

# Hitachi Adaptable Modular Storage 2300 Dynamically Provisioned 20,000 User Exchange 2010 Mailbox Resiliency Storage Solution

Tested with: ESRP – Storage Version 3.0

Test Date: May 2010

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## Overview

This document provides information on a Hitachi Adaptable Modular Storage 2300 Resiliency storage solution using Hitachi Dynamic Provisioning software for Microsoft® Exchange Server 2010, based on the Microsoft Exchange Solution Reviewed Program (ESRP) – Storage program. For more information about the contents of this document or Hitachi Data Systems best practice recommendations for Microsoft Exchange Server 2010 storage design, see Hitachi Data Systems [Microsoft Exchange Solutions Web page](#).

The ESRP – Storage program was developed by Microsoft Corporation to provide a common storage testing framework for vendors to provide information on its storage solutions for Microsoft Exchange Server software. For more information about the Microsoft ESRP – Storage program, see [TechNet's overview of the program](#).

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## Features

The purpose of this testing was to measure the ESRP 3.0 results on a Microsoft Exchange 2010 environment with 20,000 users and 8 servers. This testing used the Hitachi Adaptable Modular Storage 2300 storage system using Hitachi Dynamic Provisioning software in a two-pool RAID-1+0 configuration (one for databases and one for logs) in a resiliency configuration. These results help answer questions about the kind of performance capabilities to expect with a large-scale Exchange deployment on the 2300.

This solution includes Exchange 2010 Mailbox Resiliency by using the new Database Availability Group (DAG) feature. This tested configuration utilizes eight DAG's, each containing two database copies and two servers. The test configuration was capable of supporting 20,000 users with a 0.12 IOPS per user profile and user mailbox size of 1GB. A 2300 with 240 1TB 7.2K RPM SATA disks, 16GB of cache and eight 4Gbit/s paths was used for these tests. Testing used eight Sun Fire 4600 servers with 64GB of RAM, two quad-core AMD Opteron Processor 2300MHz, 16 Emulex 4Gbit/s Fibre Channel adapters, and Windows Server 2008 R2 Enterprise.

The Hitachi Adaptable Modular Storage 2300 is a medium-sized, high-performance, highly reliable midrange storage system that can scale to 240 disks while maintaining 99.999% availability. It is highly suitable for a variety of applications and host platforms and is modular in scale. With the option of in-system and cross-system replication functionality, the 2300 is fully capable of being used as the core underlying storage platform for high-performance Exchange Server 2010 architectures.

## Solution Description

Deploying Microsoft Exchange Server 2010 requires careful consideration of all aspects of the solution architecture. Host servers need to be configured so that they are robust enough to handle the required Exchange load. The storage solution must be designed to provide the necessary performance while also being reliable and easy to administer. Of course, an effective backup and recovery plan should be incorporated into the solution as well. The aim of this solution report is to provide a tested configuration that utilizes the 2300 to meet the needs of a large Exchange Server deployment.

This solution uses Hitachi Dynamic Provisioning software, which is enabled on the 2300 via a license key. In the most basic sense, Hitachi Dynamic Provisioning software is similar to the use of a host-based logical volume manager (LVM), but with several additional features available within the 2300 and without the need to install software on the host or incur host processing overhead. Hitachi Dynamic Provisioning software is a superior solution. Hitachi Dynamic Provisioning software provides for one or more pools of wide striping across many RAID groups within a 2300. One or more Dynamic Provisioning virtual volumes (DP-VOLs) of a user-specified logical size (with no initial physical space allocated) are created against each pool.

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

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

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

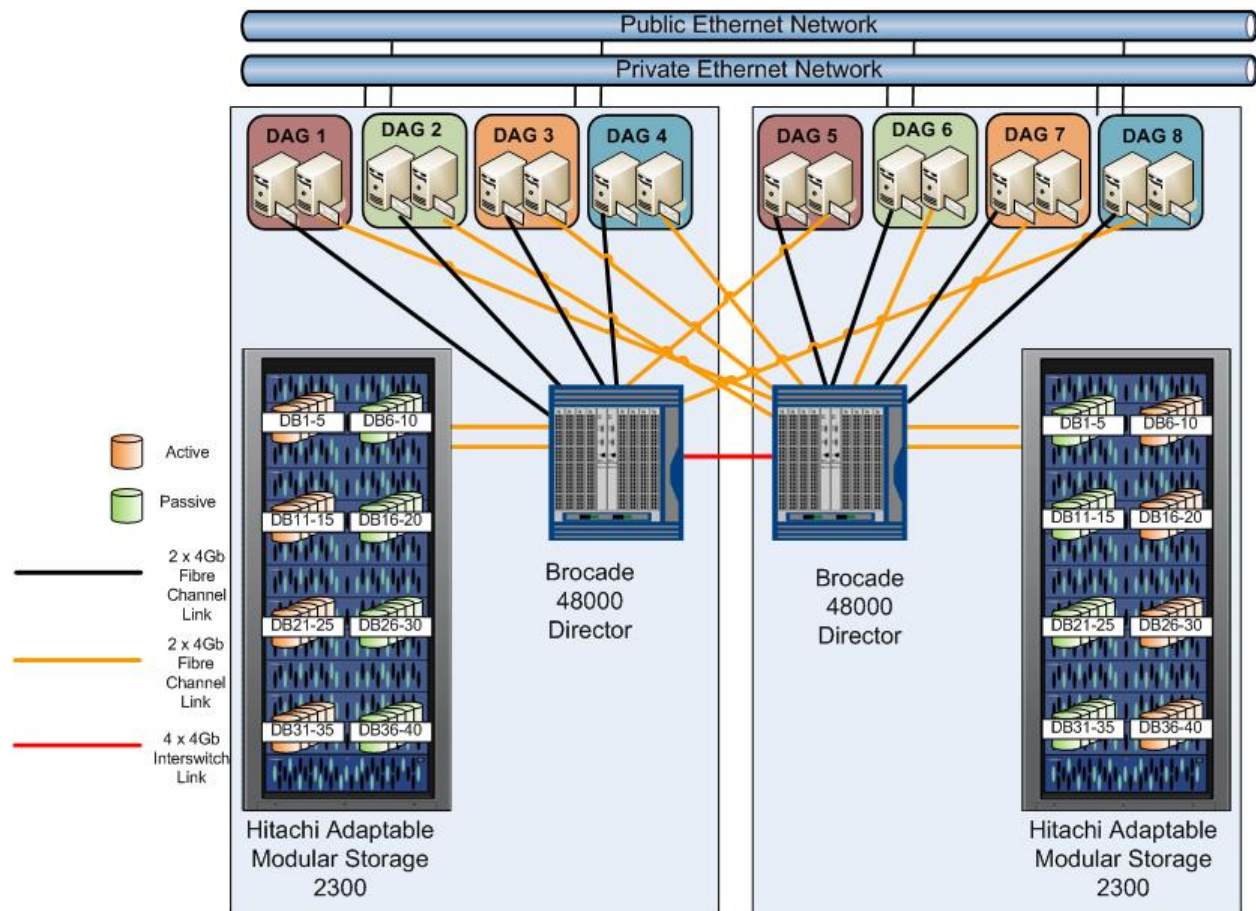
Any server in a DAG can host a copy of a mailbox database from any other server in the DAG. When a server is added to a DAG, it monitors and works with the other servers in the DAG to provide automatic recovery delivering a robust, highly available Exchange solution without the administrative complexities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

This solution includes two copies of each Exchange database using eight DAGs, each configured with two servers that host active mailboxes in five databases. To target the 20,000-user resiliency solution, a Hitachi Adaptable Modular Storage 2300 configured with 240 disks (the maximum) and eight servers, each configured with 2,500 mailboxes, were used to host the 40 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 2300 and the passive copy on another server connected to a second 2300. This recommended configuration can support both high-availability and disaster-recovery scenarios when the active and passive database copies are allocated among both DAG members and dispersed across both 2300 storage systems. 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. Recommended Database Availability Group Configuration**

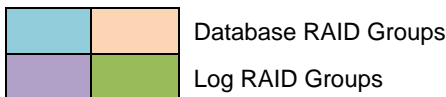


This solution enables organizations to consolidate Exchange Server 2010 DAG deployments on two 2300 storage systems. Using identical hardware and software configurations guarantees that an active database and its replicated copy do not share storage paths, disk spindles or storage controllers, making it a very reliable, high-performing, highly available Exchange Server 2010 solution that is cost effective and easy to manage. This helps ensure that performance and service levels related to storage are maintained regardless of which server is hosting the active database. If further protection is needed in a production environment, additional Exchange Server 2010 mailbox servers can be easily added to support these failover scenarios.

Table 1 illustrates how the 2300 storage system's disks were organized into RAID groups for use by either databases or logs. Each set of colored disks represents a RAID-1+0 (4D+4D) group. Except for RKA-0 (with 15 internal SATA disks), each RKA is an external disk enclosure with 15 SATA disks.

**Table 1. Adaptable Modular Storage 2300 RAID Groups by RKA Tray Layout**

<b>Drive Slot</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>
RKA 15	29	29	29	29	29	29	29	30	30	30	30	30	30	30	30
RKA 14	27	27	27	27	27	27	28	28	28	28	28	28	28	28	29
RKA 13	25	25	25	25	25	26	26	26	26	26	26	26	26	27	27
RKA 12	23	23	23	23	24	24	24	24	24	24	24	24	25	25	25
RKA 11	21	21	21	22	22	22	22	22	22	22	22	23	23	23	23
RKA 10	19	19	20	20	20	20	20	20	20	20	21	21	21	21	21
RKA 9	17	18	18	18	18	18	18	18	18	19	19	19	19	19	19
RKA 8	16	16	16	16	16	16	16	16	17	17	17	17	17	17	17
RKA 7	14	14	14	14	14	14	14	15	15	15	15	15	15	15	15
RKA 6	12	12	12	12	12	12	13	13	13	13	13	13	13	13	14
RKA 5	10	10	10	10	10	11	11	11	11	11	11	11	11	12	12
RKA 4	8	8	8	8	9	9	9	9	9	9	9	9	10	10	10
RKA 3	6	6	6	7	7	7	7	7	7	7	7	8	8	8	8
RKA 2	4	4	5	5	5	5	5	5	5	5	6	6	6	6	6
RKA 1	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4
RKA 0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2



Two Dynamic Provisioning pools were created, one for the databases and the other for the logs. The database pool was created from 27 RAID-1+0 groups and the log pool was created from three RAID-1+0 groups. From the database pool, 40 DP-VOLs (each specified to have a 2,000GB size limit) were created for 40 databases (five per server). From the log pool, 40 DP-VOLs (each specified to have a size limit of 200GB) were created for 40 logs (five per server).

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

**Table 2. Adaptable Modular Storage 2300 Port to Server Layout**

<i>Server</i>	<i>Primary Path</i>	<i>Secondary Path</i>
Sun21	0A	1A
Sun22	0B	1B
Sun23	0C	1C
Sun24	0D	1D
Sun25	1A	0A
Sun26	1B	0B
Sun27	1C	0C
Sun28	1D	0D

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

**Table 3. Adaptable Modular Storage 2300 Port to Database DP-VOL Layout**

<i>Port</i>	<i>Database</i>	<i>DP-VOL</i>
0A	1-5	0-4
0B	6-10	5-9
0C	11-15	10-14
0D	16-20	15-19
1A	21-25	20-24
1B	26-30	25-29
1C	31-35	30-34
1D	36-40	35-39

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

**Table 4. Adaptable Modular Storage 2300 Port to Log DP-VOL Layout**

<i>Port</i>	<i>Log</i>	<i>DP-VOL</i>
0A	1-5	40-44
0B	6-10	45-49
0C	11-15	50-54
0D	16-20	55-59
1A	21-25	60-64
1B	26-30	65-69
1C	31-35	70-74
1D	36-40	75-79

Table 5 provides the detailed specifications for the storage configuration which uses RAID-1+0 (4+4) groups and 1TB 7.2K disks. Dynamic Provisioning pool 0 is dedicated for the databases and Dynamic Provisioning pool 1 is dedicated for the logs.

**Table 5. Adaptable Modular Storage 2300 Configuration Details**

<i>Host</i>	<i>Pool</i>	<i>Port</i>	<i>DP-VOL</i>	<i>Size (GB)</i>	<i>Description</i>
SUN21	0	0A/1A	0 – 4	2000	Databases 1-5
SUN22	0	0B/1B	5 – 9	2000	Databases 6-10
SUN23	0	0C/1C	10 – 14	2000	Databases 11-15
SUN24	0	0D/1D	15 – 19	2000	Databases 16-20
SUN25	0	1A/0A	20 – 24	2000	Databases 21-25
SUN26	0	1B/0B	25 - 29	2000	Databases 26-30
SUN27	0	1C/0C	30 – 34	2000	Databases 31-35
SUN28	0	1D/0D	35 – 39	2000	Databases 36-40
SUN21	1	0A/1A	40 – 44	200	Log 1-5
SUN22	1	0B/1B	45 – 49	200	Log 6-10
SUN23	1	0C/1C	50 – 54	200	Log 11-15
SUN24	1	0D/1D	55 – 59	200	Log 16-20
SUN25	1	1A/0A	60 – 64	200	Log 21-25
SUN26	1	1B/0B	65 – 69	200	Log 26-30
SUN27	1	1C/0C	70 – 74	200	Log 31-35
SUN28	1	1D/0D	75 - 79	200	Log 36-40

The ESRP – Storage program focuses on storage solution testing to address performance and reliability issues with storage design. However, storage is not the only factor to take into consideration when designing a scale-up Exchange solution. These factors also affect server scalability:

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

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

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

## Targeted Customer Profile

This solution is designed for medium to large organizations that plan to consolidate their Exchange Server 2010 storage on high-performance, high-reliability storage systems. This configuration is designed to support 20,000 Exchange users with the following specifications:

- Sixteen Exchange servers (eight tested, simulating 16 for the database copies)
- Eight Database Availability Groups, each maintaining two servers and two copies per database
- Two Adaptable Modular Storage 2300 storage systems (one tested)
- 0.1 IOPS per user (0.12 tested for 20 percent growth)
- 1GB mailbox size
- Mailbox resiliency provides high-availability and used as primary data protection mechanism.
- Adaptable Modular Storage RAID protection against physical failure or loss
- 24x7 background database maintenance enabled

## Tested Deployment

The following tables summarize the testing environment.

**Table 6. Simulated Exchange Configuration**

<i>Number of Exchange mailboxes simulated</i>	20,000
<i>Number of database availability groups (DAGs)</i>	8
<i>Number of servers per DAG</i>	2
<i>Number of active mailboxes per server</i>	2,500
<i>Number of databases per host</i>	5
<i>Number of copies per database</i>	2
<i>Number of mailboxes per database</i>	500
<i>Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)</i>	0.12
<i>Database LU size</i>	200GB
<i>Log LU size</i>	200GB
<i>Total database size for performance testing</i>	20,000GB
<i>% storage capacity used by Exchange database**</i>	21 %

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

**Table 7. Primary Storage Hardware**

<b>Storage connectivity (Fibre Channel, SATA, SATA, iSCSI)</b>	Fibre Channel
<b>Storage model and OS/firmware revision</b>	1 Hitachi Adaptable Modular Storage 2300 Firmware: 0890/B-Y WHQL listing: <a href="#">Hitachi Adaptable Modular Storage 2300</a>
<b>Storage cache</b>	16GB
<b>Number of storage controllers</b>	2
<b>Number of storage ports</b>	8
<b>Maximum bandwidth of storage connectivity to host</b>	32Gb/s (8 x 4Gbit/s ports)
<b>Switch type/model/firmware revision</b>	Brocade 5320, Fabric OS v6.3.0b
<b>HBA model and firmware</b>	Emulex LPe11002, FW:2.80A4
<b>Number of HBAs per host</b>	2 dual-ported HBA per host, 1 4Gbit/s port used per HBA
<b>Host server type</b>	Sun Fire 4600 4 2.3Hz Quad-core AMD Opterno 8356 CPUs, 64GB memory
<b>Total number of disks tested in solution</b>	240
<b>Maximum number of spindles can be hosted in the storage</b>	240

**Table 8. Primary Storage Software**

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

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

<b>Disk type, speed and firmware revision</b>	SATA Disk 1TB 7.2K AD0A
<b>Raw capacity per disk (GB)</b>	1TB
<b>Number of physical disks in test</b>	216 (Dynamic Provisioning pool)
<b>Total raw storage capacity (GB)</b>	216,000GB
<b>Disk slice size (GB)</b>	N/A
<b>Number of slices per LUN or number of disks per LUN</b>	N/A
<b>RAID level</b>	RAID 1+0 (4+4) at storage level
<b>Total formatted capacity</b>	76,032GB (Dynamic Provisioning database pool)
<b>Storage capacity utilization</b>	44%
<b>Database capacity utilization</b>	37%

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

<b>Disk type, speed and firmware revision</b>	SATA Disk 1TB 7.2K AD0A
<b>Raw capacity per disk (GB)</b>	1TB
<b>Number of spindles in test</b>	24 (Dynamic Provisioning pool)
<b>Total raw storage capacity (GB)</b>	24,000GB
<b>Disk slice size (GB)</b>	N/A
<b>Number of slices per LU or number of disks per LU</b>	N/A
<b>RAID level</b>	RAID 1+0 (4+4) at storage level
<b>Total formatted capacity</b>	8,448GB (Dynamic Provisioning log pool)

## Replication Configuration

The following tables summarize the replication environment.

**Table 11. Replicated Configuration**

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

**Table 12. Replicated Storage Hardware**

<b>Storage connectivity (Fibre Channel, SATA, SATA, iSCSI)</b>	Fibre Channel
<b>Storage model and OS/firmware revision</b>	1 Hitachi Adaptable Modular Storage 2300 Firmware: 0890/B-Y WHQL listing: <a href="#">Hitachi Adaptable Modular Storage 2300</a>
<b>Storage cache</b>	16GB
<b>Number of storage controllers</b>	2
<b>Number of storage ports</b>	8
<b>Maximum bandwidth of storage connectivity to host</b>	32Gb/s (8 x 4Gbit/s ports)
<b>Switch type/model/firmware revision</b>	Brocade 5320, Fabric OS v6.3.0b
<b>HBA model and firmware</b>	Emulex LPe11002, FW:2.80A4
<b>Number of HBAs per host</b>	2 dual-ported HBA per host, 1 4Gbit/s port used per HBA
<b>Host server type</b>	Sun Fire 4600 4 2.3Hz Quad-core AMD Opterno 8356 CPUs, 64GB memory
<b>Total number of disks tested in solution</b>	240
<b>Maximum number of spindles can be hosted in the storage</b>	240

**Table 13. Replicated Storage Software**

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

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

<b>Disk type, speed and firmware revision</b>	SATA Disk 1TB 7.2K AD0A
<b>Raw capacity per disk (GB)</b>	1TB
<b>Number of physical disks in test</b>	216 (Dynamic Provisioning pool)
<b>Total raw storage capacity (GB)</b>	216,000GB
<b>Disk slice size (GB)</b>	N/A
<b>Number of slices per LUN or number of disks per LUN</b>	N/A
<b>RAID level</b>	RAID 1+0 (4+4) at storage level
<b>Total formatted capacity</b>	76,032GB (Dynamic Provisioning database pool)
<b>Storage capacity utilization</b>	44%
<b>Database capacity utilization</b>	37%

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

<b>Disk type, speed and firmware revision</b>	SATA Disk 1TB 7.2K AD0A
<b>Raw capacity per disk (GB)</b>	1TB
<b>Number of spindles in test</b>	24 (Dynamic Provisioning pool)
<b>Total raw storage capacity (GB)</b>	24,000GB
<b>Disk slice size (GB)</b>	N/A
<b>Number of slices per LU or number of disks per LU</b>	N/A
<b>RAID level</b>	RAID 1+0 (4+4) at storage level
<b>Total formatted capacity</b>	8,448GB (Dynamic Provisioning log pool)

## Best Practices

Microsoft Exchange Server 2010 is a disk-intensive application. It presents two distinct workload patterns to the storage, with 32KB random read/write operations to the databases, and sequential write operations of varying size (between 512 bytes up to the log buffer size) to the transaction logs. For this reason, designing an optimal storage configuration can prove challenging in practice. Based on the testing run using the ESRP framework, Hitachi Data Systems recommends these best practices to improve the performance of the Hitachi Adaptable Modular Storage 2300 running Exchange 2010.

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

### Storage – Mailbox Resiliency

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

5. Use Hitachi Dynamic Provisioning software to simplify storage management of the Exchange database and log volumes.
6. Due to the difference in I/O patterns, isolate the Exchange database from the log groups. Create a dedicated Dynamic Provisioning pool for the databases and a separate pool for the logs.
7. Hitachi Data Systems recommends RAID-5 or RAID-1+0 groups for both the database pools and for the log pool. Use of RAID-1+0 allows more writes at a lower response time under heavier loads. RAID-1+0 also supports a shorter RAID group rebuild time on failure of a disk.
8. The Log LUs should be at least 10 percent of the size of the database LUs.
9. Hitachi Data Systems does not recommend LU concatenation.
10. Hitachi Data Systems recommends implementing Mailbox Resiliency using the Exchange Server 2010 Database Availability Group feature.
11. Ensure that each Database Availability Groups maintains at least two database copies to provide high availability.
12. Isolate active databases and their replicated copies in separate Dynamic Provisioning pools or ensure that they are located on a separate 2300.
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 Result Summary

This section provides a high-level summary of the test data from ESRP and the link to the detailed HTML reports that are generated by ESRP testing framework.

### Reliability

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

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

## Storage [Performance](#) Results

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

### *Individual Server Metrics*

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

**Table 16. Individual Server Metrics for Exchange Server (SUN21)**

Database I/O	
<i>Database disk transfers per second</i>	362
<i>Database disk reads per second</i>	218
<i>Database disk writes per second</i>	144
<i>Average database disk read latency (ms)</i>	16.5
<i>Average database disk write latency (ms)</i>	6.1
Transaction Log I/O	
<i>Log disk writes per second</i>	114
<i>Average log disk write latency (ms)</i>	3.4

**Table 17. Individual Server Metrics for Exchange Server (SUN22)**

Database I/O	
<i>Database disk transfers per second</i>	351
<i>Database disk reads per second</i>	211
<i>Database disk writes per second</i>	140
<i>Average database disk read latency (ms)</i>	17.1
<i>Average database disk write latency (ms)</i>	6.7
Transaction Log I/O	
<i>Log disk writes per second</i>	110
<i>Average log disk write latency (ms)</i>	3.7

Table 18. Individual Server Metrics for Exchange Server (SUN23)

Database I/O	
<i>Database disk transfers per second</i>	348
<i>Database disk reads per second</i>	209
<i>Database disk writes per second</i>	139
<i>Average database disk read latency (ms)</i>	17.1
<i>Average database disk write latency (ms)</i>	6.9
Transaction Log I/O	
<i>Log disk writes per second</i>	108
<i>Average log disk write latency (ms)</i>	3.9

Table 19. Individual Server Metrics for Exchange Server (SUN24)

Database I/O	
<i>Database disk transfers per second</i>	360
<i>Database disk reads per second</i>	216
<i>Database disk writes per second</i>	144
<i>Average database disk read latency (ms)</i>	16.8
<i>Average database disk write latency (ms)</i>	6.4
Transaction Log I/O	
<i>Log disk writes per second</i>	113
<i>Average log disk write latency (ms)</i>	3.5

Table 20. Individual Server Metrics for Exchange Server (SUN25)

Database I/O	
<i>Database disk transfers per second</i>	366
<i>Database disk reads per second</i>	220
<i>Database disk writes per second</i>	146
<i>Average database disk read latency (ms)</i>	16.8
<i>Average database disk write latency (ms)</i>	6.1
Transaction Log I/O	
<i>Log disk writes per second</i>	116
<i>Average log disk write latency (ms)</i>	3.1

**Table 21. Individual Server Metrics for Exchange Server (SUN26)**

<b>Database I/O</b>	
<i>Database disk transfers per second</i>	378
<i>Database disk reads per second</i>	227
<i>Database disk writes per second</i>	151
<i>Average database disk read latency (ms)</i>	16.5
<i>Average database disk write latency (ms)</i>	5.6
<b>Transaction Log I/O</b>	
<i>Log disk writes per second</i>	121
<i>Average log disk write latency (ms)</i>	2.8

**Table 22. Individual Server Metrics for Exchange Server (SUN27)**

<b>Database I/O</b>	
<i>Database disk transfers per second</i>	383
<i>Database disk reads per second</i>	230
<i>Database disk writes per second</i>	153
<i>Average database disk read latency (ms)</i>	16.2
<i>Average database disk write latency (ms)</i>	5.6
<b>Transaction Log I/O</b>	
<i>Log disk writes per second</i>	122
<i>Average log disk write latency (ms)</i>	2.8

**Table 23. Individual Server Metrics for Exchange Server (SUN28)**

<b>Database I/O</b>	
<i>Database disk transfers per second</i>	362
<i>Database disk reads per second</i>	218
<i>Database disk writes per second</i>	144
<i>Average database disk read latency (ms)</i>	16.6
<i>Average database disk write latency (ms)</i>	6.1
<b>Transaction Log I/O</b>	
<i>Log disk writes per second</i>	114
<i>Average log disk write latency (ms)</i>	3.4

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

Database I/O	
<i>Database disk transfers per second</i>	2910
<i>Database disk reads per second</i>	1749
<i>Database disk writes per second</i>	1161
<i>Average database disk read latency (ms)</i>	16.7
<i>Average database disk write latency (ms)</i>	6.2
Transaction Log I/O	
<i>Log disk writes per second</i>	918
<i>Average log disk write latency (ms)</i>	3.3

## Database Backup and Recovery Performance

This section has two tests: The first measures the sequential read rate of the database files and the second measures recovery/replay performance (playing transaction logs in to the database).

### Database Read-only Performance

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

**Table 25. Database Read-only Performance**

<i>MB read per second per database</i>	36.2
<i>MB read per second total per server</i>	181

### Transaction Log Recovery/Replay Performance

This test measures the maximum rate at which the log files can be played against the databases. The following table shows the average rate for 500 log files played in a single Database. Each log file was 1MB in size.

**Table 26. Transaction Log Recovery/Replay Performance**

<i>Average time to play one log file (sec)</i>	2.5
--	-----

## Conclusion

This document details a tested a robust Exchange Server 2010 Resiliency solution capable of supporting 20,000 users with a 0.12 IOPS per user profile and user mailbox size of 1GB using eight DAGs each configured with two server nodes. An Adaptable Modular Storage 2300, with 16GB of cache and eight 4Gbit/s Fibre Channel host paths, using Hitachi Dynamic Provisioning (with two pools) and 240 1TB 7.2K RPM SATA disks in a RAID-1+0 configuration was used for these tests. Testing confirmed that the 2300 is more than capable of delivering the IOPS and capacity requirements needed to support the active and replicated databases for 20,000 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 Adaptable Modular Storage RAID technology to provide high-availability and protection from logical and physical failures. Adding protection requirements can affect performance and capacity requirements of the underlying storage configuration, and as such needs to be factored into the storage design accordingly.

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

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

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

## Appendix — 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: SUN21

#### Test Summary

---

<b>Overall Test Result</b>	Pass
<b>Machine Name</b>	SUN21
<b>Test Description</b>	
<b>Test Start Time</b>	5/16/2010 11:44:18 AM
<b>Test End Time</b>	5/16/2010 6:09:14 PM
<b>Collection Start Time</b>	5/16/2010 11:49:04 AM
<b>Collection End Time</b>	5/16/2010 1:48:57 PM
<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:\ESRP\Performance Test\Performance_2010_5_16_11_44_30.blg C:\ESRP\Performance Test\DBCchecksum_2010_5_16_18_9_14.blg

---

#### Database Sizing and Throughput

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<b>Achieved Transactional I/O per Second</b>	362.75
<b>Target Transactional I/O per Second</b>	300
<b>Initial Database Size (bytes)</b>	4332472565760
<b>Final Database Size (bytes)</b>	4336046112768
<b>Database Files (Count)</b>	5

---

### *Jetstress System Parameters*

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<b><i>Thread Count</i></b>	3 (per database)
<b><i>Minimum Database Cache</i></b>	160.0 MB
<b><i>Maximum Database Cache</i></b>	1280.0 MB
<b><i>Insert Operations</i></b>	40%
<b><i>Delete Operations</i></b>	20%
<b><i>Replace Operations</i></b>	5%
<b><i>Read Operations</i></b>	35%
<b><i>Lazy Commits</i></b>	70%
<b><i>Run Background Database Maintenance</i></b>	True
<b><i>Number of Copies per Database</i></b>	2

---

### *Database Configuration*

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<b><i>Instance3868.1</i></b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b><i>Instance3868.2</i></b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b><i>Instance3868.3</i></b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b><i>Instance3868.4</i></b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb
<b><i>Instance3868.5</i></b>	Log Path: C:\logluns\log5 Database: C:\dbluns\db5\Jetstress005001.edb

---

### Transactional I/O Performance

<b>MSExchange Database =&gt; Instance</b>	<b>I/O Database Reads Average Latency (msec)</b>	<b>I/O Database Writes Average Latency (msec)</b>	<b>I/O Database Reads /sec</b>	<b>I/O Database Writes /sec</b>	<b>I/O Database Reads Average Bytes</b>	<b>I/O Database Writes Average Bytes</b>	<b>I/O Log Reads Average Latency (msec)</b>	<b>I/O Log Writes Average Latency (msec)</b>	<b>I/O Log Reads /sec</b>	<b>I/O Log Writes /sec</b>	<b>I/O Log Reads Average Bytes</b>	<b>I/O Log Writes Average Bytes</b>
Instance3868.1	16.107	6.722	43.010	28.440	35797.939	35258.818	0.000	3.459	0.000	22.661	0.000	4896.987
Instance3868.2	17.472	6.559	43.446	28.714	35409.384	35277.406	0.000	3.349	0.000	22.960	0.000	4844.481
Instance3868.3	15.813	6.281	43.914	29.168	35888.217	35320.139	0.000	3.457	0.000	23.009	0.000	4882.362
Instance3868.4	17.311	5.843	43.975	29.199	35385.732	35298.306	0.000	3.333	0.000	22.987	0.000	4955.190
Instance3868.5	15.826	5.446	43.770	29.113	35854.295	35272.841	0.000	3.473	0.000	23.041	0.000	4922.564

### Background Database Maintenance I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>Database Maintenance IO Reads/sec</b>	<b>Database Maintenance IO Reads Average Bytes</b>
Instance3868.1	24.459	261675.013
Instance3868.2	23.076	261677.855
Instance3868.3	24.299	261659.977
Instance3868.4	23.389	261629.329
Instance3868.5	24.288	261661.991

### Log Replication I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Log Reads/sec</b>	<b>I/O Log Reads Average Bytes</b>
Instance3868.1	0.448	174108.120
Instance3868.2	0.451	173691.537
Instance3868.3	0.457	173996.035
Instance3868.4	0.462	176622.672
Instance3868.5	0.460	176300.687

### Total I/O Performance

MSExchange => Instance	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s	I/O Database Writes/s	I/O Database Average Bytes	I/O Database Write Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s	I/O Log Writes/s	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 3868.1	16.107	6.722	67.469	28.440	117683.575	35258.818	6.280	3.459	0.448	22.661	174108.120	4896.987
Instance 3868.2	17.472	6.559	66.522	28.714	113900.581	35277.406	4.205	3.349	0.451	22.960	173691.537	4844.481
Instance 3868.3	15.813	6.281	68.213	29.168	116312.461	35320.139	5.985	3.457	0.457	23.009	173996.035	4882.362
Instance 3868.4	17.311	5.843	67.363	29.199	113937.732	35298.306	4.024	3.333	0.462	22.987	176622.672	4955.190
Instance 3868.5	15.826	5.446	68.059	29.113	116439.544	35272.841	6.695	3.473	0.460	23.041	176300.687	4922.564

### Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.788	0.434	1.192
Available MBytes	60609.113	60596.000	60724.000
Free System Page Table Entries	33555587.994	33555586.000	33555588.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	102777900.894	102744064.000	102813696.000
Pool Paged Bytes	123492604.259	123420672.000	123625472.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

### Test Log

```

5/16/2010 11:44:18 AM -- Jetstress testing begins ...
5/16/2010 11:44:18 AM -- Prepare testing begins ...
5/16/2010 11:44:23 AM -- Attaching databases ...
5/16/2010 11:44:23 AM -- Prepare testing ends.
5/16/2010 11:44:23 AM -- Dispatching transactions begins ...
5/16/2010 11:44:23 AM -- Database cache settings: (minimum: 160.0 MB,
maximum: 1.2 GB)
5/16/2010 11:44:23 AM -- Database flush thresholds: (start: 12.8 MB, stop:
25.6 MB)
5/16/2010 11:44:30 AM -- Database read latency thresholds: (average: 20
msec/read, maximum: 100 msec/read).
5/16/2010 11:44:30 AM -- Log write latency thresholds: (average: 10
msec/write, maximum: 100 msec/write).
5/16/2010 11:44:38 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%,
Replaces 5%, Reads 35%, Lazy Commits 70%.
5/16/2010 11:44:38 AM -- Performance logging begins (interval: 15000 ms).
5/16/2010 11:44:38 AM -- Attaining prerequisites:
5/16/2010 11:49:04 AM -- \MSExchange Database(JetstressWin)\Database Cache

```

Size, Last: 1212015000.0 (lower bound: 1207960000.0, upper bound: none)  
5/16/2010 1:49:05 PM -- Performance logging ends.  
5/16/2010 6:08:54 PM -- JetInterop batch transaction stats: 50426, 50799, 50605, 50457 and 50535.  
5/16/2010 6:08:58 PM -- Dispatching transactions ends.  
5/16/2010 6:08:58 PM -- Shutting down databases ...  
5/16/2010 6:09:14 PM -- Instance3868.1 (complete), Instance3868.2 (complete), Instance3868.3 (complete), Instance3868.4 (complete) and Instance3868.5 (complete)  
5/16/2010 6:09:15 PM -- Performance logging begins (interval: 30000 ms).  
5/16/2010 6:09:15 PM -- Verifying database checksums ...  
5/17/2010 3:23:47 AM -- C:\db\uns\db1 (100% processed), C:\db\uns\db2 (100% processed), C:\db\uns\db3 (100% processed), C:\db\uns\db4 (100% processed) and C:\db\uns\db5 (100% processed)  
5/17/2010 3:23:47 AM -- Performance logging ends.  
5/17/2010 3:23:47 AM -- C:\ESRP\Performance  
Test\DBChecksum\_2010\_5\_16\_18\_9\_14.blg has 1107 samples.  
5/17/2010 3:23:56 AM -- C:\ESRP\Performance  
Test\DBChecksum\_2010\_5\_16\_18\_9\_14.html is saved.  
5/17/2010 3:23:56 AM -- Verifying log checksums ...  
5/17/2010 3:24:00 AM -- C:\log\uns\log1 (8 log(s) processed), C:\log\uns\log2 (7 log(s) processed), C:\log\uns\log3 (7 log(s) processed), C:\log\uns\log4 (8 log(s) processed) and C:\log\uns\log5 (8 log(s) processed)  
5/17/2010 3:24:00 AM -- C:\ESRP\Performance  
Test\Performance\_2010\_5\_16\_11\_44\_30.blg has 496 samples.  
5/17/2010 3:24:00 AM -- Creating test report ...  
5/17/2010 3:24:04 AM -- Instance3868.1 has 16.1 for I/O Database Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.1 has 3.5 for I/O Log Writes Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.1 has 3.5 for I/O Log Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.2 has 17.5 for I/O Database Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.2 has 3.3 for I/O Log Writes Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.2 has 3.3 for I/O Log Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.3 has 15.8 for I/O Database Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.3 has 3.5 for I/O Log Writes Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.3 has 3.5 for I/O Log Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.4 has 17.3 for I/O Database Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.4 has 3.3 for I/O Log Writes Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.4 has 3.3 for I/O Log Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.5 has 15.8 for I/O Database Reads Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.5 has 3.5 for I/O Log Writes Average Latency.  
5/17/2010 3:24:04 AM -- Instance3868.5 has 3.5 for I/O Log Reads Average Latency.  
5/17/2010 3:24:04 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
5/17/2010 3:24:04 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
5/17/2010 3:24:04 AM -- C:\ESRP\Performance  
Test\Performance\_2010\_5\_16\_11\_44\_30.xml has 478 samples queried.

## Performance Test Database Checksums Results: SUN21

### Checksum Statistics - All

<i>Database</i>	<i>Seen pages</i>	<i>Bad pages</i>	<i>Correctable pages</i>	<i>Wrong page-number pages</i>	<i>File length / seconds taken</i>
C:\dbluns\db1\Jetstress001001.edb	26465330	0	0	0	827041 MBytes / 30834 sec
C:\dbluns\db2\Jetstress002001.edb	26464818	0	0	0	827025 MBytes / 33271 sec
C:\dbluns\db3\Jetstress003001.edb	26464562	0	0	0	827017 MBytes / 30751 sec
C:\dbluns\db4\Jetstress004001.edb	26465842	0	0	0	827057 MBytes / 32782 sec
C:\dbluns\db5\Jetstress005001.edb	26465074	0	0	0	827033 MBytes / 30774 sec
(Sum)	132325626	0	0	0	4135175 MBytes / 33271 sec

### Disk Subsystem Performance of Checksum

<i>Logical Disk</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>
C:\dbluns\db1	0.116	0.000	428.060	0.000	65536.000
C:\dbluns\db2	0.123	0.000	395.918	0.000	65536.000
C:\dbluns\db3	0.116	0.000	430.366	0.000	65536.000
C:\dbluns\db4	0.122	0.000	401.955	0.000	65536.000
C:\dbluns\db5	0.115	0.000	429.495	0.000	65536.000

### Memory System Performance of Checksum

<i>Counter</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>
% Processor Time	2.014	0.318	3.694
Available MBytes	61944.229	61928.000	61966.000
Free System Page Table Entries	33555587.997	33555586.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	102903808.000	102748160.000	103219200.000
Pool Paged Bytes	123463578.248	123244544.000	124063744.000

### Test Log

```

5/16/2010 11: 44: 18 AM -- Jetstress testing begins ...
5/16/2010 11: 44: 18 AM -- Prepare testing begins ...
5/16/2010 11: 44: 23 AM -- Attaching databases ...
5/16/2010 11: 44: 23 AM -- Prepare testing ends.
5/16/2010 11: 44: 23 AM -- Dispatching transactions begins ...
5/16/2010 11: 44: 23 AM -- Database cache settings: (minimum: 160.0 MB,
maximum: 1.2 GB)

```

5/16/2010 11:44:23 AM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)  
5/16/2010 11:44:30 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).  
5/16/2010 11:44:30 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).  
5/16/2010 11:44:38 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.  
5/16/2010 11:44:38 AM -- Performance logging begins (interval: 15000 ms).  
5/16/2010 11:44:38 AM -- Attaining prerequisites:  
5/16/2010 11:49:04 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1212015000.0 (lower bound: 1207960000.0, upper bound: none)  
5/16/2010 1:49:05 PM -- Performance logging ends.  
5/16/2010 6:08:54 PM -- JetInterop batch transaction stats: 50426, 50799, 50605, 50457 and 50535.  
5/16/2010 6:08:58 PM -- Dispatching transactions ends.  
5/16/2010 6:08:58 PM -- Shutting down databases ...  
5/16/2010 6:09:14 PM -- Instance3868.1 (complete), Instance3868.2 (complete), Instance3868.3 (complete), Instance3868.4 (complete) and Instance3868.5 (complete)  
5/16/2010 6:09:15 PM -- Performance logging begins (interval: 30000 ms).  
5/16/2010 6:09:15 PM -- Verifying database checksums ...  
5/17/2010 3:23:47 AM -- C:\db\uns\db1 (100% processed), C:\db\uns\db2 (100% processed), C:\db\uns\db3 (100% processed), C:\db\uns\db4 (100% processed) and C:\db\uns\db5 (100% processed)  
5/17/2010 3:23:47 AM -- Performance logging ends.  
5/17/2010 3:23:47 AM -- C:\ESRP\Performance Test\DBChecksum\_2010\_5\_16\_18\_9\_14.blg has 1107 samples.

## Stress Test Database Performance Results: SUN21

### Test Summary

<b>Overall Test Result</b>	Pass
<b>Machine Name</b>	SUN21
<b>Test Description</b>	
<b>Test Start Time</b>	5/14/2010 11:40:42 AM
<b>Test End Time</b>	5/15/2010 9:31:09 PM
<b>Collection Start Time</b>	5/14/2010 11:45:49 AM
<b>Collection End Time</b>	5/15/2010 11:45:43 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:\ESRP\Stress Test\Stress_2010_5_14_11_40_55.blg C:\ESRP\Stress Test\DBChecksum_2010_5_15_21_31_9.blg

### Database Sizing and Throughput

<b>Achieved Transactional I/O per Second</b>	349.9
<b>Target Transactional I/O per Second</b>	300
<b>Initial Database Size (bytes)</b>	4314034405376
<b>Final Database Size (bytes)</b>	4332472565760
<b>Database Files (Count)</b>	5

### *Jetstress System Parameters*

---

<b>Thread Count</b>	3 (per database)
<b>Minimum Database Cache</b>	160.0 MB
<b>Maximum Database Cache</b>	1280.0 MB
<b>Insert Operations</b>	40%
<b>Delete Operations</b>	20%
<b>Replace Operations</b>	5%
<b>Read Operations</b>	35%
<b>Lazy Commits</b>	70%
<b>Run Background Database Maintenance</b>	True
<b>Number of Copies per Database</b>	2

---

### *Database Configuration*

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<b>Instance3868.1</b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b>Instance3868.2</b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b>Instance3868.3</b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b>Instance3868.4</b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb
<b>Instance3868.5</b>	Log Path: C:\logluns\log5 Database: C:\dbluns\db5\Jetstress005001.edb

---

### Transactional I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Database Reads /sec</b>	<b>I/O Database Writes /sec</b>	<b>I/O Database Reads /sec</b>	<b>I/O Database Writes /sec</b>	<b>I/O Database Reads Average Bytes</b>	<b>I/O Database Writes Average Bytes</b>	<b>I/O Log Reads Average Latency (msec)</b>	<b>I/O Log Writes Average Latency (msec)</b>	<b>I/O Log Reads /sec</b>	<b>I/O Log Writes /sec</b>	<b>I/O Log Reads Average Bytes</b>	<b>I/O Log Writes Average Bytes</b>
Instance3868.1	17.000	6.975	42.139	27.882	35673.869	35476.297	0.000	3.583	0.000	22.264	0.000	4899.190
Instance3868.2	17.296	6.740	42.089	27.836	35723.558	35517.213	0.000	3.537	0.000	22.268	0.000	4919.992
Instance3868.3	16.780	6.556	42.201	27.906	35715.198	35479.514	0.000	3.574	0.000	22.268	0.000	4888.701
Instance3868.4	17.272	6.073	42.138	27.893	35739.399	35507.457	0.000	3.543	0.000	22.240	0.000	4915.507
Instance3868.5	16.813	5.832	42.022	27.792	35851.811	35495.498	0.000	3.559	0.000	22.241	0.000	4912.307

### Background Database Maintenance I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>Database Maintenance IO Reads/sec</b>	<b>Database Maintenance IO Reads Average Bytes</b>
Instance3868.1	23.917	261610.463
Instance3868.2	23.333	261585.837
Instance3868.3	23.808	261599.411
Instance3868.4	23.352	261618.032
Instance3868.5	23.752	261605.922

### Log Replication I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Log Reads/sec</b>	<b>I/O Log Reads Average Bytes</b>
Instance3868.1	0.444	170686.428
Instance3868.2	0.445	171095.500
Instance3868.3	0.442	169763.389
Instance3868.4	0.444	170559.288
Instance3868.5	0.444	171091.264

## Total I/O Performance

MSExchange => Instances	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s	I/O Database Writes/s	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads Average Latency (msec)	I/O Log Writes Average Latency (msec)	I/O Log Reads/s	I/O Log Writes/s	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 3868.1	17.000	6.975	66.056	27.882	11747.9225	35476.297	5.856	3.583	0.444	22.264	17068.6428	4899.190
Instance 3868.2	17.296	6.740	65.422	27.836	11627.8500	35517.213	4.822	3.537	0.445	22.268	17109.5500	4919.992
Instance 3868.3	16.780	6.556	66.009	27.906	11718.5959	35479.514	5.767	3.574	0.442	22.268	16976.3389	4888.701
Instance 3868.4	17.272	6.073	65.490	27.893	11628.1005	35507.457	4.631	3.543	0.444	22.240	17055.9288	4915.507
Instance 3868.5	16.813	5.832	65.775	27.792	11737.4768	35495.498	5.728	3.559	0.444	22.241	17109.1264	4912.307

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	0.758	0.304	7.177
Available MBytes	60631.368	60601.000	60707.000
Free System Page Table Entries	33555587.987	33555584.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	102595107.916	102551552.000	102707200.000
Pool Paged Bytes	119912240.170	119066624.000	123015168.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

```

5/14/2010 11: 40: 42 AM -- Jetstress testing begins ...
5/14/2010 11: 40: 42 AM -- Prepare testing begins ...
5/14/2010 11: 40: 48 AM -- Attaching databases ...
5/14/2010 11: 40: 48 AM -- Prepare testing ends.
5/14/2010 11: 40: 48 AM -- Dispatching transactions begins ...
5/14/2010 11: 40: 48 AM -- Database cache settings: (minimum: 160.0 MB,
maximum: 1.2 GB)
5/14/2010 11: 40: 48 AM -- Database flush thresholds: (start: 12.8 MB, stop:
25.6 MB)
5/14/2010 11: 40: 55 AM -- Database read latency thresholds: (average: 20
msec/read, maximum: 200 msec/read).
5/14/2010 11: 40: 55 AM -- Log write latency thresholds: (average: 10
msec/write, maximum: 200 msec/write).
5/14/2010 11: 41: 02 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%,
Replaces 5%, Reads 35%, Lazy Commits 70%.
5/14/2010 11: 41: 02 AM -- Performance logging begins (interval: 15000 ms).
5/14/2010 11: 41: 02 AM -- Attaining prerequisites:
5/14/2010 11: 45: 49 AM -- \MSExchange Database(JetstressWin)\Database Cache

```

Size, Last: 1210003000.0 (lower bound: 1207960000.0, upper bound: none)  
5/15/2010 11:45:50 AM -- Performance logging ends.  
5/15/2010 9:31:05 PM -- JetInterop batch transaction stats: 261165, 261389, 261689, 261341 and 261167.  
5/15/2010 9:31:05 PM -- Dispatching transactions ends.  
5/15/2010 9:31:05 PM -- Shutting down databases ...  
5/15/2010 9:31:09 PM -- Instance3868.1 (complete), Instance3868.2 (complete), Instance3868.3 (complete), Instance3868.4 (complete) and Instance3868.5 (complete)  
5/15/2010 9:31:10 PM -- Performance logging begins (interval: 30000 ms).  
5/15/2010 9:31:10 PM -- Verifying database checksums ...  
5/16/2010 7:07:31 AM -- C:\db\uns\db1 (100% processed), C:\db\uns\db2 (100% processed), C:\db\uns\db3 (100% processed), C:\db\uns\db4 (100% processed) and C:\db\uns\db5 (100% processed)  
5/16/2010 7:07:31 AM -- Performance logging ends.  
5/16/2010 7:07:31 AM -- C:\ESRP\Stress Test\DBChecksum\_2010\_5\_15\_21\_31\_9.blg has 1151 samples.  
5/16/2010 7:07:41 AM -- C:\ESRP\Stress Test\DBChecksum\_2010\_5\_15\_21\_31\_9.html is saved.  
5/16/2010 7:07:41 AM -- Verifying log checksums ...  
5/16/2010 7:07:42 AM -- C:\log\uns\log1 (8 log(s) processed), C:\log\uns\log2 (9 log(s) processed), C:\log\uns\log3 (9 log(s) processed), C:\log\uns\log4 (9 log(s) processed) and C:\log\uns\log5 (8 log(s) processed)  
5/16/2010 7:07:42 AM -- C:\ESRP\Stress Test\Stress\_2010\_5\_14\_11\_40\_55.blg has 5764 samples.  
5/16/2010 7:07:42 AM -- Creating test report ...  
5/16/2010 7:08:24 AM -- Instance3868.1 has 17.0 for I/O Database Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.1 has 3.6 for I/O Log Writes Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.1 has 3.6 for I/O Log Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.2 has 17.3 for I/O Database Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.2 has 3.5 for I/O Log Writes Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.2 has 3.5 for I/O Log Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.3 has 16.8 for I/O Database Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.3 has 3.6 for I/O Log Writes Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.3 has 3.6 for I/O Log Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.4 has 17.3 for I/O Database Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.4 has 3.5 for I/O Log Writes Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.4 has 3.5 for I/O Log Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.5 has 16.8 for I/O Database Reads Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.5 has 3.6 for I/O Log Writes Average Latency.  
5/16/2010 7:08:24 AM -- Instance3868.5 has 3.6 for I/O Log Reads Average Latency.  
5/16/2010 7:08:24 AM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
5/16/2010 7:08:24 AM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
5/16/2010 7:08:24 AM -- C:\ESRP\Stress Test\Stress\_2010\_5\_14\_11\_40\_55.xml has 5744 samples queried.

## Stress Test Results Database Checksums: SUN21

### Checksum Statistics - All

<b>Database</b>	<b>Seen pages</b>	<b>Bad pages</b>	<b>Correctable pages</b>	<b>Wrong page-number pages</b>	<b>File length / seconds taken</b>
C:\dbluns\db1\Jetstress001001.edb	26443570	0	0	0	826361 MBytes / 34494 sec
C:\dbluns\db2\Jetstress002001.edb	26443058	0	0	0	826345 MBytes / 27833 sec
C:\dbluns\db3\Jetstress003001.edb	26442802	0	0	0	826337 MBytes / 34481 sec
C:\dbluns\db4\Jetstress004001.edb	26443826	0	0	0	826369 MBytes / 27738 sec
C:\dbluns\db5\Jetstress005001.edb	26443314	0	0	0	826353 MBytes / 34581 sec
(Sum)	132216570	0	0	0	4131767 MBytes / 34581 sec

### Disk Subsystem Performance of Checksum

<b>Logical Disk</b>	<b>Avg. Disk sec/Read</b>	<b>Avg. Disk sec/Write</b>	<b>Disk Reads/sec</b>	<b>Disk Writes/sec</b>	<b>Avg. Disk Bytes/Read</b>
C:\dbluns\db1	0.124	0.000	383.400	0.000	65536.000
C:\dbluns\db2	0.107	0.000	474.929	0.000	65536.000
C:\dbluns\db3	0.124	0.000	383.660	0.000	65536.000
C:\dbluns\db4	0.106	0.000	476.613	0.000	65536.000
C:\dbluns\db5	0.123	0.000	381.811	0.000	65536.000

### Memory System Performance of Checksum

<b>Counter</b>	<b>Average</b>	<b>Minimum</b>	<b>Maximum</b>
% Processor Time	1.930	0.792	5.493
Available MBytes	61960.177	61946.000	61972.000
Free System Page Table Entries	33555588.003	33555586.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	103183983.652	102981632.000	103489536.000
Pool Paged Bytes	119801914.718	119042048.000	120180736.000

### Test Log

5/14/2010 11: 40: 42 AM -- Jetstress testing begins ...  
5/14/2010 11: 40: 42 AM -- Prepare testing begins ...  
5/14/2010 11: 40: 48 AM -- Attaching databases ...  
5/14/2010 11: 40: 48 AM -- Prepare testing ends.  
5/14/2010 11: 40: 48 AM -- Dispatching transactions begins ...  
5/14/2010 11: 40: 48 AM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)

5/14/2010 11:40:48 AM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)  
5/14/2010 11:40:55 AM -- Database read latency thresholds: (average: 20 msec/read, maximum: 200 msec/read).  
5/14/2010 11:40:55 AM -- Log write latency thresholds: (average: 10 msec/write, maximum: 200 msec/write).  
5/14/2010 11:41:02 AM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.  
5/14/2010 11:41:02 AM -- Performance logging begins (interval: 15000 ms).  
5/14/2010 11:41:02 AM -- Attaining prerequisites:  
5/14/2010 11:45:49 AM -- \MSEExchange Database(JetstressWin)\Database Cache Size, Last: 1210003000.0 (lower bound: 1207960000.0, upper bound: none)  
5/15/2010 11:45:50 AM -- Performance logging ends.  
5/15/2010 9:31:05 PM -- JetInterop batch transaction stats: 261165, 261389, 261689, 261341 and 261167.  
5/15/2010 9:31:05 PM -- Dispatching transactions ends.  
5/15/2010 9:31:05 PM -- Shutting down databases ...  
5/15/2010 9:31:09 PM -- Instance3868.1 (complete), Instance3868.2 (complete), Instance3868.3 (complete), Instance3868.4 (complete) and Instance3868.5 (complete)  
5/15/2010 9:31:10 PM -- Performance logging begins (interval: 30000 ms).  
5/15/2010 9:31:10 PM -- Verifying database checksums ...  
5/16/2010 7:07:31 AM -- C:\dbluns\db1 (100% processed), C:\dbluns\db2 (100% processed), C:\dbluns\db3 (100% processed), C:\dbluns\db4 (100% processed) and C:\dbluns\db5 (100% processed)  
5/16/2010 7:07:31 AM -- Performance logging ends.  
5/16/2010 7:07:31 AM -- C:\ESRP\Stress Test\DBChecksum\_2010\_5\_15\_21\_31\_9.blg has 1151 samples.

## Database Backup Test Result: SUN21

### Database Backup Statistics - All

Database Instance	Database Size (MBytes)	Elapsed Backup Time	MBytes Transferred/sec
Instance2420.1	827329.59	07:31:25	30.54
Instance2420.2	827313.59	03:24:05	67.56
Instance2420.3	827305.59	03:23:16	67.83
Instance2420.4	827345.59	10:09:59	22.61
Instance2420.5	827329.59	04:50:14	47.51

### Jetstress System Parameters

<b>Thread Count</b>	3 (per database)
<b>Minimum Database Cache</b>	160.0 MB
<b>Maximum Database Cache</b>	1280.0 MB
<b>Insert Operations</b>	40%
<b>Delete Operations</b>	20%
<b>Replace Operations</b>	5%
<b>Read Operations</b>	35%
<b>Lazy Commits</b>	70%

## Database Configuration

<b>Instance2420.1</b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b>Instance2420.2</b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b>Instance2420.3</b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b>Instance2420.4</b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb
<b>Instance2420.5</b>	Log Path: C:\logluns\log5 Database: C:\dbluns\db5\Jetstress005001.edb

## Transactional I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Data base Read s Average Latency (msec)</b>	<b>I/O Data base Write s Average Latency (msec)</b>	<b>I/O Datab ase Reads /sec</b>	<b>I/O Datab ase Writes /sec</b>	<b>I/O Datab ase Reads Average Bytes</b>	<b>I/O Data base Write s Average Bytes</b>	<b>I/O Log Rea ds Aver age Late ncy (msec)</b>	<b>I/O Log Writ es Aver age Late ncy (msec)</b>	<b>I/O Log Reads /sec</b>	<b>I/O Log Writes /sec</b>	<b>I/O Log Rea ds Aver age Byte s</b>	<b>I/O Log Writ es Aver age Byte s</b>
Instance 2420.1	15.698	0.000	122.128	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2420.2	6.156	0.000	270.103	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2420.3	6.164	0.000	271.336	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2420.4	24.912	0.000	90.431	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Instance 2420.5	10.117	0.000	189.867	0.000	262144.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

## Host System Performance

<b>Counter</b>	<b>Average</b>	<b>Minimum</b>	<b>Maximum</b>
% Processor Time	0.784	0.019	5.340
Available MBytes	62140.626	62119.000	62150.000
Free System Page Table Entries	33555587.989	33555556.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	105396950.384	105312256.000	108802048.000
Pool Paged Bytes	81348275.074	78016512.000	82554880.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/17/2010 11:55:40 PM -- Jetstress testing begins ...  
5/17/2010 11:55:40 PM -- Prepare testing begins ...  
5/17/2010 11:55:46 PM -- Attaching databases ...  
5/17/2010 11:55:46 PM -- Prepare testing ends.  
5/17/2010 11:55:56 PM -- Performance Logging begins (interval: 30000 ms).  
5/17/2010 11:55:56 PM -- Backing up databases ...  
5/18/2010 10:05:55 AM -- Performance Logging ends.  
5/18/2010 10:05:55 AM -- Instance2420.1 (100% processed), Instance2420.2  
(100% processed), Instance2420.3 (100% processed), Instance2420.4 (100%  
processed) and Instance2420.5 (100% processed)  
5/18/2010 10:05:55 AM -- C:\ESRP\Database Backup  
Test\DatabaseBackup\_2010\_5\_17\_23\_55\_46.blg has 1218 samples.  
5/18/2010 10:05:55 AM -- Creating test report ...

## Soft Recovery Test: SUN21

### Soft Recovery Statistics - All

Database Instance	Log files replayed	Elapsed seconds
Instance2420.1	508	1485.042
Instance2420.2	500	1449.24
Instance2420.3	511	1473.6384
Instance2420.4	515	1051.362
Instance2420.5	513	1460.3784

### Database Configuration

<b>Instance2420.1</b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b>Instance2420.2</b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b>Instance2420.3</b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b>Instance2420.4</b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb
<b>Instance2420.5</b>	Log Path: C:\logluns\log5 Database: C:\dbluns\db5\Jetstress005001.edb

### Transactional I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Database Reads</b>	<b>I/O Database Writes</b>	<b>I/O Database Reads/s/sec</b>	<b>I/O Database Writes/s/sec</b>	<b>I/O Database Reads Average Bytes</b>	<b>I/O Database Writes Average Bytes</b>	<b>I/O Log Reads Average Latency (msec)</b>	<b>I/O Log Writes Average Latency (msec)</b>	<b>I/O Log Reads/s/sec</b>	<b>I/O Log Writes/s/sec</b>	<b>I/O Log Reads Average Bytes</b>	<b>I/O Log Writes Average Bytes</b>
Instance 2420.1	41.409	23.407	371.786	2.035	36931.063	30089.417	10.129	0.000	3.053	0.000	208276.580	0.000
Instance 2420.2	42.325	24.330	383.602	2.072	36667.234	30394.830	6.154	0.018	3.108	0.002	206410.313	1.426
Instance 2420.3	42.449	24.362	382.430	2.083	36567.058	30523.616	10.551	0.018	3.125	0.002	208830.024	1.403
Instance 2420.4	32.838	19.198	512.947	2.942	36386.564	32641.969	6.937	0.000	4.412	0.000	230831.944	0.000
Instance 2420.5	42.958	22.458	383.218	2.106	36550.391	30589.518	12.032	0.000	3.159	0.000	214660.443	0.000

### Background Database Maintenance I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>Database Maintenance IO Reads/sec</b>	<b>Database Maintenance IO Reads Average Bytes</b>
Instance2420.1	21.439	261777.134
Instance2420.2	20.854	261639.076
Instance2420.3	21.522	261545.478
Instance2420.4	23.826	261583.924
Instance2420.5	21.118	261688.984

## Total I/O Performance

MSExchange => Instance	I/O Database Reads Average Latency (msec)	I/O Database Writes Average Latency (msec)	I/O Database Reads/s	I/O Database Writes/s	I/O Database Reads Average Bytes	I/O Database Writes Average Bytes	I/O Log Reads	I/O Log Writes	I/O Log Reads/s	I/O Log Writes/s	I/O Log Reads Average Bytes	I/O Log Writes Average Bytes
Instance 2420.1	41.409	23.407	393.225	2.035	49189.839	30089.417	10.129	0.000	3.053	0.000	208276.580	0.000
Instance 2420.2	42.325	24.330	404.456	2.072	48267.040	30394.830	6.154	0.018	3.108	0.002	206410.313	1.426
Instance 2420.3	42.449	24.362	403.952	2.083	48553.795	30523.616	10.551	0.018	3.125	0.002	208830.024	1.403
Instance 2420.4	32.838	19.198	536.774	2.942	46382.537	32641.969	6.937	0.000	4.412	0.000	230831.944	0.000
Instance 2420.5	42.958	22.458	404.336	2.106	48309.083	30589.518	12.032	0.000	3.159	0.000	214660.443	0.000

## Host System Performance

Counter	Average	Minimum	Maximum
% Processor Time	1.901	0.508	3.003
Available MBytes	60808.622	60783.000	61969.000
Free System Page Table Entries	33555589.989	33555588.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	107930913.391	106147840.000	108625920.000
Pool Paged Bytes	82169766.957	82149376.000	82251776.000
Database Page Fault Stalls/sec	0.001	0.000	0.248

## Test Log

```

5/18/2010 8:46:41 PM -- Jetstress testing begins ...
5/18/2010 8:46:41 PM -- Prepare testing begins ...
5/18/2010 8:46:46 PM -- Attaching databases ...
5/18/2010 8:46:46 PM -- Prepare testing ends.
5/18/2010 8:46:46 PM -- Dispatching transactions begins ...
5/18/2010 8:46:46 PM -- Database cache settings: (minimum: 160.0 MB, maximum:
1.2 GB)
5/18/2010 8:46:46 PM -- Database flush thresholds: (start: 12.8 MB, stop:
25.6 MB)
5/18/2010 8:46:54 PM -- Database read latency thresholds: (average: 20
msec/read, maximum: 100 msec/read).
5/18/2010 8:46:54 PM -- Log write latency thresholds: (average: 10
msec/write, maximum: 100 msec/write).
5/18/2010 8:46:58 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%,
Replaces 5%, Reads 35%, Lazy Commits 70%.
5/18/2010 8:46:58 PM -- Performance logging begins (interval: 15000 ms).
5/18/2010 8:46:58 PM -- Generating log files ...
5/18/2010 11:16:43 PM -- C:\log\uns\log1 (101.8% generated), C:\log\uns\log2

```

(100.2% generated), C:\logluns\log3 (102.4% generated), C:\logluns\log4 (103.2% generated) and C:\logluns\log5 (102.8% generated)  
5/18/2010 11:16:43 PM -- Performance logging ends.  
5/18/2010 11:16:43 PM -- JetInterop batch transaction stats: 21952, 21591, 21794, 21971 and 22096.  
5/18/2010 11:16:44 PM -- Dispatching transactions ends.  
5/18/2010 11:16:44 PM -- Shutting down databases ...  
5/18/2010 11:16:47 PM -- Instance2420.1 (complete), Instance2420.2 (complete), Instance2420.3 (complete), Instance2420.4 (complete) and Instance2420.5 (complete)  
5/18/2010 11:16:47 PM -- C:\ESRP\Soft Recovery Test\Performance\_2010\_5\_18\_20\_46\_54.blg has 598 samples.  
5/18/2010 11:16:47 PM -- Creating test report ...  
5/18/2010 11:16:50 PM -- Instance2420.1 has 18.3 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.1 has 2.8 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.1 has 2.8 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.2 has 17.6 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.2 has 2.5 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.2 has 2.5 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.3 has 17.7 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.3 has 2.8 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.3 has 2.8 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 15.3 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 2.4 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 2.4 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 17.7 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 2.8 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 2.8 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
5/18/2010 11:16:50 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.  
5/18/2010 11:16:50 PM -- C:\ESRP\Soft Recovery Test\Performance\_2010\_5\_18\_20\_46\_54.xml has 597 samples queried.  
5/18/2010 11:16:51 PM -- C:\ESRP\Soft Recovery Test\Performance\_2010\_5\_18\_20\_46\_54.html is saved.  
5/18/2010 11:19:50 PM -- Performance logging begins (interval: 4000 ms).  
5/18/2010 11:19:50 PM -- Recovering databases ...  
5/18/2010 11:44:35 PM -- Performance logging ends.  
5/18/2010 11:44:35 PM -- Instance2420.1 (1485.042), Instance2420.2 (1449.24), Instance2420.3 (1473.6384), Instance2420.4 (1051.362) and Instance2420.5 (1460.3784)  
5/18/2010 11:44:36 PM -- C:\ESRP\Soft Recovery Test\SoftRecovery\_2010\_5\_18\_23\_19\_45.blg has 368 samples.  
5/18/2010 11:44:36 PM -- Creating test report ...

# Soft Recovery Test Performance Result: SUN21

## Test Summary

---

<b>Overall Test Result</b>	Pass
<b>Machine Name</b>	SUN21
<b>Test Description</b>	
<b>Test Start Time</b>	5/18/2010 8:46:41 PM
<b>Test End Time</b>	5/18/2010 11:16:47 PM
<b>Collection Start Time</b>	5/18/2010 8:47:13 PM
<b>Collection End Time</b>	5/18/2010 11:16:42 PM
<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:\ESRP\Soft Recovery Test\Performance_2010_5_18_20_46_54.blg

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## Database Sizing and Throughput

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<b>Achieved Transactional I/O per Second</b>	399.835
<b>Capacity Percentage</b>	100%
<b>Throughput Percentage</b>	100%
<b>Initial Database Size (bytes)</b>	4337564450816
<b>Final Database Size (bytes)</b>	4339200229376
<b>Database Files (Count)</b>	5

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## Jetstress System Parameters

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<b>Thread Count</b>	3 (per database)
<b>Minimum Database Cache</b>	160.0 MB
<b>Maximum Database Cache</b>	1280.0 MB
<b>Insert Operations</b>	40%
<b>Delete Operations</b>	20%
<b>Replace Operations</b>	5%
<b>Read Operations</b>	35%
<b>Lazy Commits</b>	70%

---

## Database Configuration

<b>Instance2420.1</b>	Log Path: C:\logluns\log1 Database: C:\dbluns\db1\Jetstress001001.edb
<b>Instance2420.2</b>	Log Path: C:\logluns\log2 Database: C:\dbluns\db2\Jetstress002001.edb
<b>Instance2420.3</b>	Log Path: C:\logluns\log3 Database: C:\dbluns\db3\Jetstress003001.edb
<b>Instance2420.4</b>	Log Path: C:\logluns\log4 Database: C:\dbluns\db4\Jetstress004001.edb
<b>Instance2420.5</b>	Log Path: C:\logluns\log5 Database: C:\dbluns\db5\Jetstress005001.edb

## Transactional I/O Performance

<b>MSExchange Database =&gt; Instances</b>	<b>I/O Data base Read s Average Latency (msec)</b>	<b>I/O Data base Write s Average Latency (msec)</b>	<b>I/O Datab ase Reads /sec</b>	<b>I/O Datab ase Writes /sec</b>	<b>I/O Datab ase Read s Average Bytes</b>	<b>I/O Datab ase Write s Average Bytes</b>	<b>I/O Log Rea ds Aver age Late ncy (msec)</b>	<b>I/O Log Writ es Aver age Late ncy (msec)</b>	<b>I/O Log Reads /sec</b>	<b>I/O Log Writes /sec</b>	<b>I/O Log Rea ds Aver age Byte s</b>	<b>I/O Log Write s Aver age Byte s</b>
Instance 2420.1	18.333	5.841	48.026	31.397	32768.000	35393.089	0.000	2.825	0.000	25.554	0.000	4902.505
Instance 2420.2	17.639	5.515	47.885	31.234	32768.000	35377.167	0.000	2.505	0.000	25.539	0.000	4828.748
Instance 2420.3	17.651	4.977	48.440	31.701	32768.000	35361.173	0.000	2.815	0.000	25.827	0.000	4866.343
Instance 2420.4	15.263	4.520	48.531	31.865	32768.000	35455.749	0.000	2.450	0.000	26.183	0.000	4835.212
Instance 2420.5	17.666	5.101	48.730	32.027	32768.000	35406.943	0.000	2.791	0.000	26.038	0.000	4853.390

## Host System Performance

<b>Counter</b>	<b>Average</b>	<b>Minimum</b>	<b>Maximum</b>
% Processor Time	0.709	0.415	1.122
Available MBytes	60807.589	60785.000	61898.000
Free System Page Table Entries	33555588.171	33555587.000	33555590.000
Transition Pages RePurposed/sec	0.000	0.000	0.000
Pool Nonpaged Bytes	105351373.485	105328640.000	105443328.000
Pool Paged Bytes	81895725.378	81879040.000	82087936.000
Database Page Fault Stalls/sec	0.000	0.000	0.000

## Test Log

5/18/2010 8:46:41 PM -- Jetstress testing begins ...  
5/18/2010 8:46:41 PM -- Prepare testing begins ...  
5/18/2010 8:46:46 PM -- Attaching databases ...  
5/18/2010 8:46:46 PM -- Prepare testing ends.  
5/18/2010 8:46:46 PM -- Dispatching transactions begins ...  
5/18/2010 8:46:46 PM -- Database cache settings: (minimum: 160.0 MB, maximum: 1.2 GB)  
5/18/2010 8:46:46 PM -- Database flush thresholds: (start: 12.8 MB, stop: 25.6 MB)  
5/18/2010 8:46:54 PM -- Database read latency thresholds: (average: 20 msec/read, maximum: 100 msec/read).  
5/18/2010 8:46:54 PM -- Log write latency thresholds: (average: 10 msec/write, maximum: 100 msec/write).  
5/18/2010 8:46:58 PM -- Operation mix: Sessions 3, Inserts 40%, Deletes 20%, Replaces 5%, Reads 35%, Lazy Commits 70%.  
5/18/2010 8:46:58 PM -- Performance logging begins (interval: 15000 ms).  
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5/18/2010 11:16:50 PM -- Instance2420.2 has 2.5 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.2 has 2.5 for I/O Log Reads Average Latency.  
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5/18/2010 11:16:50 PM -- Instance2420.3 has 2.8 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.3 has 2.8 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 15.3 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 2.4 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.4 has 2.4 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 17.7 for I/O Database Reads Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 2.8 for I/O Log Writes Average Latency.  
5/18/2010 11:16:50 PM -- Instance2420.5 has 2.8 for I/O Log Reads Average Latency.  
5/18/2010 11:16:50 PM -- Test has 0 Maximum Database Page Fault Stalls/sec.  
5/18/2010 11:16:50 PM -- Test has 0 Database Page Fault Stalls/sec samples higher than 0.

5/18/2010 11:16:50 PM -- C:\ESRP\Soft Recovery  
Test\Performance\_2010\_5\_18\_20\_46\_54.xml has 597 samples queried.



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