 (complete), Instance3632.2 (complete), Instance3632.3 (complete), Instance3632.4 (complete) and Instance3632.5 (complete)
4/17/2010 12:00:09 AM -- Performance logging begins (interval: 30000 ms).
4/17/2010 12:00:09 AM -- Verifying database checksums ...
4/17/2010 7:20:21 AM -- C:\asgluns\sg1 (100% processed), C:\asgluns\sg2 (100% processed), C:\asgluns\sg3 (100% processed), C:\asgluns\sg4 (100% processed) and C:\asgluns\sg5 (100% processed)
4/17/2010 7:20:21 AM -- Performance logging ends.
4/17/2010 7:20:21 AM -- C:\ESRP RAID 5 3GB\Stress Test\DBChecksum_2010_4_17_0_0_8.blg has 879 samples.

Database Backup Test Result: SUN149

Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance2868.1	1466139.09	12:20:58	32.98
Instance2868.2	1466115.09	12:13:20	33.32
Instance2868.3	1466139.09	12:06:23	33.64
Instance2868.4	1466155.09	11:59:06	33.98
Instance2868.5	1466059.09	12:15:26	33.22

Jetstress System Parameters

Thread Count	7 (per database)
Minimum Database Cache	160.0 MB
Maximum Database Cache	1280.0 MB
Insert Operations	40%
Delete Operations	20%
Replace Operations	5%
Read Operations	35%
Lazy Commits	70%

Database Configuration

Instance2868.1	Log Path: C:\alogluns\log1 Database: C:\asgluns\sg1\Jetstress001001.edb
Instance2868.2	Log Path: C:\alogluns\log2 Database: C:\asgluns\sg2\Jetstress002001.edb
Instance2868.3	Log Path: C:\alogluns\log3 Database: C:\asgluns\sg3\Jetstress003001.edb
Instance2868.4	Log Path: C:\alogluns\log4 Database: C:\asgluns\sg4\Jetstress004001.edb
Instance2868.5	Log Path: C:\alogluns\log5 Database: C:\asgluns\sg5\Jetstress005001.edb

Transactional I/O Performance

MSExchange => Instance	I/O Database Reads /sec Average Latency (msec)	I/O Database Writes /sec Average Latency (msec)	I/O Database Reads /sec	I/O Database Writes /sec	I/O Database Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2868.1	11.550	0.000	131.271	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2868.2	10.424	0.000	133.255	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2868.3	10.343	0.000	134.514	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2868.4	10.191	0.000	135.854	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2868.5	10.515	0.000	132.801	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	0.726	0.000	2.952
Available MBytes	30775.602	30760.000	30784.000
Free System Page Table Entries	33555131.001	33555131.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	72835949.319	72830976.000	72851456.000
Pool Paged Bytes	122038125.319	120811520.000	124702720.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

```

4/17/2010 8:54:04 AM -- Jetstress testing begins ...
4/17/2010 8:54:04 AM -- Prepare testing begins ...
4/17/2010 8:54:09 AM -- Attaching databases ...
4/17/2010 8:54:09 AM -- Prepare testing ends.
4/17/2010 8:54:19 AM -- Performance logging begins (interval: 30000 ms).
4/17/2010 8:54:19 AM -- Backing up databases ...
4/17/2010 9:15:17 PM -- Performance logging ends.
4/17/2010 9:15:17 PM -- Instance2868.1 (100% processed), Instance2868.2 (100%
processed), Instance2868.3 (100% processed), Instance2868.4 (100% processed)
and Instance2868.5 (100% processed)
4/17/2010 9:15:17 PM -- C:\ESRP RAID 5 3GB\Database
Backup\DatabaseBackup_2010_4_17_8_54_9.blg has 1480 samples.
4/17/2010 9:15:18 PM -- Creating test report ...

```

Soft Recovery Test Result: SUN149

Soft-Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2868.1	506	603.8614607
Instance2868.2	501	613.143477
Instance2868.3	503	591.6622392
Instance2868.4	501	610.7566728
Instance2868.5	500	606.7786658

Database Configuration

Instance2868.1	Log Path: C:\alogluns\log1 Database: C:\asgluns\sg1\Jetstress001001.edb
Instance2868.2	Log Path: C:\alogluns\log2 Database: C:\asgluns\sg2\Jetstress002001.edb
Instance2868.3	Log Path: C:\alogluns\log3 Database: C:\asgluns\sg3\Jetstress003001.edb
Instance2868.4	Log Path: C:\alogluns\log4 Database: C:\asgluns\sg4\Jetstress004001.edb
Instance2868.5	Log Path: C:\alogluns\log5 Database: C:\asgluns\sg5\Jetstress005001.edb

Transactional I/O Performance

MSExchange => Instance	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s	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
Instance 2868.1	23.495	14.085	993.332	5.038	36191.459	32548.081	4.066	0.000	7.556	0.000	231007.620	0.000
Instance 2868.2	22.450	13.925	983.495	4.806	35860.326	32550.993	12.570	0.000	7.211	0.000	230962.629	0.000
Instance 2868.3	23.304	13.698	1005.674	5.134	35881.525	32543.562	4.589	0.002	7.705	0.005	230855.814	3.507
Instance 2868.4	22.156	13.577	985.744	4.921	35982.780	32550.993	11.986	0.000	7.382	0.000	230959.680	0.000
Instance 2868.5	23.091	13.567	1002.265	4.953	35866.112	32549.547	4.561	0.000	7.431	0.000	230995.827	0.000

Background Database Maintenance I/O Performance

MSExchange Database ==> Instances	Database Maintenance IO Reads/sec	Database Maintenance IO Reads Average Bytes
Instance2868.1	24.162	261907.678
Instance2868.2	23.590	261872.325
Instance2868.3	23.542	261902.353
Instance2868.4	23.757	262014.060
Instance2868.5	23.676	261828.900

Total I/O Performance

MSExchange Database ==> Instance s	I/O Data base Reads Average Latency (msec)	I/O Data base Writes Average Latency (msec)	I/O Database Reads/s/sec	I/O Database Writes/s/sec	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s/sec	I/O Log Writes/s/sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2868.1	23.495	14.085	1017.494	5.038	41551.542	32548.081	4.066	0.000	7.556	0.000	231007.620	0.000
Instance 2868.2	22.450	13.925	1007.085	4.806	41154.438	32550.993	12.570	0.000	7.211	0.000	230962.629	0.000
Instance 2868.3	23.304	13.698	1029.216	5.134	41051.478	32543.562	4.589	0.002	7.705	0.005	230855.814	3.507
Instance 2868.4	22.156	13.577	1009.501	4.921	41302.027	32550.993	11.986	0.000	7.382	0.000	230959.680	0.000
Instance 2868.5	23.091	13.567	1025.940	4.953	41080.649	32549.547	4.561	0.000	7.431	0.000	230995.827	0.000

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	2.470	0.000	8.900
Available MBytes	29415.171	29370.000	30562.000
Free System Page Table Entries	33555131.296	33555130.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	79651678.316	73367552.000	80306176.000
Pool Paged Bytes	123373729.684	123322368.000	123420672.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

4/17/2010 8:54:04 AM -- Jetstress testing begins ...
4/17/2010 8:54:04 AM -- Prepare testing begins ...
4/17/2010 8:54:09 AM -- Attaching databases ...
4/17/2010 8:54:09 AM -- Prepare testing ends.
4/17/2010 8:54:19 AM -- Performance logging begins (interval: 30000 ms).
4/17/2010 8:54:19 AM -- Backing up databases ...
4/17/2010 9:15:17 PM -- Performance logging ends.
4/17/2010 9:15:17 PM -- Instance2868.1 (100% processed), Instance2868.2 (100% processed), Instance2868.3 (100% processed), Instance2868.4 (100% processed) and Instance2868.5 (100% processed)
4/17/2010 9:15:17 PM -- C:\ESRP RAID 5 3GB\Database Backup\DatabaseBackup_2010_4_17_8_54_9.blg has 1480 samples.
4/17/2010 9:15:18 PM -- Creating test report ...
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database Backup\DatabaseBackup_2010_4_17_8_54_9.html is saved.
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database Backup\Application_2010_4_17_21_15_24.evt is saved.
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database Backup\System_2010_4_17_21_15_24.evt is saved.
4/17/2010 9:15:24 PM -- Jetstress testing ends.
4/17/2010 9:47:07 PM -- Jetstress testing begins ...
4/17/2010 9:47:07 PM -- Prepare testing begins ...
4/17/2010 9:47:12 PM -- Attaching databases ...
4/17/2010 9:47:12 PM -- Prepare testing ends.
4/17/2010 9:47:12 PM -- Dispatching transactions begins ...
4/17/2010 9:47:13 PM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)
4/17/2010 9:47:13 PM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)
4/17/2010 9:47:18 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).
4/17/2010 9:47:18 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).
4/17/2010 9:47:23 PM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.
4/17/2010 9:47:23 PM -- Performance logging begins (interval: 15000 ms).
4/17/2010 9:47:23 PM -- Generating log files ...
4/17/2010 10:46:22 PM -- C:\alogs\log1 (101.4% generated), C:\alogs\log2 (100.4% generated), C:\alogs\log3 (100.8% generated), C:\alogs\log4 (100.4% generated) and C:\alogs\log5 (100.2% generated)
4/17/2010 10:46:22 PM -- Performance logging ends.
4/17/2010 10:46:22 PM -- JetInterop batch transaction stats: 21653, 21837, 21821, 21716 and 21931.
4/17/2010 10:46:22 PM -- Dispatching transactions ends.
4/17/2010 10:46:22 PM -- Shutting down databases ...
4/17/2010 10:46:31 PM -- Instance2868.1 (complete), Instance2868.2 (complete), Instance2868.3 (complete), Instance2868.4 (complete) and Instance2868.5 (complete)
4/17/2010 10:46:31 PM -- C:\ESRP RAID 5 3GB\Soft Recovery\Performance_2010_4_17_21_47_18.blg has 235 samples.
4/17/2010 10:46:31 PM -- Creating test report ...
4/17/2010 10:46:32 PM -- Instance2868.1 has 14.0 for I/O Database Reads Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.1 has 0.7 for I/O Log Writes Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.1 has 0.7 for I/O Log Reads Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 12.8 for I/O Database Reads Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 1.5 for I/O Log Writes Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 1.5 for I/O Log Reads Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.3 has 12.9 for I/O Database Reads Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.3 has 0.7 for I/O Log Writes Average

Latency.
 4/17/2010 10:46:32 PM -- Instance2868.3 has 0.7 for I/O Log Reads Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.4 has 12.8 for I/O Database Reads Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.4 has 1.5 for I/O Log Writes Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.4 has 1.5 for I/O Log Reads Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.5 has 12.9 for I/O Database Reads Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.5 has 0.7 for I/O Log Writes Average Latency.
 4/17/2010 10:46:32 PM -- Instance2868.5 has 0.7 for I/O Log Reads Average Latency.
 4/17/2010 10:46:32 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
 4/17/2010 10:46:32 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.
 4/17/2010 10:46:32 PM -- C:\ESRP RAID 5 3GB\Soft Recovery\Performance_2010_4_17_21_47_18.xml has 234 samples queried.
 4/17/2010 10:46:32 PM -- C:\ESRP RAID 5 3GB\Soft Recovery\Performance_2010_4_17_21_47_18.html is saved.
 4/17/2010 10:48:49 PM -- Performance logging begins (interval: 4000 ms).
 4/17/2010 10:48:49 PM -- Recovering databases ...
 4/17/2010 10:59:02 PM -- Performance logging ends.
 4/17/2010 10:59:02 PM -- Instance2868.1 (603.8614607), Instance2868.2 (613.143477), Instance2868.3 (591.6622392), Instance2868.4 (610.7566728) and Instance2868.5 (606.7786658)
 4/17/2010 10:59:02 PM -- C:\ESRP RAID 5 3GB\Soft Recovery\SoftRecovery_2010_4_17_22_48_45.blg has 152 samples.
 4/17/2010 10:59:02 PM -- Creating test report ...

Soft Recovery Test Performance Result: SUN149

Test Summary

Overall Test Result	Pass
Machine Name	SUN149
Test Description	
Test Start Time	4/17/2010 9:47:07 PM
Test End Time	4/17/2010 10:46:31 PM
Collection Start Time	4/17/2010 9:47:38 PM
Collection End Time	4/17/2010 10:46:11 PM
Jetstress Version	14.01.0043.000
Ese Version	14.00.0639.019
Operating System	Windows Server 2008 R2 Enterprise (6.1.7600.0)
Performance Log	C:\ESRP RAID 5 3GB\Soft Recovery\Performance_2010_4_17_21_47_18.blg

Database Sizing and Throughput

Achieved Transactional I/O per Second	1086.95
Capacity Percentage	100%
Throughput Percentage	100%
Initial Database Size (bytes)	7686740836352
Final Database Size (bytes)	7688301117440
Database Files (Count)	5

Jetstress System Parameters

Thread Count	7 (per database)
Minimum Database Cache	160.0 MB
Maximum Database Cache	1280.0 MB
Insert Operations	40%
Delete Operations	20%
Replace Operations	5%
Read Operations	35%
Lazy Commits	70%

Database Configuration

Instance2868.1	Log Path: C:\alogluns\log1 Database: C:\asgluns\sg1\Jetstress001001.edb
Instance2868.2	Log Path: C:\alogluns\log2 Database: C:\asgluns\sg2\Jetstress002001.edb
Instance2868.3	Log Path: C:\alogluns\log3 Database: C:\asgluns\sg3\Jetstress003001.edb
Instance2868.4	Log Path: C:\alogluns\log4 Database: C:\asgluns\sg4\Jetstress004001.edb
Instance2868.5	Log Path: C:\alogluns\log5 Database: C:\asgluns\sg5\Jetstress005001.edb

Transactional I/O Performance

MSExchange => Instance	I/O Database Reads /sec Average Latency (msec)	I/O Database Writes /sec 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 /sec Average Latency (msec)	I/O Log Writes /sec Average Latency (msec)	I/O Log Reads /sec	I/O Log Writes /sec	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2868.1	13.99 4	10.94 7	136.4 79	81.322	32768 .652	34970 .803	0.00 0	0.74 6	0.000	66.646	0.00 0	4728.426
Instance 2868.2	12.83 3	9.526	135.6 28	80.768	32768 .439	34974 .745	0.00 0	1.49 6	0.000	63.729	0.00 0	4880.800
Instance 2868.3	12.92 5	7.892	136.3 65	81.266	32768 .000	34958 .720	0.00 0	0.74 4	0.000	66.753	0.00 0	4705.776
Instance 2868.4	12.79 1	6.330	136.3 02	81.004	32768 .265	34986 .826	0.00 0	1.47 8	0.000	63.734	0.00 0	4881.715
Instance 2868.5	12.90 5	4.571	136.5 71	81.245	32768 .000	34978 .340	0.00 0	0.73 3	0.000	66.966	0.00 0	4646.910

Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.304	0.000	2.904
Available MBytes	29400.983	29379.000	30320.000
Free System Page Table Entries	33555131.004	33555129.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	73038338.179	72810496.000	73129984.000
Pool Paged Bytes	123209858.723	123166720.000	123289600.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log

```

4/17/2010 8:54:04 AM -- Jetstress testing begins ...
4/17/2010 8:54:04 AM -- Prepare testing begins ...
4/17/2010 8:54:09 AM -- Attaching databases ...
4/17/2010 8:54:09 AM -- Prepare testing ends.
4/17/2010 8:54:19 AM -- Performance logging begins (interval: 30000 ms).
4/17/2010 8:54:19 AM -- Backing up databases ...
4/17/2010 9:15:17 PM -- Performance logging ends.
4/17/2010 9:15:17 PM -- Instance2868.1 (100% processed), Instance2868.2 (100%
processed), Instance2868.3 (100% processed), Instance2868.4 (100% processed)
and Instance2868.5 (100% processed)
4/17/2010 9:15:17 PM -- C:\ESRP RAID 5 3GB\Database
Backup\DatabaseBackup_2010_4_17_8_54_9.blg has 1480 samples.
4/17/2010 9:15:18 PM -- Creating test report ...
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database
Backup\DatabaseBackup_2010_4_17_8_54_9.html is saved.
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database
Backup\Appl ication_2010_4_17_21_15_24 evt is saved.
4/17/2010 9:15:24 PM -- C:\ESRP RAID 5 3GB\Database

```

Backup\System_2010_4_17_21_15_24.evt is saved.
4/17/2010 9:15:24 PM -- Jetstress testing ends.
4/17/2010 9:47:07 PM -- Jetstress testing begins ...
4/17/2010 9:47:07 PM -- Prepare testing begins ...
4/17/2010 9:47:12 PM -- Attaching databases ...
4/17/2010 9:47:12 PM -- Prepare testing ends.
4/17/2010 9:47:12 PM -- Dispatching transactions begins ...
4/17/2010 9:47:13 PM -- Database cache settings: (minimum: 160.0 MB, maximum:
1.2 GB)
4/17/2010 9:47:13 PM -- Database flush thresholds: (start: 12.8 MB, stop:
25.6 MB)
4/17/2010 9:47:18 PM -- Database read latency thresholds: (average: 20
msec/read, maximum: 100 msec/read).
4/17/2010 9:47:18 PM -- Log write latency thresholds: (average: 10
msec/write, maximum: 100 msec/write).
4/17/2010 9:47:23 PM -- Operation mix: Sessions 7, Inserts 40%, Deletes 20%,
Replaces 5%, Reads 35%, Lazy Commits 70%.
4/17/2010 9:47:23 PM -- Performance logging begins (interval: 15000 ms).
4/17/2010 9:47:23 PM -- Generating log files ...
4/17/2010 10:46:22 PM -- C:\alogs\log1 (101.4% generated),
C:\alogs\log2 (100.4% generated), C:\alogs\log3 (100.8% generated),
C:\alogs\log4 (100.4% generated) and C:\alogs\log5 (100.2% generated)
4/17/2010 10:46:22 PM -- Performance logging ends.
4/17/2010 10:46:22 PM -- JetInterop batch transaction stats: 21653, 21837,
21821, 21716 and 21931.
4/17/2010 10:46:22 PM -- Dispatching transactions ends.
4/17/2010 10:46:22 PM -- Shutting down databases ...
4/17/2010 10:46:31 PM -- Instance2868.1 (complete), Instance2868.2
(complete), Instance2868.3 (complete), Instance2868.4 (complete) and
Instance2868.5 (complete)
4/17/2010 10:46:31 PM -- C:\ESRP RAID 5 3GB\Soft
Recovery\Performance_2010_4_17_21_47_18.blg has 235 samples.
4/17/2010 10:46:31 PM -- Creating test report ...
4/17/2010 10:46:32 PM -- Instance2868.1 has 14.0 for I/O Database Reads
Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.1 has 0.7 for I/O Log Writes Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.1 has 0.7 for I/O Log Reads Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 12.8 for I/O Database Reads
Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 1.5 for I/O Log Writes Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.2 has 1.5 for I/O Log Reads Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.3 has 12.9 for I/O Database Reads
Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.3 has 0.7 for I/O Log Writes Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.3 has 0.7 for I/O Log Reads Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.4 has 12.8 for I/O Database Reads
Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.4 has 1.5 for I/O Log Writes Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.4 has 1.5 for I/O Log Reads Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.5 has 12.9 for I/O Database Reads
Average Latency.
4/17/2010 10:46:32 PM -- Instance2868.5 has 0.7 for I/O Log Writes Average
Latency.
4/17/2010 10:46:32 PM -- Instance2868.5 has 0.7 for I/O Log Reads Average
Latency.
4/17/2010 10:46:32 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.
4/17/2010 10:46:32 PM -- Test has 0 Database Page Fault Stalls/sec samples
higher than 0.
4/17/2010 10:46:32 PM -- C:\ESRP RAID 5 3GB\Soft
Recovery\Performance_2010_4_17_21_47_18.xml has 234 samples queried.



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