

# Hitachi Universal Storage Platform® V Dynamically Provisioned 96,000 Mailbox Microsoft Exchange 2010 Resiliency Storage Solution

Tested with: ESRP — Storage Version 3.0

Test Date: November — December 2010

## Notices and Disclaimer

Copyright © 2011 Hitachi Data Systems Corporation. All rights reserved.

The performance data contained herein was obtained in a controlled isolated environment. Actual results that may be obtained in other operating environments may vary significantly. While Hitachi Data Systems Corporation has reviewed each item for accuracy in a specific situation, there is no guarantee that the same results can be obtained elsewhere.

All designs, specifications, statements, information and recommendations (collectively, "designs") in this manual are presented "AS IS," with all faults. Hitachi Data Systems Corporation and its suppliers disclaim all warranties, including without limitation, the warranty of merchantability, fitness for a particular purpose and non-infringement or arising from a course of dealing, usage or trade practice. In no event shall Hitachi Data Systems Corporation or its suppliers be liable for any indirect, special, consequential or incidental damages, including without limitation, lost profit or loss or damage to data arising out of the use or inability to use the designs, even if Hitachi Data Systems Corporation or its suppliers have been advised of the possibility of such damages.

This document has been reviewed for accuracy as of the date of initial publication. Hitachi Data Systems Corporation may make improvements and/or changes in product and/or programs at any time without notice.

# Table of Contents

<b>Overview</b> .....	<b>3</b>
<b>Disclaimer</b> .....	<b>3</b>
<b>Features</b> .....	<b>3</b>
<b>Solution Description</b> .....	<b>4</b>
<b>Targeted Customer Profile</b> .....	<b>13</b>
<b>Test Deployment</b> .....	<b>13</b>
<b>Replication Configuration</b> .....	<b>15</b>
<b>Best Practices</b> .....	<b>17</b>
Core Storage .....	17
Storage-based Replication .....	18
Backup Strategy .....	18
<b>Test Results Summary</b> .....	<b>18</b>
Reliability .....	18
Storage Performance Results .....	19
Replicated Storage Performance Results .....	25
Database Backup and Recovery Performance .....	31
<b>Conclusion</b> .....	<b>31</b>
<b>Appendix — Test Reports</b> .....	<b>32</b>
Performance Test Result Report: SUN141 .....	32
Performance Test Database Checksums Result: SUN141 .....	39
Stress Test Database Performance Result: SUN141 .....	42
Stress Test Database Checksums Result: SUN141 .....	48
Database Backup Test Result: SUN141 .....	50
Soft Recovery Test Result: SUN141 .....	52
Soft Recovery Test Performance Result: SUN141 .....	57

# Hitachi Universal Storage Platform® V Dynamically Provisioned 96,000 Mailbox Microsoft Exchange 2010 Resiliency Storage Solution

Tested with: ESRP — Storage Version 3.0

Test Date: November — December 2010

## Overview

This document provides information on a Hitachi Universal Storage Platform® V storage solution 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 [“Solutions: Microsoft Exchange”](#) on the Hitachi Data Systems website.

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, see [“Exchange 2007 Solution Reviewed Program \(ESRP\) – Storage v2.1”](#) on *TechNet*.

## Disclaimer

This document has been produced independently of Microsoft Corporation. Microsoft Corporation expressly disclaims responsibility for, and makes no warranty, express or implied, with respect to, the accuracy of the contents of this document.

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

## Features

The purpose of this testing was to measure the ESRP 3.0 results on a Microsoft Exchange 2010 environment with 96,000 users and 16 servers. This tested configuration uses 16 database availability groups (DAGs), each containing two database copies and two servers. This testing used the Hitachi Universal Storage Platform V storage system using Hitachi Dynamic Provisioning in a two-pool RAID-10 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 Universal Storage Platform V.

This solution includes Exchange 2010 mailbox resiliency by using DAGs. The test configuration was capable of supporting 96,000 users with a 0.12 IOPS per user profile and user mailbox size of 1GB. A Universal Storage Platform V with 512 600GB 15K RPM SATA disks, 512 GB of cache and 32 4Gb/sec paths was used for these tests. Testing used 16 Sun Fire 4270 servers with 32GB of RAM, two quad-core Intel E5540 2.53GHz CPUs, 32 Emulex 4Gb/sec Fibre Channel adapters, and Windows Server 2008 R2 Enterprise.

Hitachi Universal Storage Platform V delivers proven enterprise class functionality—advanced virtualization of externally attached storage, logical partitioning, thin provisioning and universal replication—with the industry's most reliable, scalable and highest performing storage services platform. Universal Storage Platform V is a large-sized, high-performance, highly reliable enterprise-class storage system that can scale to 1,152 disks and over 65,000 logical units (LUs) while capable of maintaining 100 percent data availability. In addition, Universal Storage Platform V boasts an aggregate internal cache bandwidth of 106 GB/sec, 4 million aggregate IOPS, and, under the SPC-2 methodology, an aggregated average of 8,724.67 SPC-2 MB/sec with a single storage controller.

Universal Storage Platform V is highly suitable for a variety of applications and host platforms that support the most demanding workloads. With internal and external storage virtualization capabilities, advanced replication technologies, tiered storage features and a tightly integrated management suite, Universal Storage Platform V is fully capable of serving as the core underlying storage platform of high performance Exchange Server 2010 architectures, while maintaining the ability to support additional workloads of an organization such as Microsoft SQL Server and Microsoft SharePoint Server.

## 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 Hitachi Universal Storage Platform V to meet the needs of a large Exchange Server deployment.

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

Primarily, Hitachi Dynamic Provisioning 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 also carries the side benefit of thin provisioning, where physical space is only assigned from the pool to the DP-VOL as needed up to the logical size specified for each DP-VOL using 42MB pages.

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 comprising the pool.

High availability is also a part of this solution with the use of DAGs, 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 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 DAGs in Exchange Server 2010, see "[Understanding Database Availability Groups](#)."

This solution includes two copies of each Exchange database using 16 DAGs, each configured with two servers (one simulated) and that host active mailboxes in four databases per server.

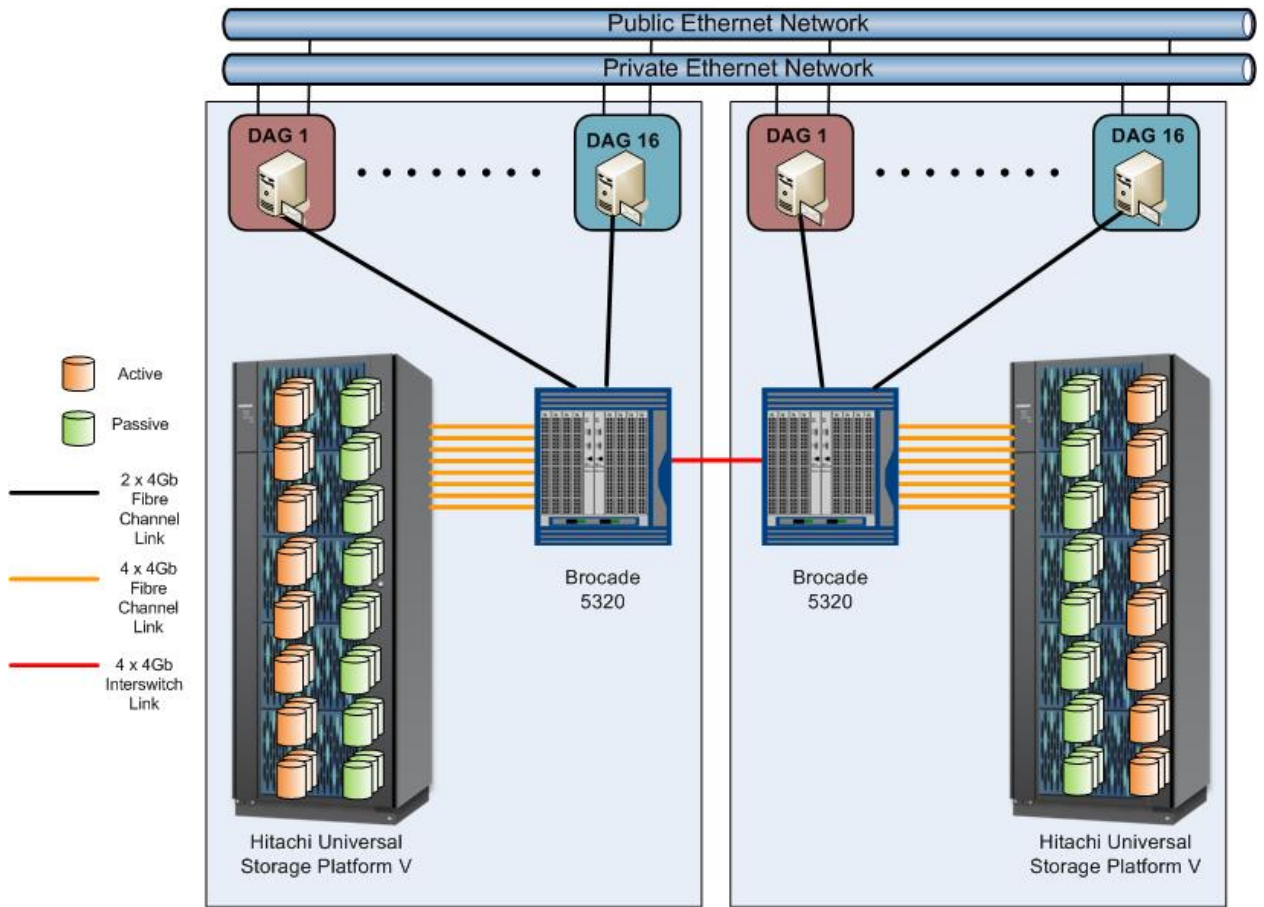
To target the 96,000 user resiliency solution, a Hitachi Universal Storage Platform V configured with 512 (maximum 1152) disks and 16 host servers — each configured with 6000 mailboxes — was used to host the four active databases and the simulated database copies for the tests.

Each DAG contained two copies of every database:

- A local, active copy on a server connected to the primary Universal Storage Platform V
- A passive copy on another server connected to a second Universal Storage Platform V.

This recommended configuration can support both high-availability and disaster-recovery scenarios when the active and passive database copies are allocated among DAG members and dispersed across both Universal Storage Platform V. Each simulated DAG server node in this solution maintains a mirrored configuration and possesses 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**

This solution enables organizations to consolidate Exchange Server 2010 DAG deployments on two Universal Storage Platform V 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.

Figure 2 shows how the LDEVs were created from RAID groups and back-end directors.

Each Parity Group is 2D+2D 600GB FC drives containing a LDEV of size 1.048 TB

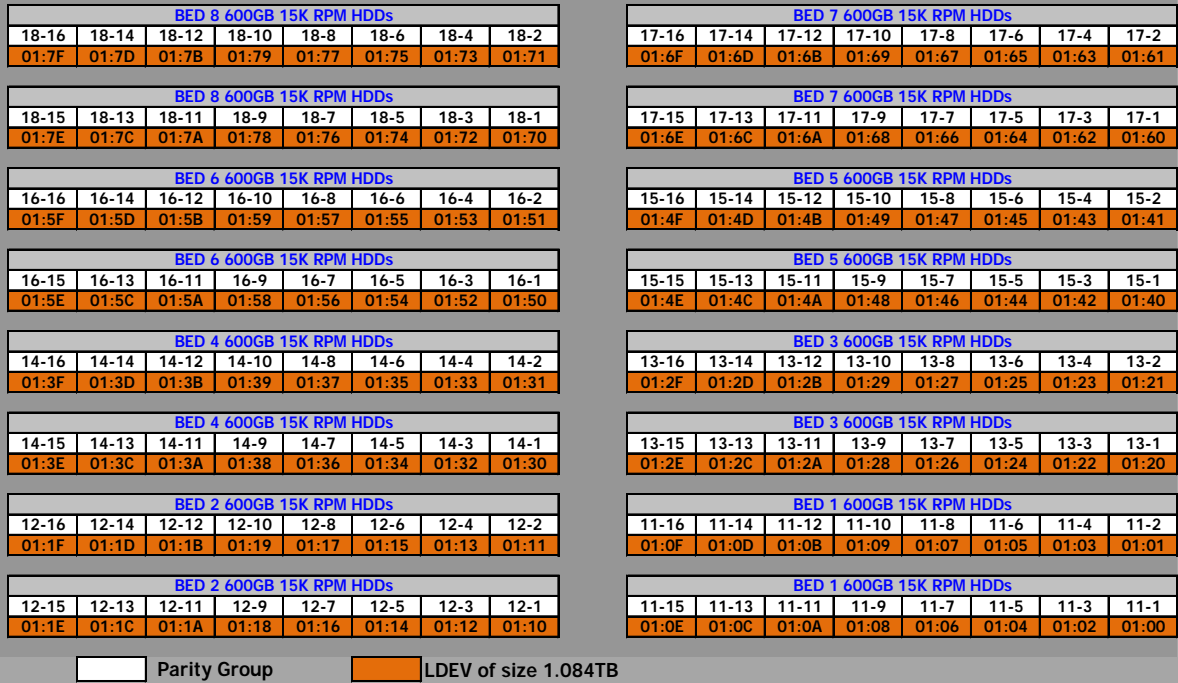


Figure 2

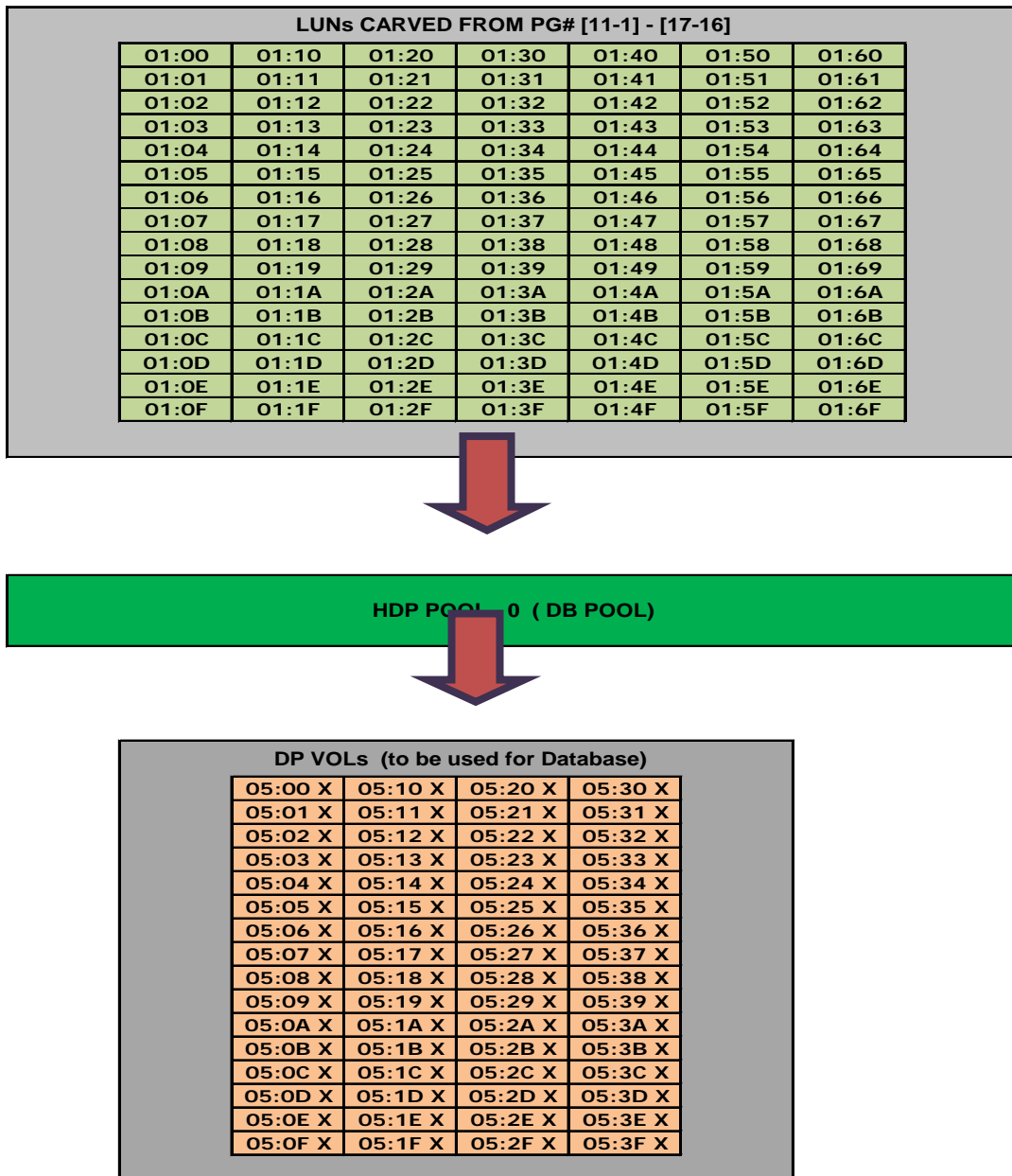
There are 128 RAID-10 (2+2) FC RAID groups, each containing one LDEV of 1.048 TB. The LDEVs from Parity Groups 11-1 to 17-16 were added to DP Pool 0 (database pool). The LDEVs from Parity Group 18-1 to 18-16 were added to the DP Pool 1 (log pool).

There were 64 V-VOL Groups (DP-VOL containers) created from the DP Pool 0 (database pool) and each group had one 1800GB DP-VOL in it.

Similarly, from DP Pool 1 (log pool) there were 64 V-VOL Groups created and each group had one 180GB DP-VOL in it.

The database DP-VOLs and log DP-VOLs were assigned to the host as LUNs.

Figure 3 shows which LDEVs were added to the dynamic provisioning pools and what DP-VOLs were created from the pool.



**Figure 3**

Figure 4 shows which LDEVs were added to the dynamic provisioning pools and what DP-VOLs were created from the pool.

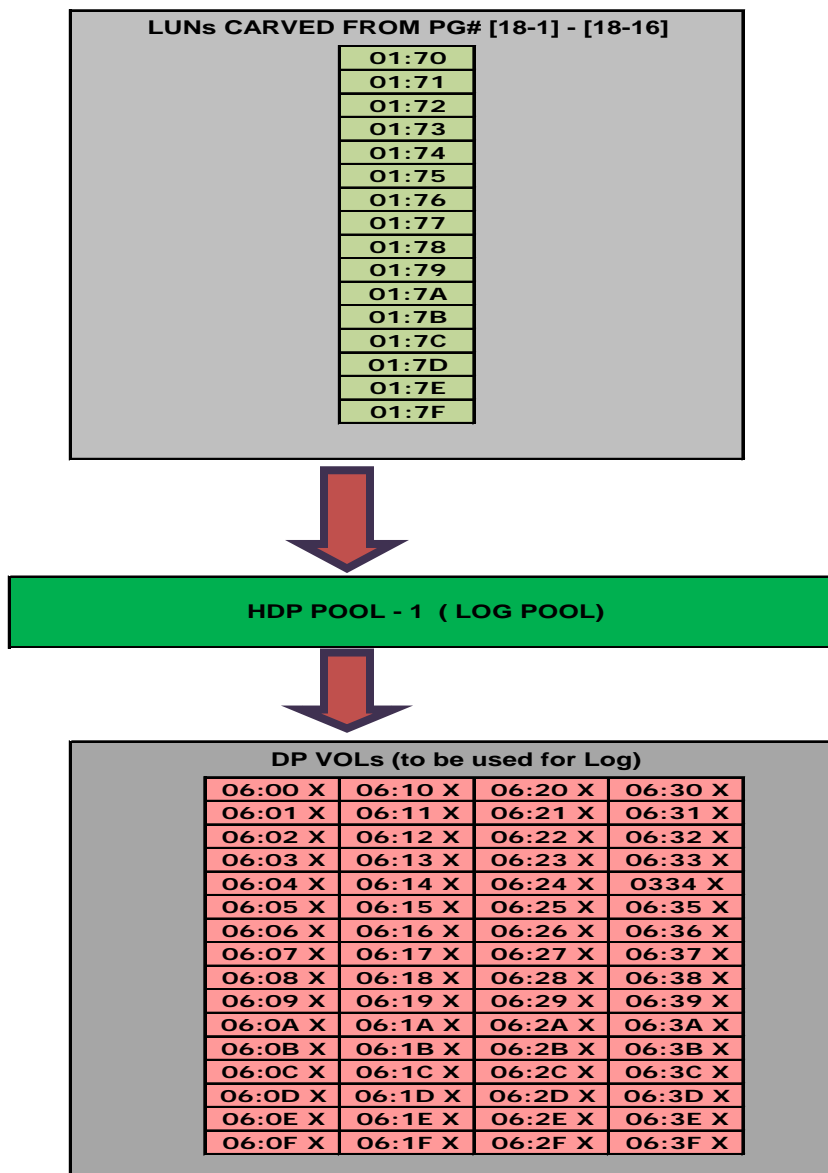


Figure 4

Table 1 outlines the primary storage port layout for the servers.

Table 1. Universal Storage Platform V Port to Server Layout

Server	Primary path	Secondary path
SUN141	1A	1B
SUN142	1C	1D
SUN143	1E	1F
SUN144	1G	1H
SUN145	1J	1K

<i>Server</i>	<i>Primary path</i>	<i>Secondary path</i>
SUN146	1L	1M
SUN147	1N	1P
SUN148	1Q	1R
SUN149	2A	2B
SUN150	2C	2D
SUN151	2E	2F
SUN152	2G	2H
SUN153	2J	2K
SUN154	2L	2M
SUN155	2N	2P
SUN156	2Q	2R

Table 2 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 2. Universal Storage Platform V Port to Database DP-VOL Layout**

<i>Port</i>	<i>Database</i>	<i>DB DP-VOL</i>
1A	Database 1-4	05:00X-05:03X
1C	Database 5-8	05:04X-05:07X
1E	Database 9-12	05:08X-05:0BX
1G	Database 13-16	05:0CX-05:0FX
1J	Database 17-20	05:10X-05:13X
1L	Database 21-24	05:14X-05:17X
1N	Database 25-28	05:18X-05:1BX
1Q	Database 29-32	05:1CX-05:1FX
2A	Database 33-36	05:20X-05:23X
2C	Database 37-40	05:24X-05:27X
2E	Database 41-44	05:28X-05:3BX
2G	Database 45-48	05:3CX-05:3FX
2J	Database 49-52	05:40X-05:43X
2L	Database 53-56	05:44X-05:47X
2N	Database 57-60	05:48X-05:4BX
2Q	Database 61-64	05:4CX-05:4FX

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

**Table 3. Universal Storage Platform V Port to Log DP-VOL Layout**

<i>Port</i>	<i>Log</i>	<i>DP-VOL</i>
1A	Log 1-4	06:00X-06:03X
1C	Log 5-8	06:04X-06:07X
1E	Log 9-12	06:08X-06:0BX
1G	Log 13-16	06:0CX-06:0FX
1J	Log 17-20	06:10X-06:13X
1L	Log 21-24	06:14X-06:17X
1N	Log 25-28	06:18X-06:1BX
1Q	Log 29-32	06:1CX-06:1FX
2A	Log 33-36	06:20X-06:23X
2C	Log 37-40	06:24X-06:27X
2E	Log 41-44	06:28X-06:3BX
2G	Log 45-48	06:3CX-06:3FX
2J	Log 49-52	06:40X-06:43X
2L	Log 53-56	06:44X-06:47X
2N	Log 57-60	06:48X-06:4BX
2Q	Log 61-64	06:4CX-06:4FX

Table 4 provides the detailed specifications for the storage configuration which uses RAID-10 (2D+2D) groups and 600GB 15K FC disks. DP Pool 0 is dedicated for the database and DP Pool 1 is dedicated for the logs.

**Table 4. Universal Storage Platform V Configuration Details**

<i>Host</i>	<i>Pool</i>	<i>Port</i>	<i>LDEVs</i>	<i>Size (GB)</i>	<i>Description</i>
Sun141	0	1A/1B	05:00X-05:03X	2000	Databases 1-4
Sun142	0	1C/1D	05:04X-05:07X	2000	Databases 5-8
Sun143	0	1E/1F	05:08X-05:0BX	2000	Databases 9-12
Sun144	0	1G/1H	05:0CX-05:0FX	2000	Databases 13-16
Sun145	0	1J/1K	05:10X-05:13X	2000	Databases 17-20
Sun146	0	1L/1M	05:14X-05:17X	2000	Databases 21-24
Sun147	0	1N/1P	05:18X-05:1BX	2000	Databases 25-28
Sun148	0	1Q/1R	05:1CX-05:1FX	2000	Databases 29-32
Sun149	0	2A/2B	05:20X-05:23X	2000	Databases 33-36
Sun150	0	2C/2D	05:24X-05:27X	2000	Databases 37-40
Sun151	0	2E/2F	05:28X-05:3BX	2000	Databases 41-44
Sun152	0	2G/2H	05:3CX-05:3FX	2000	Databases 45-48
Sun153	0	2J/2K	05:40X-05:43X	2000	Databases 49-52

<i>Host</i>	<i>Pool</i>	<i>Port</i>	<i>LDEVs</i>	<i>Size (GB)</i>	<i>Description</i>
Sun154	0	2L/2M	05:44X-05:47X	2000	Databases 53-56
Sun155	0	2N/2P	05:48X-05:4BX	2000	Databases 57-60
Sun156	0	2Q/2R	05:4CX-05:4FX	2000	Databases 61-64
Sun141	1	1A/1B	06:00X-06:03X	200	Logs 1-4
Sun142	1	1C/1D	06:04X-06:07X	200	Logs 5-8
Sun143	1	1E/1F	06:08X-06:0BX	200	Logs 9-12
Sun144	1	1G/1H	06:0CX-06:0FX	200	Logs 13-16
Sun145	1	1J/1K	06:10X-06:13X	200	Logs 17-20
Sun146	1	1L/1M	06:14X-06:17X	200	Logs 21-24
Sun147	1	1N/1P	06:18X-06:1BX	200	Logs 25-28
Sun148	1	1Q/1R	06:1CX-06:1FX	200	Logs 29-32
Sun149	1	2A/2B	06:20X-06:23X	200	Logs 33-36
Sun150	1	2C/2D	06:24X-06:27X	200	Logs 37-40
Sun151	1	2E/2F	06:28X-06:3BX	200	Logs 41-44
Sun152	1	2G/2H	06:3CX-06:3FX	200	Logs 45-48
Sun153	1	2J/2K	06:40X-06:43X	200	Logs 49-52
Sun154	1	2L/2M	06:44X-06:47X	200	Logs 53-56
Sun155	1	2N/2P	06:48X-06:4BX	200	Logs 57-60
Sun156	1	2Q/2R	06:4CX-06:4FX	200	Logs 61-64

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 was designed for medium to large organizations that plan to consolidate their Microsoft Exchange Server 2010 storage on high-performance, high-reliability storage systems. This configuration is designed to support 96,000 Exchange users with the following specifications:

- 32 Microsoft Exchange servers (16 tested, simulating 32 for the database copies)
- Two Hitachi Universal Storage Platform systems (one tested)
- 0.10 IOPS per user (0.12 tested for 20% growth)
- 1GB mailbox size
- Mailbox resiliency for high-availability and used as primary data protection mechanism
- Hitachi Universal Storage Platform V RAID protection against physical failure or loss
- 24x7 background database maintenance enabled

## Test Deployment

The following tables summarize the testing environment.

**Table 5. Simulated Exchange Configuration**

<i>Number of Exchange mailboxes simulated</i>	96000
<i>Number of database availability groups (DAGs)</i>	16
<i>Number of servers per DAG</i>	2
<i>Number of active mailboxes per server</i>	6000
<i>Number of databases per host</i>	4
<i>Number of copies per database</i>	2
<i>Number of mailboxes per database</i>	1500
<i>Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)</i>	0.12
<i>Database LU size</i>	1800GB
<i>Log LU Size</i>	180GB
<i>Total database size for performance testing</i>	96,000
<i>% storage capacity used by Exchange database**</i>	80%

\*\*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 6. Storage Hardware**

<i>Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)</i>	Fibre Channel
<i>Storage model and OS/firmware revision</i>	1 Hitachi Universal Storage Platform V Firmware: 60-07-34-00/00 WHQL listing: Hitachi Universal Storage Platform V
<i>Storage cache</i>	512GB
<i>Number of storage controllers</i>	16 Front-end and 16 Back-end boards
<i>Number of storage ports</i>	32
<i>Maximum bandwidth of storage connectivity to host</i>	128Gb/sec (32x4Gb/sec HBA)
<i>Switch type/model/firmware revision</i>	Brocade 5320, Fabric OS v6.4.0b
<i>HBA model and firmware</i>	Emulex LPe11002, FW:2.80A4
<i>Number of HBAs per host</i>	2 dual-ported HBAs per host
<i>Host server type</i>	Sun Fire 4270 2 2.54 GHz quad-core Intel Xeon CPUs, 32 GB memory
<i>Total number of disks tested in solution</i>	512
<i>Maximum number of spindles that can be hosted in the storage</i>	1152

**Table 7. Storage Software**

<i>HBA driver</i>	STOR Miniport 7.2.30.16
<i>HBA QueueTarget setting</i>	0
<i>HBA QueueDepth setting</i>	32
<i>Multipathing</i>	Hitachi Dynamic Link Manager v6.4.0
<i>Host OS</i>	Microsoft Windows Server 2008 R2 Enterprise
<i>ESE.dll file version</i>	14.00.0639.019
<i>Replication solution name/version</i>	N/A

**Table 8. Storage Disk Configuration (Mailbox Store Disks)**

<i>Disk type, speed and firmware revision</i>	FC Disk 600GB 15K FW : 5E-57
<i>Raw capacity per disk (GB)</i>	600
<i>Number of physical disks in test</i>	448
<i>Total raw storage capacity (GB)</i>	268,800
<i>Disk slice size (GB)</i>	N/A
<i>Number of slices per LU or number of disks per LU</i>	N/A
<i>RAID level</i>	RAID-10 (2+2)
<i>Total formatted capacity (Dynamic Provisioning Database Pool)</i>	120,064
<i>Storage capacity utilization</i>	44.7%
<i>Database capacity utilization</i>	42.9%

**Table 9. Storage Disk Configuration (Transaction Log Disks)**

<i>Disk type, speed and firmware revision</i>	FC Disk 600GB 15K FW : 5E-57
<i>Raw capacity per disk (GB)</i>	600
<i>Number of spindles in test</i>	64
<i>Total raw storage capacity (GB)</i>	38,400
<i>Disk slice size (GB)</i>	N/A
<i>Number of slices per LU or number of disks per LU</i>	N/A
<i>RAID level</i>	RAID-10 (2+2)
<i>Total formatted capacity (Dynamic Provisioning Log Pool)</i>	17,152

## Replication Configuration

**Table 10. Replication Configuration**

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

**Table 11. Replicated Storage Hardware**

<i>Storage connectivity (Fiber Channel, SAS, SATA, iSCSI)</i>	1 Hitachi Universal Storage Platform V Firmware: 60-07-34-00/00 WHQL listing: Hitachi Universal Storage Platform V
<i>Storage model and OS/firmware revision</i>	512GB
<i>Storage cache</i>	16 Front-end and 16 Back-end boards
<i>Number of storage controllers</i>	32
<i>Number of storage ports</i>	128Gb/sec (32x4Gb/sec HBA)
<i>Maximum bandwidth of storage connectivity to host</i>	Brocade 5320, Fabric OS v6.4.0b
<i>Switch type/model/firmware revision</i>	Emulex LPe11002, FW:2.80A4
<i>HBA model and firmware</i>	2 dual-ported HBAs per host
<i>Number of HBAs per host</i>	Sun Fire 4270 2 2.54 GHz quad-core Intel Xeon CPUs, 32 GB memory
<i>Host server type</i>	512
<i>Total number of disks tested in solution</i>	1152
<i>Maximum number of spindles that can be hosted in the storage</i>	1 Hitachi Universal Storage Platform V Firmware: 60-07-34-00/00 WHQL listing: Hitachi Universal Storage Platform V

**Table 12. Replicated Storage Software**

<i>HBA driver</i>	STOR Miniport 7.2.30.16
<i>HBA QueueTarget setting</i>	0
<i>HBA QueueDepth setting</i>	32
<i>Multipathing</i>	Hitachi Dynamic Link Manager v6.4.0
<i>Host OS</i>	Microsoft Windows Server 2008 R2 Enterprise
<i>ESE.dll file version</i>	14.00.0639.019
<i>Replication solution name/version</i>	N/A

**Table 13. Replicated Storage Disk Configuration (Mailbox Store Disks)**

<i>Disk type, speed and firmware revision</i>	FC Disk 600GB 15K FW : 5E-57
<i>Raw capacity per disk (GB)</i>	600
<i>Number of physical disks in test</i>	448
<i>total raw storage capacity (GB)</i>	268,800
<i>Disk slice size (GB)</i>	N/A
<i>Number of slices per LU or number of disks per LU</i>	N/A
<i>RAID level</i>	RAID-10 (2+2)
<i>Total formatted capacity</i>	120,064
<i>Storage capacity utilization</i>	44.7%
<i>Database capacity utilization</i>	42.9%

**Table 14. Replicated Storage Disk Configuration (Transactional Log Disks)**

<i>Disk type, speed and firmware revision</i>	FC Disk 600GB 15K FW : 5E-57
<i>Raw capacity per disk (GB)</i>	600
<i>Number of spindles in test</i>	64
<i>Total raw storage capacity (GB)</i>	38,400
<i>Disk slice size (GB)</i>	N/A
<i>Number of slices per LU or number of disks per LU</i>	N/A
<i>RAID level</i>	RAID-10 (2+2)
<i>Total formatted capacity</i>	17,152

## Best Practices

Microsoft Exchange Server 2010 is a very disk-intensive application. It presents two distinct workload patterns to the storage, with 8KB random read/write operations to the databases, and with sequential write operations from 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 Universal Storage Platform V running Exchange.

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

### Core Storage

1. When formatting a newly partitioned LU, Hitachi Data Systems recommends setting the ALU to 64K for database and to 4K for 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 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-10 groups for both the database pools and for the log pool when SATA disks are used. Use of RAID-10 allows more writes at a lower response time under heavier loads. RAID-10 also supports a shorter RAID group rebuild time on failure of a disk.
8. Log LUs should be at least 10 percent of the size of the database LUs.
9. Hitachi Data Systems does not recommend LU concatenation.
10. Hitachi Data Systems recommends implementing mailbox resiliency using a database availability group (DAG) in Microsoft Exchange Server 2010.
11. Ensure that each DAG 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 Universal Storage Platform V.
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.

## Storage-based Replication

N/A

## Backup Strategy

N/A

## Test Results 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
- If done, no errors were reported during the backup to disk test [process](#)
- No errors were reported for the database checksum on the remote storage database

## 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 storage groups and the average latency across all storage groups on a per-server basis.

**Table 15. Individual Server Metrics for Exchange Server (SUN141)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1146
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	319
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 16. Individual Server Metrics for Exchange Server (SUN142)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1095
<i>Database Disk Reads Per Second</i>	691
<i>Database Disk Writes Per Second</i>	404
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	303
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 17. Individual Server Metrics for Exchange Server (SUN143)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1133
<i>Database Disk Reads Per Second</i>	715
<i>Database Disk Writes Per Second</i>	418
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 18. Individual Server Metrics for Exchange Server (SUN144)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1681
<i>Database Disk Reads Per Second</i>	1046
<i>Database Disk Writes Per Second</i>	635
<i>Average Database Disk Read Latency (ms)</i>	5.2
<i>Average Database Disk Write Latency (ms)</i>	4.8
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	375
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 19. Individual Server Metrics for Exchange Server (SUN145)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1146
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	432
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 20. Individual Server Metrics for Exchange Server (SUN146)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1146
<i>Database Disk Reads Per Second</i>	723
<i>Database Disk Writes Per Second</i>	423
<i>Average Database Disk Read Latency (ms)</i>	6.0
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 21. Individual Server Metrics for Exchange Server (SUN147)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1143
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	421
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.5
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 22. Individual Server Metrics for Exchange Server (SUN148)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1128
<i>Database Disk Reads Per Second</i>	713
<i>Database Disk Writes Per Second</i>	415
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.2
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 23. Individual Server Metrics for Exchange Server (SUN149)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1136
<i>Database Disk Reads Per Second</i>	717
<i>Database Disk Writes Per Second</i>	419
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 24. Individual Server Metrics for Exchange Server (SUN150)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1719
<i>Database Disk Reads Per Second</i>	1069
<i>Database Disk Writes Per Second</i>	650
<i>Average Database Disk Read Latency (ms)</i>	5.1
<i>Average Database Disk Write Latency (ms)</i>	4.7
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	379
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 25. Individual Server Metrics for Exchange Server (SUN151)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1144
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 26. Individual Server Metrics for Exchange Server (SUN152)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1149
<i>Database Disk Reads Per Second</i>	725
<i>Database Disk Writes Per Second</i>	424
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	319
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 27. Individual Server Metrics for Exchange Server (SUN153)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1410
<i>Database Disk Reads Per Second</i>	882
<i>Database Disk Writes Per Second</i>	528
<i>Average Database Disk Read Latency (ms)</i>	5.7
<i>Average Database Disk Write Latency (ms)</i>	4.8
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	532
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 28. Individual Server Metrics for Exchange Server (SUN154)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1130
<i>Database Disk Reads Per Second</i>	713
<i>Database Disk Writes Per Second</i>	417
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.2
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 29. Individual Server Metrics for Exchange Server (SUN155)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1147
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	423
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	320
<i>Average Log Disk Write Latency (ms)</i>	1.2

**Table 30. Individual Server Metrics for Exchange Server (SUN156)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1144
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

### *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 31. Aggregate Performance for Exchange Server 2010**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	19598
<i>Database Disk Reads Per Second</i>	12332
<i>Database Disk Writes Per Second</i>	7275
<i>Average Database Disk Read Latency (ms)</i>	5.9
<i>Average Database Disk Write Latency (ms)</i>	4.41
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	5384
<i>Average Log Disk Write Latency (ms)</i>	1.24

## Replicated Storage [Performance](#) Results

These performance tests measure the performance of the secondary storage. The performance tests are identical to that of the primary storage and verify that the secondary storage is capable of being transitioned to become the primary storage. Each server is listed separately and the aggregate numbers across all servers is listed as well.

### *Individual Server Metrics*

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

**Table 32. Individual Server Metrics for Exchange Server (SUN141)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1146
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	319
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 33. Individual Server Metrics for Exchange Server (SUN142)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1095
<i>Database Disk Reads Per Second</i>	691
<i>Database Disk Writes Per Second</i>	404
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	303
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 34. Individual Server Metrics for Exchange Server (SUN143)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1133
<i>Database Disk Reads Per Second</i>	715
<i>Database Disk Writes Per Second</i>	418
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 35. Individual Server Metrics for Exchange Server (SUN144)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1681
<i>Database Disk Reads Per Second</i>	1046
<i>Database Disk Writes Per Second</i>	635
<i>Average Database Disk Read Latency (ms)</i>	5.2
<i>Average Database Disk Write Latency (ms)</i>	4.8
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	375
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 36. Individual Server Metrics for Exchange Server (SUN145)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1147
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	432
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 38. Individual Server Metrics for Exchange Server (SUN146)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1146
<i>Database Disk Reads Per Second</i>	723
<i>Database Disk Writes Per Second</i>	423
<i>Average Database Disk Read Latency (ms)</i>	6.0
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 38. Individual Server Metrics for Exchange Server (SUN147)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1143
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	421
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.5
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 39. Individual Server Metrics for Exchange Server (SUN148)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1128
<i>Database Disk Reads Per Second</i>	713
<i>Database Disk Writes Per Second</i>	415
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.2
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 40. Individual Server Metrics for Exchange Server (SUN149)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1136
<i>Database Disk Reads Per Second</i>	717
<i>Database Disk Writes Per Second</i>	419
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 41. Individual Server Metrics for Exchange Server (SUN150)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1719
<i>Database Disk Reads Per Second</i>	1069
<i>Database Disk Writes Per Second</i>	650
<i>Average Database Disk Read Latency (ms)</i>	5.1
<i>Average Database Disk Write Latency (ms)</i>	4.7
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	379
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 42. Individual Server Metrics for Exchange Server (SUN151)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1144
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 43. Individual Server Metrics for Exchange Server (SUN152)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1149
<i>Database Disk Reads Per Second</i>	725
<i>Database Disk Writes Per Second</i>	424
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	319
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 44. Individual Server Metrics for Exchange Server (SUN153)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1410
<i>Database Disk Reads Per Second</i>	882
<i>Database Disk Writes Per Second</i>	528
<i>Average Database Disk Read Latency (ms)</i>	5.7
<i>Average Database Disk Write Latency (ms)</i>	4.8
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	532
<i>Average Log Disk Write Latency (ms)</i>	1.0

**Table 45. Individual Server Metrics for Exchange Server (SUN154)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1130
<i>Database Disk Reads Per Second</i>	713
<i>Database Disk Writes Per Second</i>	417
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.2
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	313
<i>Average Log Disk Write Latency (ms)</i>	1.3

**Table 46. Individual Server Metrics for Exchange Server (SUN155)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1147
<i>Database Disk Reads Per Second</i>	724
<i>Database Disk Writes Per Second</i>	423
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.4
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	320
<i>Average Log Disk Write Latency (ms)</i>	1.2

**Table 47. Individual Server Metrics for Exchange Server (SUN156)**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	1144
<i>Database Disk Reads Per Second</i>	722
<i>Database Disk Writes Per Second</i>	422
<i>Average Database Disk Read Latency (ms)</i>	6.1
<i>Average Database Disk Write Latency (ms)</i>	4.3
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	317
<i>Average Log Disk Write Latency (ms)</i>	1.3

### *Aggregate Performance Across All Servers Metrics*

This is the sum of the inputs/outputs across servers in the solution and the average latency across all servers in the solution.

**Table 48. Aggregate Performance for Exchange Server 2010**

<i>Database I/O</i>	
<i>Database Disk Transfers Per Second</i>	19598
<i>Database Disk Reads Per Second</i>	12332
<i>Database Disk Writes Per Second</i>	7266
<i>Average Database Disk Read Latency (ms)</i>	5.9
<i>Average Database Disk Write Latency (ms)</i>	4.41
<i>Transaction Log I/O</i>	
<i>Log Disk Writes Per Second</i>	5204
<i>Average Log Disk Write Latency (ms)</i>	0.957

## 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*

The [performance](#) that this test measures is the maximum rate at which databases can be backed up via VSS. The following table shows the average rate for a single database file.

**Table 49. Database Read-only Performance**

<i>MB Read Per Second Per Database</i>	115.34
<i>MB Read Per Second Total Per Server</i>	461.37

### *Transaction Log Recovery/Replay Performance*

The [performance](#) that this test measures is the maximum rate at which the log files can be played against the databases. The following table shows the average rate for 500 log files played in a single storage group. Each log file is 1MB in size.

**Table 50. Transaction Log Recovery/Replay Performance**

<i>Average Time to Play One Log File (sec)</i>	0.93
--	------

## Conclusion

This document is developed by Hitachi Data Systems and is reviewed by the 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.

This document details a tested, robust Exchange Server 2010 resiliency solution capable of supporting 96,000 users with a 0.12 IOPS per user profile and a user mailbox size of 1GB using 16 DAGs, each configured with one server node. A Hitachi Universal Storage Platform V, with 512GB of cache and 16 4Gb/sec Fibre Channel host paths, using Hitachi Dynamic Provisioning with two pools, and 512 600GB 15K RPM FC disks in a RAID-10 configuration was used for these tests.

Testing confirmed that the Universal Storage Platform V is more than capable of delivering the IOPS and capacity requirements needed to support the active and replicated databases for 96,000 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 Universal Storage Platform V RAID technology to provide high-availability and protection from logical and physical failures. Adding protection requirements might affect performance and capacity requirements of the underlying storage configuration, and as such need to be factored into the storage design accordingly.

For more information about planning Exchange Server 2010 storage architectures for Hitachi Universal Storage Platform V family, see [“Products: Hitachi Universal Storage Platform V.”](#)

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

## Appendix—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 Report: SUN141

#### Test Summary

<i>Overall Test Result</i>	Pass
<i>Machine Name</i>	SUN141
<i>Test Description</i>	
<i>Test Start Time</i>	11/22/2010 9:56:39 AM
<i>Test End Time</i>	11/22/2010 6:38:29 PM
<i>Collection Start Time</i>	11/22/2010 9:58:09 AM
<i>Collection End Time</i>	11/22/2010 11:58:05 AM
<i>Jetstress Version</i>	14.01.0043.000
<i>Ese Version</i>	14.00.0639.019
<i>Operating System</i>	Windows Server 2008 R2 Enterprise (6.1.7600.0)
<i>Performance Log</i>	C:\USPV_600GBFC_R10_1GBMBox\Performance\Performance_2010_11_22_9_56_48.blg C:\USPV_600GBFC_R10_1GBMBox\Performance\DBCchecksum_2010_11_22_18_38_29.blg

#### Database Sizing and Throughput

<i>Achieved Transactional I/O per Second</i>	1146.12
<i>Target Transactional I/O per Second</i>	720
<i>Initial Database Size (bytes)</i>	6447362736128
<i>Final Database Size (bytes)</i>	6461338157056
<i>Database Files (Count)</i>	4

### Jetstress System Parameters

<i>Thread Count</i>	5 (per database)
<i>Minimum Database Cache</i>	128.0 MB
<i>Maximum Database Cache</i>	1024.0 MB
<i>Insert Operations</i>	40%
<i>Delete Operations</i>	20%
<i>Replace Operations</i>	5%
<i>Read Operations</i>	35%
<i>Lazy Commits</i>	70%
<i>Run Background Database Maintenance</i>	True
<i>Number of Copies per Database</i>	2

### Database Configuration

<i>Instance1460.1</i>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<i>Instance1460.2</i>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<i>Instance1460.3</i>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<i>Instance1460.4</i>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb

Transactional I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance1460.1</b>	6.183	4.826	181.693	105.957	33219.237	35702.358	0.000	1.253	0.000	80.252	0.000	5125.599
<b>Instance1460.2</b>	6.031	4.701	180.958	105.608	33264.778	35663.970	0.000	1.250	0.000	79.886	0.000	5164.977
<b>Instance1460.3</b>	6.030	4.487	181.114	105.746	33229.497	35677.129	0.000	1.255	0.000	79.826	0.000	5135.972
<b>Instance1460.4</b>	6.012	3.718	180.041	105.003	33247.533	35691.862	0.000	1.251	0.000	79.526	0.000	5138.533

### Background Database Maintenance I/O Performance

<i>MSEExchange Database ==&gt; Instances</i>	<i>Database Maintenance IO Reads/sec</i>	<i>Database Maintenance IO Reads Average Bytes</i>
<b>Instance1460.1</b>	30.606	261848.671
<b>Instance1460.2</b>	30.616	261851.691
<b>Instance1460.3</b>	30.613	261875.502
<b>Instance1460.4</b>	30.660	261884.262

### Log Replication I/O Performance

<i>MSEExchange Database ==&gt; Instances</i>	<i>I/O Log Reads/sec</i>	<i>I/O Log Reads Average Bytes</i>
<b>Instance1460.1</b>	1.685	232561.778
<b>Instance1460.2</b>	1.691	232548.829
<b>Instance1460.3</b>	1.680	232571.617
<b>Instance1460.4</b>	1.676	232561.778

Total I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance1460.1</b>	6.183	4.826	212.299	105.957	66179.049	35702.358	2.195	1.253	1.685	80.252	232561.778	5125.599
<b>Instance1460.2</b>	6.031	4.701	211.574	105.608	66342.576	35663.970	2.136	1.250	1.691	79.886	232548.829	5164.977
<b>Instance1460.3</b>	6.030	4.487	211.727	105.746	66288.965	35677.129	2.304	1.255	1.680	79.826	232571.617	5135.972
<b>Instance1460.4</b>	6.012	3.718	210.701	105.003	66516.983	35691.862	2.230	1.251	1.676	79.526	232561.778	5138.533

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.987	0.000	3.576
Available MBytes	29781.958	29771.000	29877.000
Free System Page Table Entries	33554619.579	33554613.000	33554621.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65463731.200	65224704.000	65626112.000
Pool Paged Bytes	92284245.333	92225536.000	92463104.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/22/2010 9:33:47 AM -- Jetstress testing begins ...

11/22/2010 9:33:47 AM -- Prepare testing begins ...

11/22/2010 9:33:51 AM -- Attaching databases ...

11/22/2010 9:33:51 AM -- Prepare testing ends.

11/22/2010 9:33:51 AM -- Dispatching transactions begins ...

11/22/2010 9:33:51 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/22/2010 9:33:51 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/22/2010 9:33:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

11/22/2010 9:33:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

11/22/2010 9:34:02 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/22/2010 9:34:02 AM -- Performance logging begins (interval: 15000 ms).

11/22/2010 9:34:02 AM -- Attaining prerequisites:

11/22/2010 9:35:10 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 966398000.0 (lower bound: 966367600.0, upper bound: none)

11/22/2010 9:41:16 AM -- Performance logging ends.

11/22/2010 9:43:34 AM -- JetInterop batch transaction stats: 4669, 4778, 4754 and 4726.

11/22/2010 9:43:34 AM -- Dispatching transactions ends.

11/22/2010 9:43:34 AM -- Shutting down databases ...

11/22/2010 9:43:35 AM -- Instance1460.1 (complete), Instance1460.2 (complete), Instance1460.3 (complete) and Instance1460.4 (complete)

11/22/2010 9:43:36 AM -- Performance logging begins (interval: 30000 ms).

11/22/2010 9:43:36 AM -- Verifying database checksums ...

11/22/2010 9:45:01 AM -- C:\dbluns\db1 (0% processed), C:\dbluns\db2 (0% processed), C:\dbluns\db3 (0% processed) and C:\dbluns\db4 (0% processed)

11/22/2010 9:45:01 AM -- Verifying log checksums ...

11/22/2010 9:45:01 AM -- C:\logluns\log1 (0 log(s) processed), C:\logluns\log2 (0 log(s) processed), C:\logluns\log3 (0 log(s) processed) and C:\logluns\log4 (0 log(s) processed)

11/22/2010 9:45:01 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.blg has 28 samples.

11/22/2010 9:45:02 AM -- Creating test report ...

11/22/2010 9:45:02 AM -- Instance1460.1 has 6.3 for I/O Database Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.1 has 1.3 for I/O Log Writes Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.1 has 1.3 for I/O Log Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 6.1 for I/O Database Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 1.3 for I/O Log Writes Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 1.3 for I/O Log Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.3 has 6.1 for I/O Database Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.3 has 1.3 for I/O Log Writes Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.3 has 1.3 for I/O Log Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 6.1 for I/O Database Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 1.3 for I/O Log Writes Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 1.3 for I/O Log Reads Average Latency.  
11/22/2010 9:45:02 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
11/22/2010 9:45:02 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
11/22/2010 9:45:02 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.xml has 23 samples queried.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.html is saved.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Application\_2010\_11\_22\_9\_45\_3.evt is saved.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\System\_2010\_11\_22\_9\_45\_3.evt is saved.  
11/22/2010 9:45:03 AM -- Jetstress testing ends.  
11/22/2010 9:56:39 AM -- Jetstress testing begins ...  
11/22/2010 9:56:39 AM -- Prepare testing begins ...  
11/22/2010 9:56:44 AM -- Attaching databases ...  
11/22/2010 9:56:44 AM -- Prepare testing ends.  
11/22/2010 9:56:44 AM -- Dispatching transactions begins ...  
11/22/2010 9:56:44 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
11/22/2010 9:56:44 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
11/22/2010 9:56:48 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).  
11/22/2010 9:56:48 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).  
11/22/2010 9:56:54 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.  
11/22/2010 9:56:54 AM -- Performance logging begins (interval: 15000 ms).  
11/22/2010 9:56:54 AM -- Attaining prerequisites:  
11/22/2010 9:58:09 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 977838100.0 (lower bound: 966367600.0, upper bound: none)  
11/22/2010 11:58:10 AM -- Performance logging ends.  
11/22/2010 6:38:28 PM -- JetInterop batch transaction stats: 250101, 249714, 250115 and 250514.  
11/22/2010 6:38:28 PM -- Dispatching transactions ends.  
11/22/2010 6:38:28 PM -- Shutting down databases ...  
11/22/2010 6:38:29 PM -- Instance1460.1 (complete), Instance1460.2 (complete), Instance1460.3 (complete) and Instance1460.4 (complete)  
11/22/2010 6:38:30 PM -- Performance logging begins (interval: 30000 ms).  
11/22/2010 6:38:30 PM -- Verifying database checksums ...  
11/23/2010 3:40:06 AM -- C:\dbluns\db1 (100% processed), C:\dbluns\db2 (100% processed), C:\dbluns\db3 (100% processed) and C:\dbluns\db4 (100% processed)  
11/23/2010 3:40:06 AM -- Performance logging ends.  
11/23/2010 3:40:06 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\DBChecksum\_2010\_11\_22\_18\_38\_29.blg has 1082 samples.  
11/23/2010 3:40:10 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\DBChecksum\_2010\_11\_22\_18\_38\_29.html is

saved.

11/23/2010 3:40:10 AM -- Verifying log checksums ...

11/23/2010 3:40:11 AM -- C:\logluns\log1 (12 log(s) processed), C:\logluns\log2 (11 log(s) processed), C:\logluns\log3 (12 log(s) processed) and C:\logluns\log4 (13 log(s) processed)

11/23/2010 3:40:11 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_56\_48.blg has 484 samples.

11/23/2010 3:40:11 AM -- Creating test report ...

11/23/2010 3:40:13 AM -- Instance1460.1 has 6.2 for I/O Database Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.1 has 1.3 for I/O Log Writes Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.1 has 1.3 for I/O Log Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.2 has 6.0 for I/O Database Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.2 has 1.3 for I/O Log Writes Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.2 has 1.3 for I/O Log Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.3 has 6.0 for I/O Database Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.3 has 1.3 for I/O Log Writes Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.3 has 1.3 for I/O Log Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.4 has 6.0 for I/O Database Reads Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.4 has 1.3 for I/O Log Writes Average Latency.

11/23/2010 3:40:13 AM -- Instance1460.4 has 1.3 for I/O Log Reads Average Latency.

11/23/2010 3:40:13 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.

11/23/2010 3:40:13 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

11/23/2010 3:40:13 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_56\_48.xml has 479 samples queried.

## Performance Test Database Checksums Result: SUN141

### Checksum Statistics—All

Database	Seen pages	Bad pages	Correctable pages	Wrong page-number pages	File length / seconds taken
C:\dbluns\db1\Jetstress001001.edb	49296226	0	0	0	1540507 MBytes / 32495 sec
C:\dbluns\db2\Jetstress002001.edb	49296226	0	0	0	1540507 MBytes / 32232 sec
C:\dbluns\db3\Jetstress003001.edb	49295714	0	0	0	1540491 MBytes / 32111 sec
C:\dbluns\db4\Jetstress004001.edb	49296226	0	0	0	1540507 MBytes / 32311 sec
(Sum)	197184392	0	0	0	6162012 MBytes / 32495 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
C:\dbluns\db1	0.091	0.000	757.467	0.000	65536.000
C:\dbluns\db2	0.089	0.000	764.367	0.000	65536.000
C:\dbluns\db3	0.089	0.000	767.450	0.000	65536.000
C:\dbluns\db4	0.089	0.000	762.498	0.000	65536.000

### Memory System Performance (of checksum)

Counter	Average	Minimum	Maximum
% Processor Time	1.132	0.000	3.321
Available MBytes	30867.179	30854.000	30882.000
Free System Page Table Entries	33555086.018	33554621.000	33555133.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65784031.349	65720320.000	65916928.000
Pool Paged Bytes	94623002.026	90992640.000	95391744.000

Test Log 11/22/2010 9:33:47 AM -- Jetstress testing begins ...

11/22/2010 9:33:47 AM -- Prepare testing begins ...

11/22/2010 9:33:51 AM -- Attaching databases ...

11/22/2010 9:33:51 AM -- Prepare testing ends.

11/22/2010 9:33:51 AM -- Dispatching transactions begins ...

11/22/2010 9:33:51 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/22/2010 9:33:51 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/22/2010 9:33:56 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

11/22/2010 9:33:56 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

11/22/2010 9:34:02 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/22/2010 9:34:02 AM -- Performance logging begins (interval: 15000 ms).

11/22/2010 9:34:02 AM -- Attaining prerequisites:

11/22/2010 9:35:10 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 966398000.0 (lower bound: 966367600.0, upper bound: none)

11/22/2010 9:41:16 AM -- Performance logging ends.

11/22/2010 9:43:34 AM -- JetInterop batch transaction stats: 4669, 4778, 4754 and 4726.

11/22/2010 9:43:34 AM -- Dispatching transactions ends.

11/22/2010 9:43:34 AM -- Shutting down databases ...

11/22/2010 9:43:35 AM -- Instance1460.1 (complete), Instance1460.2 (complete), Instance1460.3 (complete) and Instance1460.4 (complete)

11/22/2010 9:43:36 AM -- Performance logging begins (interval: 30000 ms).

11/22/2010 9:43:36 AM -- Verifying database checksums ...

11/22/2010 9:45:01 AM -- C:\dbluns\db1 (0% processed), C:\dbluns\db2 (0% processed), C:\dbluns\db3 (0% processed) and C:\dbluns\db4 (0% processed)

11/22/2010 9:45:01 AM -- Verifying log checksums ...

11/22/2010 9:45:01 AM -- C:\logluns\log1 (0 log(s) processed), C:\logluns\log2 (0 log(s) processed), C:\logluns\log3 (0 log(s) processed) and C:\logluns\log4 (0 log(s) processed)

11/22/2010 9:45:01 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.blg has 28 samples.

11/22/2010 9:45:02 AM -- Creating test report ...

11/22/2010 9:45:02 AM -- Instance1460.1 has 6.3 for I/O Database Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.1 has 1.3 for I/O Log Writes Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.1 has 1.3 for I/O Log Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 6.1 for I/O Database Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 1.3 for I/O Log Writes Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.2 has 1.3 for I/O Log Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.3 has 6.1 for I/O Database Reads Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.3 has 1.3 for I/O Log Writes Average Latency.

11/22/2010 9:45:02 AM -- Instance1460.3 has 1.3 for I/O Log Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 6.1 for I/O Database Reads Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 1.3 for I/O Log Writes Average Latency.  
11/22/2010 9:45:02 AM -- Instance1460.4 has 1.3 for I/O Log Reads Average Latency.  
11/22/2010 9:45:02 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
11/22/2010 9:45:02 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
11/22/2010 9:45:02 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.xml has 23 samples queried.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Performance\_2010\_11\_22\_9\_33\_56.html is saved.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\Application\_2010\_11\_22\_9\_45\_3.evt is saved.  
11/22/2010 9:45:03 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\System\_2010\_11\_22\_9\_45\_3.evt is saved.  
11/22/2010 9:45:03 AM -- Jetstress testing ends.  
11/22/2010 9:56:39 AM -- Jetstress testing begins ...  
11/22/2010 9:56:39 AM -- Prepare testing begins ...  
11/22/2010 9:56:44 AM -- Attaching databases ...  
11/22/2010 9:56:44 AM -- Prepare testing ends.  
11/22/2010 9:56:44 AM -- Dispatching transactions begins ...  
11/22/2010 9:56:44 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)  
11/22/2010 9:56:44 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)  
11/22/2010 9:56:48 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).  
11/22/2010 9:56:48 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).  
11/22/2010 9:56:54 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.  
11/22/2010 9:56:54 AM -- Performance logging begins (interval: 15000 ms).  
11/22/2010 9:56:54 AM -- Attaining prerequisites:  
11/22/2010 9:58:09 AM -- \MSExchange Database(JetstressWin)\Database Cache Size, Last: 977838100.0 (lower bound: 966367600.0, upper bound: none)  
11/22/2010 11:58:10 AM -- Performance logging ends.  
11/22/2010 6:38:28 PM -- JetInterop batch transaction stats: 250101, 249714, 250115 and 250514.  
11/22/2010 6:38:28 PM -- Dispatching transactions ends.  
11/22/2010 6:38:28 PM -- Shutting down databases ...  
11/22/2010 6:38:29 PM -- Instance1460.1 (complete), Instance1460.2 (complete), Instance1460.3 (complete) and Instance1460.4 (complete)  
11/22/2010 6:38:30 PM -- Performance logging begins (interval: 30000 ms).  
11/22/2010 6:38:30 PM -- Verifying database checksums ...  
11/23/2010 3:40:06 AM -- C:\dbluns\db1 (100% processed), C:\dbluns\db2 (100% processed), C:\dbluns\db3 (100% processed) and C:\dbluns\db4 (100% processed)  
11/23/2010 3:40:06 AM -- Performance logging ends.  
11/23/2010 3:40:06 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\Performance\DBChecksum\_2010\_11\_22\_18\_38\_29.blg has 1082 samples.

## Stress Test Database Performance Result: SUN141

### Test Summary

<i>Overall Test Result</i>	Pass
<i>Machine Name</i>	SUN141
<i>Test Description</i>	
<i>Test Start Time</i>	11/23/2010 4:07:00 AM
<i>Test End Time</i>	11/24/2010 4:14:36 AM
<i>Collection Start Time</i>	11/23/2010 4:08:50 AM
<i>Collection End Time</i>	11/24/2010 4:08:40 AM
<i>Jetstress Version</i>	14.01.0043.000
<i>Ese Version</i>	14.00.0639.019
<i>Operating System</i>	Windows Server 2008 R2 Enterprise (6.1.7600.0)
<i>Performance Log</i>	C:\USPV_600GBFC_R10_1GBMBox\Stress\Stress_2010_11_23_4_7_10.blg C:\USPV_600GBFC_R10_1GBMBox\Stress\DBChecksum_2010_11_24_4_14_36.blg

### Database Sizing and Throughput

<i>Achieved Transactional I/O per Second</i>	1326.803
<i>Target Transactional I/O per Second</i>	720
<i>Initial Database Size (bytes)</i>	6461338157056
<i>Final Database Size (bytes)</i>	6501754470400
<i>Database Files (Count)</i>	4

### Jetstress System Parameters

<i>Thread Count</i>	5 (per database)
<i>Minimum Database Cache</i>	128.0 MB
<i>Maximum Database Cache</i>	1024.0 MB
<i>Insert Operations</i>	40%
<i>Delete Operations</i>	20%
<i>Replace Operations</i>	5%
<i>Read Operations</i>	35%
<i>Lazy Commits</i>	70%
<i>Run Background Database Maintenance</i>	True
<i>Number of Copies per Database</i>	2

## Database Configuration

<i>Instance2216.1</i>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<i>Instance2216.2</i>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<i>Instance2216.3</i>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<i>Instance2216.4</i>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb

Transactional I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance2216.1</b>	6.005	5.245	207.749	124.151	33921.331	34779.212	0.000	0.921	0.000	86.853	0.000	4825.211
<b>Instance2216.2</b>	5.801	5.134	207.692	124.164	33969.650	34777.533	0.000	0.922	0.000	86.750	0.000	4836.418
<b>Instance2216.3</b>	5.801	4.930	207.439	123.986	33967.187	34781.115	0.000	0.923	0.000	86.704	0.000	4845.067
<b>Instance2216.4</b>	5.802	4.131	207.508	124.115	33939.978	34782.454	0.000	0.922	0.000	86.869	0.000	4836.586

### Background Database Maintenance I/O Performance

<i>MSEExchange Database ==&gt; Instances</i>	<i>Database Maintenance IO Reads/sec</i>	<i>Database Maintenance IO Reads Average Bytes</i>
<b>Instance2216.1</b>	30.459	261880.875
<b>Instance2216.2</b>	30.471	261904.996
<b>Instance2216.3</b>	30.474	261889.004
<b>Instance2216.4</b>	30.478	261886.391

### Log Replication I/O Performance

<i>MSEExchange Database ==&gt; Instances</i>	<i>I/O Log Reads/sec</i>	<i>I/O Log Reads Average Bytes</i>
<b>Instance2216.1</b>	1.706	232560.611
<b>Instance2216.2</b>	1.708	232557.168
<b>Instance2216.3</b>	1.710	232559.485
<b>Instance2216.4</b>	1.711	232561.852

Total I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
Instance2216.1	6.005	5.245	238.208	124.151	63069.994	34779.212	1.861	0.921	1.706	86.853	232560.611	4825.211
Instance2216.2	5.801	5.134	238.162	124.164	63131.998	34777.533	1.866	0.922	1.708	86.750	232557.168	4836.418
Instance2216.3	5.801	4.930	237.913	123.986	63161.446	34781.115	1.880	0.923	1.710	86.704	232559.485	4845.067
Instance2216.4	5.802	4.131	237.986	124.115	63132.430	34782.454	1.853	0.922	1.711	86.869	232561.852	4836.586

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.006	0.000	3.894
Available MBytes	29787.222	29774.000	29815.000
Free System Page Table Entries	33555130.983	33555119.000	33555131.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65207941.097	64151552.000	66408448.000
Pool Paged Bytes	88817628.389	86618112.000	94380032.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/23/2010 4:07:00 AM -- Jetstress testing begins ...

11/23/2010 4:07:00 AM -- Prepare testing begins ...

11/23/2010 4:07:05 AM -- Attaching databases ...

11/23/2010 4:07:05 AM -- Prepare testing ends.

11/23/2010 4:07:05 AM -- Dispatching transactions begins ...

11/23/2010 4:07:05 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/23/2010 4:07:05 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/23/2010 4:07:10 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).

11/23/2010 4:07:10 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).

11/23/2010 4:07:15 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/23/2010 4:07:15 AM -- Performance logging begins (interval: 15000 ms).

11/23/2010 4:07:15 AM -- Attaining prerequisites:

11/23/2010 4:08:50 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 972013600.0 (lower bound: 966367600.0, upper bound: none)

11/24/2010 4:08:50 AM -- Performance logging ends.

11/24/2010 4:14:34 AM -- JetInterop batch transaction stats: 718230, 717756, 718234 and 718072.

11/24/2010 4:14:34 AM -- Dispatching transactions ends.

11/24/2010 4:14:34 AM -- Shutting down databases ...

11/24/2010 4:14:36 AM -- Instance2216.1 (complete), Instance2216.2 (complete), Instance2216.3 (complete) and Instance2216.4 (complete)

11/24/2010 4:14:37 AM -- Performance logging begins (interval: 30000 ms).

11/24/2010 4:14:37 AM -- Verifying database checksums ...

11/24/2010 1:21:13 PM -- C:\dbluns\db1 (100% processed), C:\dbluns\db2 (100% processed), C:\dbluns\db3 (100% processed) and C:\dbluns\db4 (100% processed)

11/24/2010 1:21:13 PM -- Performance logging ends.

11/24/2010 1:21:13 PM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Stress\DBChecksum\_2010\_11\_24\_4\_14\_36.blg has 1092 samples.

11/24/2010 1:21:17 PM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Stress\DBChecksum\_2010\_11\_24\_4\_14\_36.html is saved.

11/24/2010 1:21:17 PM -- Verifying log checksums ...

11/24/2010 1:21:18 PM -- C:\logluns\log1 (14 log(s) processed), C:\logluns\log2 (14 log(s) processed), C:\logluns\log3 (15 log(s) processed) and C:\logluns\log4 (16 log(s) processed)

11/24/2010 1:21:18 PM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Stress\Stress\_2010\_11\_23\_4\_7\_10.blg has 5757 samples.

11/24/2010 1:21:18 PM -- Creating test report ...  
 11/24/2010 1:21:42 PM -- Instance2216.1 has 6.0 for I/O Database Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.1 has 0.9 for I/O Log Writes Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.1 has 0.9 for I/O Log Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.2 has 5.8 for I/O Database Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.2 has 0.9 for I/O Log Writes Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.2 has 0.9 for I/O Log Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.3 has 5.8 for I/O Database Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.3 has 0.9 for I/O Log Writes Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.3 has 0.9 for I/O Log Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.4 has 5.8 for I/O Database Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.4 has 0.9 for I/O Log Writes Average Latency.  
 11/24/2010 1:21:42 PM -- Instance2216.4 has 0.9 for I/O Log Reads Average Latency.  
 11/24/2010 1:21:42 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 11/24/2010 1:21:42 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
 11/24/2010 1:21:42 PM --  
 C:\USPV\_600GBFC\_R10\_1GBMBox\Stress\Stress\_2010\_11\_23\_4\_7\_10.xml has 5750 samples queried.

## Stress Test Database Checksums Result: SUN141

### Checksum Statistics — All

<i>Database</i>	<b>Seen pages</b>	<b>Bad pages</b>	<b>Correctable pages</b>	<b>Wrong page-number pages</b>	<b>File length / seconds taken</b>
<i>C:\dbluns\db1\Jetstress001001.edb</i>	49604706	0	0	0	1550147 MBytes / 32795 sec
<i>C:\dbluns\db2\Jetstress002001.edb</i>	49604450	0	0	0	1550139 MBytes / 32362 sec
<i>C:\dbluns\db3\Jetstress003001.edb</i>	49603938	0	0	0	1550123 MBytes / 32450 sec
<i>C:\dbluns\db4\Jetstress004001.edb</i>	49604706	0	0	0	1550147 MBytes / 32535 sec
<i>(Sum)</i>	198417800	0	0	0	6200556 MBytes / 32795 sec

### Disk Subsystem Performance (of checksum)

<i>LogicalDisk</i>	<i>Avg. Disk sec/Read</i>	<i>Avg. Disk sec/Write</i>	<i>Disk Reads/sec</i>	<i>Disk Writes/sec</i>	<i>Avg. Disk Bytes/Read</i>
<b>C:\dbluns\db1</b>	0.091	0.000	754.548	0.000	65536.000
<b>C:\dbluns\db2</b>	0.089	0.000	766.458	0.000	65536.000
<b>C:\dbluns\db3</b>	0.089	0.000	764.346	0.000	65536.000
<b>C:\dbluns\db4</b>	0.089	0.000	762.341	0.000	65536.000

### Memory System Performance (of checksum)

<i>Counter</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>
<b>% Processor Time</b>	1.015	0.000	3.147
<b>Available MBytes</b>	30868.367	30852.000	30884.000
<b>Free System Page Table Entries</b>	33555130.998	33555129.000	33555131.000
<b>Transition Pages RePurposed/sec</b>	0.000	0.000	0.000
<b>Pool Nonpaged Bytes</b>	66931235.634	66760704.000	67149824.000
<b>Pool Paged Bytes</b>	90343420.249	90296320.000	90460160.000

Test Log 11/23/2010 4:07:00 AM -- Jetstress testing begins ...

11/23/2010 4:07:00 AM -- Prepare testing begins ...

11/23/2010 4:07:05 AM -- Attaching databases ...

11/23/2010 4:07:05 AM -- Prepare testing ends.

11/23/2010 4:07:05 AM -- Dispatching transactions begins ...

11/23/2010 4:07:05 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/23/2010 4:07:05 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/23/2010 4:07:10 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).

11/23/2010 4:07:10 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).

11/23/2010 4:07:15 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/23/2010 4:07:15 AM -- Performance logging begins (interval: 15000 ms).

11/23/2010 4:07:15 AM -- Attaining prerequisites:

11/23/2010 4:08:50 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 972013600.0 (lower bound: 966367600.0, upper bound: none)

11/24/2010 4:08:50 AM -- Performance logging ends.

11/24/2010 4:14:34 AM -- JetInterop batch transaction stats: 718230, 717756, 718234 and 718072.

11/24/2010 4:14:34 AM -- Dispatching transactions ends.

11/24/2010 4:14:34 AM -- Shutting down databases ...

11/24/2010 4:14:36 AM -- Instance2216.1 (complete), Instance2216.2 (complete), Instance2216.3 (complete) and Instance2216.4 (complete)

11/24/2010 4:14:37 AM -- Performance logging begins (interval: 30000 ms).

11/24/2010 4:14:37 AM -- Verifying database checksums ...

11/24/2010 1:21:13 PM -- C:\dbluns\db1 (100% processed), C:\dbluns\db2 (100% processed), C:\dbluns\db3 (100% processed) and C:\dbluns\db4 (100% processed)

11/24/2010 1:21:13 PM -- Performance logging ends.

11/24/2010 1:21:13 PM --

C:\USPV\_600GBFC\_R10\_1GBMBox\Stress\DBChecksum\_2010\_11\_24\_4\_14\_36.blg has 1092 samples.

## Database Backup Test Result: SUN141

### Database Backup Statistics — All

<i>Database Instance</i>	<i>Database Size (MBytes)</i>	<i>Elapsed Backup Time</i>	<i>MBytes Transferred/sec</i>
<b>Instance1144.1</b>	1550139.09	03:56:50	109.08
<b>Instance1144.2</b>	1550131.09	03:51:29	111.61
<b>Instance1144.3</b>	1550115.09	03:50:02	112.31
<b>Instance1144.4</b>	1550139.09	03:50:08	112.26

### Jetstress System Parameters

<i>Thread Count</i>	5 (per database)
<i>Minimum Database Cache</i>	128.0 MB
<i>Maximum Database Cache</i>	1024.0 MB
<i>Insert Operations</i>	40%
<i>Delete Operations</i>	20%
<i>Replace Operations</i>	5%
<i>Read Operations</i>	35%
<i>Lazy Commits</i>	70%

### Database Configuration

<i>Instance1144.1</i>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<i>Instance1144.2</i>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<i>Instance1144.3</i>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<i>Instance1144.4</i>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb

Transactional I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance1144.1</b>	3.953	0.000	436.001	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<b>Instance1144.2</b>	3.969	0.000	446.054	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<b>Instance1144.3</b>	3.939	0.000	449.163	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<b>Instance1144.4</b>	3.936	0.000	448.962	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

## Host System Performance

<i>Counter</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>
<b>% Processor Time</b>	1.168	0.000	2.377
<b>Available MBytes</b>	30816.256	30805.000	30818.000
<b>Free System Page Table Entries</b>	33555643.000	33555643.000	33555643.000
<b>Transition Pages RePurposed/sec</b>	0.000	0.000	0.000
<b>Pool Nonpaged Bytes</b>	63489021.835	63463424.000	63582208.000
<b>Pool Paged Bytes</b>	86159403.298	86085632.000	86319104.000
<b>Database Page Fault Stalls/sec</b>	0.000	0.000	0.000

Test Log 11/24/2010 9:24:39 PM -- Jetstress testing begins ...

11/24/2010 9:24:39 PM -- Prepare testing begins ...

11/24/2010 9:24:43 PM -- Attaching databases ...

11/24/2010 9:24:43 PM -- Prepare testing ends.

11/24/2010 9:24:52 PM -- Performance logging begins (interval: 30000 ms).

11/24/2010 9:24:52 PM -- Backing up databases ...

11/25/2010 1:21:42 AM -- Performance logging ends.

11/25/2010 1:21:42 AM -- Instance1144.1 (100% processed), Instance1144.2 (100% processed), Instance1144.3 (100% processed) and Instance1144.4 (100% processed)

11/25/2010 1:21:42 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\BackupTest\DatabaseBackup\_2010\_11\_24\_21\_24\_43.blg has 473 samples.

11/25/2010 1:21:42 AM -- Creating test report ...

## Soft Recovery Test Result: SUN141

### Soft-Recovery Statistics — All

<i>Database Instance</i>	<i>Log files replayed</i>	<i>Elapsed seconds</i>
<b>Instance2584.1</b>	507	476.8304375
<b>Instance2584.2</b>	506	471.7916287
<b>Instance2584.3</b>	500	453.757997
<b>Instance2584.4</b>	510	490.8860622

### Database Configuration

<b>Instance2584.1</b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b>Instance2584.2</b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b>Instance2584.3</b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b>Instance2584.4</b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb

Transactional I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance2584.1</b>	15.940	8.556	1352.412	6.381	35839.249	32489.123	2.001	0.000	9.572	0.000	230552.511	0.000
<b>Instance2584.2</b>	15.295	8.771	1334.404	6.448	35908.140	32486.730	2.025	0.000	9.673	0.000	230584.585	0.000
<b>Instance2584.3</b>	15.502	8.440	1354.707	6.615	36102.186	32182.857	1.925	0.000	9.922	0.000	228413.033	0.000
<b>Instance2584.4</b>	15.436	8.430	1308.749	6.258	35786.131	32090.975	2.141	0.000	9.387	0.000	227774.453	0.000

Background Database Maintenance I/O Performance

<i>MSExchange Database ==&gt; Instances</i>	<i>Database Maintenance IO Reads/sec</i>	<i>Database Maintenance IO Reads Average Bytes</i>
<b>Instance2584.1</b>	29.919	261959.472
<b>Instance2584.2</b>	30.069	262014.065
<b>Instance2584.3</b>	29.909	261897.922
<b>Instance2584.4</b>	30.017	262006.069

Total I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance2584.1</b>	15.940	8.556	1382.331	6.381	40733.375	32489.123	2.001	0.000	9.572	0.000	230552.511	0.000
<b>Instance2584.2</b>	15.295	8.771	1364.473	6.448	40890.909	32486.730	2.025	0.000	9.673	0.000	230584.585	0.000
<b>Instance2584.3</b>	15.502	8.440	1384.616	6.615	40979.528	32182.857	1.925	0.000	9.922	0.000	228413.033	0.000
<b>Instance2584.4</b>	15.436	8.430	1338.766	6.258	40858.251	32090.975	2.141	0.000	9.387	0.000	227774.453	0.000

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	3.359	0.000	21.754
Available MBytes	29710.938	29684.000	30698.000
Free System Page Table Entries	33555644.193	33555642.000	33555645.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	72285011.226	66637824.000	72880128.000
Pool Paged Bytes	87351211.720	87314432.000	87490560.000
Database Page Fault Stalls/sec	0.010	0.000	0.986

Test Log 11/25/2010 1:39:57 AM -- Jetstress testing begins ...

11/25/2010 1:39:57 AM -- Prepare testing begins ...

11/25/2010 1:40:02 AM -- Attaching databases ...

11/25/2010 1:40:02 AM -- Prepare testing ends.

11/25/2010 1:40:02 AM -- Dispatching transactions begins ...

11/25/2010 1:40:02 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/25/2010 1:40:02 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/25/2010 1:40:07 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

11/25/2010 1:40:07 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

11/25/2010 1:40:11 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/25/2010 1:40:11 AM -- Performance logging begins (interval: 15000 ms).

11/25/2010 1:40:11 AM -- Generating log files ...

11/25/2010 2:28:39 AM -- C:\logluns\log1 (101.6% generated), C:\logluns\log2 (101.4% generated), C:\logluns\log3 (100.2% generated) and C:\logluns\log4 (102.2% generated)

11/25/2010 2:28:39 AM -- Performance logging ends.

11/25/2010 2:28:39 AM -- JetInterop batch transaction stats: 22190, 21962, 21828 and 22323.

11/25/2010 2:28:40 AM -- Dispatching transactions ends.

11/25/2010 2:28:40 AM -- Shutting down databases ...

11/25/2010 2:28:40 AM -- Instance2584.1 (complete), Instance2584.2 (complete), Instance2584.3 (complete) and Instance2584.4 (complete)

11/25/2010 2:28:40 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\Performance\_2010\_11\_25\_1\_40\_7.blg has 193 samples.

11/25/2010 2:28:40 AM -- Creating test report ...

11/25/2010 2:28:41 AM -- Instance2584.1 has 7.1 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.1 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.1 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
 11/25/2010 2:28:41 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
 11/25/2010 2:28:41 AM --  
 C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\Performance\_2010\_11\_25\_1\_40\_7.xml has 192 samples queried.  
 11/25/2010 2:28:41 AM --  
 C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\Performance\_2010\_11\_25\_1\_40\_7.html is saved.  
 11/25/2010 2:29:50 AM -- Performance logging begins (interval: 2000 ms).  
 11/25/2010 2:29:50 AM -- Recovering databases ...  
 11/25/2010 2:38:01 AM -- Performance logging ends.  
 11/25/2010 2:38:01 AM -- Instance2584.1 (476.8304375), Instance2584.2 (471.7916287), Instance2584.3 (453.757997) and Instance2584.4 (490.8860622)  
 11/25/2010 2:38:01 AM --  
 C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\SoftRecovery\_2010\_11\_25\_2\_29\_46.blg has 243 samples.  
 11/25/2010 2:38:01 AM -- Creating test report ...

## Soft Recovery Test Performance Result: SUN141

### Test Summary

<b>Overall Test Result</b>	Pass
<b>Machine Name</b>	SUN141
<b>Test Description</b>	
<b>Test Start Time</b>	11/25/2010 1:39:57 AM
<b>Test End Time</b>	11/25/2010 2:28:40 AM
<b>Collection Start Time</b>	11/25/2010 1:40:26 AM
<b>Collection End Time</b>	11/25/2010 2:28:27 AM
<b>Jetstress Version</b>	14.01.0043.000
<b>Ese Version</b>	14.00.0639.019
<b>Operating System</b>	Windows Server 2008 R2 Enterprise (6.1.7600.0)
<b>Performance Log</b>	C:\USPV_600GBFC_R10_1GBMBox\SoftRecovery\Performance_2010_11_25_1_40_7.blg

### Database Sizing and Throughput

<b>Achieved Transactional I/O per Second</b>	1083.145
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial Database Size (bytes)</b>	6501754470400
<b>Final Database Size (bytes)</b>	6503012761600
<b>Database Files (Count)</b>	4

### Jetstress System Parameters

<i>Thread Count</i>	5 (per database)
<i>Minimum Database Cache</i>	128.0 MB
<i>Maximum Database Cache</i>	1024.0 MB
<i>Insert Operations</i>	40%
<i>Delete Operations</i>	20%
<i>Replace Operations</i>	5%
<i>Read Operations</i>	35%
<i>Lazy Commits</i>	70%

### Database Configuration

<i>Instance2584.1</i>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<i>Instance2584.2</i>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<i>Instance2584.3</i>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<i>Instance2584.4</i>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb

Transactional I/O Performance

<i>MSExchange Database =&gt; Instances</i>	<i>I/O Database Reads Average Latency (msec)</i>	<i>I/O Database Writes Average Latency (msec)</i>	<i>I/O Database Reads/sec</i>	<i>I/O Database Writes/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/sec</i>	<i>I/O Log Writes/sec</i>	<i>I/O Log Reads Average Bytes</i>	<i>I/O Log Writes Average Bytes</i>
<b>Instance2584.1</b>	7.061	6.837	172.127	102.051	32768.428	34900.193	0.000	1.399	0.000	74.416	0.000	5132.751
<b>Instance2584.2</b>	6.757	6.640	169.396	100.200	32768.000	34910.879	0.000	1.384	0.000	73.325	0.000	5198.717
<b>Instance2584.3</b>	6.769	6.305	166.300	98.197	32768.000	34944.015	0.000	1.375	0.000	72.150	0.000	5217.776
<b>Instance2584.4</b>	6.761	4.510	172.598	102.275	32768.000	34867.606	0.000	1.378	0.000	74.810	0.000	5149.647

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.991	0.000	2.533
Available MBytes	29718.933	29695.000	30544.000
Free System Page Table Entries	33555643.819	33555643.000	33555645.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	65288054.052	63799296.000	65601536.000
Pool Paged Bytes	87023361.326	86724608.000	87130112.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

Test Log 11/25/2010 1:39:57 AM -- Jetstress testing begins ...

11/25/2010 1:39:57 AM -- Prepare testing begins ...

11/25/2010 1:40:02 AM -- Attaching databases ...

11/25/2010 1:40:02 AM -- Prepare testing ends.

11/25/2010 1:40:02 AM -- Dispatching transactions begins ...

11/25/2010 1:40:02 AM -- Database cache settings: (minimum: 128.0 MB, maximum: 1.0 GB)

11/25/2010 1:40:02 AM -- Database flush thresholds: (start: 10.2 MB, stop: 20.5 MB)

11/25/2010 1:40:07 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).

11/25/2010 1:40:07 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).

11/25/2010 1:40:11 AM -- Operation mix: Sessions 5, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.

11/25/2010 1:40:11 AM -- Performance logging begins (interval: 15000 ms).

11/25/2010 1:40:11 AM -- Generating log files ...

11/25/2010 2:28:39 AM -- C:\logluns\log1 (101.6% generated), C:\logluns\log2 (101.4% generated), C:\logluns\log3 (100.2% generated) and C:\logluns\log4 (102.2% generated)

11/25/2010 2:28:39 AM -- Performance logging ends.

11/25/2010 2:28:39 AM -- JetInterop batch transaction stats: 22190, 21962, 21828 and 22323.

11/25/2010 2:28:40 AM -- Dispatching transactions ends.

11/25/2010 2:28:40 AM -- Shutting down databases ...

11/25/2010 2:28:40 AM -- Instance2584.1 (complete), Instance2584.2 (complete), Instance2584.3 (complete) and Instance2584.4 (complete)

11/25/2010 2:28:40 AM --

C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\Performance\_2010\_11\_25\_1\_40\_7.blg has 193 samples.

11/25/2010 2:28:40 AM -- Creating test report ...

11/25/2010 2:28:41 AM -- Instance2584.1 has 7.1 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.1 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.1 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.2 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.3 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 6.8 for I/O Database Reads Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 1.4 for I/O Log Writes Average Latency.

11/25/2010 2:28:41 AM -- Instance2584.4 has 1.4 for I/O Log Reads Average Latency.

11/25/2010 2:28:41 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
11/25/2010 2:28:41 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
11/25/2010 2:28:41 AM --  
C:\USPV\_600GBFC\_R10\_1GBMBox\SoftRecovery\Performance\_2010\_11\_25\_1\_40\_7.xml has 192  
samples queried.

 **Hitachi Data Systems Corporation**

---

*Hitachi is a registered trademark of Hitachi, Ltd., in the United States and other countries. Hitachi Data Systems is a registered trademark and service mark of Hitachi, Ltd., in the United States and other countries. All other trademarks, service marks and company names mentioned in this document are properties of their respective owners.*

*Notice: This document is for informational purposes only, and does not set forth any warranty, expressed or implied, concerning any equipment or service offered or to be offered by Hitachi Data Systems Corporation*

© Hitachi Data Systems Corporation 2010. All Rights Reserved. ESRP-062-00

**Corporate Headquarters**

750 Central Expressway,  
Santa Clara, California 95050-2627 USA  
[www.HDS.com](http://www.HDS.com)

**Regional Contact Information**

**Americas:** +1 408 970 1000 or [info@hds.com](mailto:info@hds.com)  
**Europe, Middle East and Africa:** +44 (0) 1753 618000 or [info.emea@hds.com](mailto:info.emea@hds.com)  
**Asia Pacific:** +852 3189 7900 or [hds.marketing.apac@hds.com](mailto:hds.marketing.apac@hds.com)