Deploy 48,000 Microsoft Exchange 2010 Mailboxes with Hitachi Compute Blade 2000 and Hitachi Unified Storage 150

Reference Architecture Guide

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Feedback

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Deploy 48,000 Microsoft Exchange 2010 Mailboxes with Hitachi Compute Blade 2000 and Hitachi Unified Storage 150

Reference Architecture Guide

This solution describes a Microsoft Exchange 2010 high availability and site resiliency design and deployment for 48,000 mailboxes across two data centers. The following hardware was used to configure and deploy Exchange:

- Two Hitachi Compute Blade 2000 chassis with 12 Hitachi X55A2 server blades
- Two Hitachi Unified Storage 150

Included is information for planning, recommended practices, configuration, and deployment.

This reference architecture guide is intended for you if you are a storage or administrator designing, configuring, deploying, testing, and validating a Microsoft Exchange 2010 environment. You need familiarity with the following to benefit from this document:

- Hitachi Compute Blade 2000
- Hitachi Unified Storage 100 family
- Hitachi Storage Navigator Modular 2
- Microsoft Windows Server 2008 R2
- Microsoft Exchange Server 2010

**Note**—Testing of this configuration was in a lab environment. Many things affect production environments beyond prediction or duplication in a lab environment. Follow the recommended practice of conducting proof-of-concept testing for acceptable results in a non-production, isolated test environment that otherwise matches your production environment before your production implementation of this solution.
Solution Overview

The following are the components used in this solution:

- **Hardware**
  - **Hitachi Compute Blade 2000** — 10U enterprise-class blade server platform
  - **Hitachi Unified Storage 150** — Midrange platform storage that can consolidate and manage block, file and object data on a central platform
  - **Brocade 5300 Fibre Channel Switch** — SAN connectivity to the storage network

- **Software**
  - **Hitachi Dynamic Provisioning** — Thin provisioning software that provides virtual storage capacity. It simplifies application storage provisioning by allowing administrators to draw from a central virtual pool without immediately adding physical disks.
  - **Hitachi Dynamic Link Manager Advanced** — Comprehensive path failover and failback to ensure higher data availability, reliability and accessibility. Automatic work load balancing helps to maintain outstanding system performance across all available paths.
  - **Hitachi Storage Navigator Modular 2** — Enable essential functions for the management and optimization of the storage system. It provides a web-accessible graphical management interface and a command line interface.
  - **Hitachi Virtualization Manager Navigator** — Enhanced logical partitioning usability and manageability within Hitachi Compute Blade. Manage and monitor logical partitions within a graphical user interface.
  - **Microsoft Windows Server 2008 R2** — Multi-purpose server designed to increase the reliability and flexibility of your infrastructure
  - **Microsoft Exchange Server 2010** — Enterprise email application with database high availability and site resiliency through database availability groups
Figure 1 shows the complete physical architecture using Hitachi and Brocade hardware components.
Key Solution Components

The following are the key hardware and software components used to deploy this solution.

Hitachi Compute Blade 2000

Hitachi Compute Blade 2000 is an enterprise-class blade server platform. It features the following:

- A balanced system architecture that eliminates bottlenecks in performance and throughput
- Embedded logical partition virtualization
- Configuration flexibility
- Eco-friendly power-saving capabilities
- Fast server failure recovery using a N+1 cold standby design that allows replacing failed servers within minutes

Hitachi embeds logical partitioning virtualization in the firmware of the Hitachi Compute Blade 2000 server blades. This proven, mainframe-class technology combines logical partitioning expertise from Hitachi with VT technologies from Intel to improve performance, reliability, and security. Embedded logical partition virtualization does not degrade application performance and does not require the purchase and installation of additional components.

Logical partition virtualization enables physical server resource allocation among multiple securely isolated partitions. This maximizes the efficiency and utilization of blade server hardware. Each logical partition hosts its own independent guest operating system and application environment.

Because embedded logical partitioning allocates system resources at the hardware level, the logical partitions have a performance advantage over host-emulation virtualization methods. Guest operating systems directly execute in the virtualized environment without the need for host intervention.

Individual CPU cores can be assigned to specific logical partitions for maximum security (dedicated mode) or shared between partitions for maximum utilization (shared mode).

Multiple logical partitions can access a shared storage device through a single Fibre Channel card. This reduces the number of connections required between server and storage.

The virtual network interface card (VNIC) within logical partitions allows the following without the need for physical network interface hardware:

- Share I/O resources
- Enable communication between partitions
Hitachi Unified Storage 150

Hitachi Unified Storage is a midrange storage platform for all data. It helps businesses meet their service level agreements for availability, performance, and data protection.

The performance provided by Hitachi Unified Storage is reliable, scalable, and available for block and file data. Unified Storage is simple to manage, optimized for critical business applications, and efficient.

Using Unified Storage requires a smaller capital investment. Deploy this storage, which grows to meet expanding requirements and service level agreements, for critical business applications. Simplify your operations with integrated set-up and management for a quicker time to value.

Unified Storage enables extensive cost savings through file and block consolidation. Build a cloud infrastructure at your own pace to deliver your services.

Hitachi Dynamic Provisioning

On Hitachi storage systems, Hitachi Dynamic Provisioning provides wide striping and thin provisioning functionalities.

Using Dynamic Provisioning is like using a host-based logical volume manager (LVM), but without incurring host processing overhead. It provides one or more wide-striping pools across many RAID groups. Each pool has one or more dynamic provisioning virtual volumes (DP-VOLs) of a logical size you specify of up to 60 TB created against it without allocating any physical space initially.

Deploying Dynamic Provisioning avoids the routine issue of hot spots that occur on logical devices (LDEVs). These occur within individual RAID groups when the host workload exceeds the IOPS or throughput capacity of that RAID group. Dynamic provisioning distributes the host workload across many RAID groups, which provides a smoothing effect that dramatically reduces hot spots.

When used with Hitachi Unified Storage, Hitachi Dynamic Provisioning has the benefit of thin provisioning. Physical space assignment from the pool to the dynamic provisioning volume happens as needed using 1 GB chunks, up to the logical size specified for each dynamic provisioning volume. There can be a dynamic expansion or reduction of pool capacity without disruption or downtime. You can rebalance an expanded pool across the current and newly added RAID groups for an even striping of the data and the workload.

Hitachi Dynamic Link Manager

Hitachi Dynamic Link Manager, used for SAN multipathing, has configurable load balancing policies. These policies automatically select the path having the least amount of input/output processing through all available paths. This balances the load across all available paths, which optimizes IOPS and response time.
Hitachi Storage Navigator Modular 2

Hitachi Storage Navigator Modular 2 provides essential management and optimization of storage system functions. Using Java agents, Storage Navigator Modular 2 runs on most browsers. A command line interface is available.

Use Storage Navigator Modular 2 for the following:

- RAID-level configurations
- LUN creation and expansion
- Online microcode updates and other system maintenance functions
- Performance metrics

Hitachi Virtualization Manager Navigator

Hitachi Virtualization Manager Navigator provides enhanced usability and manageability of logical partitioning. You use this software to manage and monitor logical partitions within a graphical user interface instead of through a command line interface.

Hitachi Virtualization Manager Navigator provides the following functions:

- **LPAR configuration and deployment**—Navigate initial logical partition setup and booting, create the configuration, allocate resources, and set up boot devices for each logical partition.
- **Monitoring**—Monitor CPU and NIC usage, and shortage rates, on logical partitions, and takes predefined actions based on the data collected. Monitoring includes graphical displays of performance data with e-mail alert notifications.
- **Viewer**—View logical partition configurations in a list or graphical form.
- **Migrations**—Execute logical partition migration between server blades.
- **FW Update**—Use for upgrades and updates of newer Hitachi Virtualization Manager Navigator firmware versions.
Solution Design

This reference architecture is a Microsoft Exchange high availability and site resiliency design to deploy 48,000 mailboxes across two data centers.

Each data center has the following:

- One Hitachi Compute Blade 2000 with six server blades
- One Hitachi Unified Storage 150

Each mailbox server houses 8,000 mailboxes (4,000 active and 4,000 passive) using two database copies for high availability. Exchange will continue to operate without any interruption should any of the following failures or outages occur in any of the data centers:

- Server failure
- WAN outage
- Data center outage

Table 1 lists the detailed information about the hardware components used in the Hitachi Data Systems lab to validate this reference architecture.

Table 1. Hardware Components

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Detail Description</th>
<th>Firmware Version</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Unified Storage 150</td>
<td>Active/active symmetric controllers</td>
<td>0916/A-H</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2 × 4 port 8 Gb/sec Fibre Channel host I/O module</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32 GB cache memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi DBL Disk Box</td>
<td>LFF (3.5 inch) DBL disk boxes to support 552 SAS 2 TB 7.2k RPM disks</td>
<td>N/A</td>
<td>46</td>
</tr>
<tr>
<td>Hitachi Compute Blade 2000 chassis</td>
<td>2 management modules</td>
<td>A0195-C-6443</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2 × 1Gb/sec LAN switch modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 cooling fan modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 power supply modules</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2 lists the software components used in the Hitachi Data Systems lab.

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Storage Navigator Modular 2</td>
<td>21.6</td>
</tr>
<tr>
<td>Hitachi Dynamic Link Manager</td>
<td>7.2</td>
</tr>
<tr>
<td>Hitachi Dynamic Provisioning</td>
<td>Microcode Dependent</td>
</tr>
<tr>
<td>Hitachi Virtualization Manager Navigator OS</td>
<td>58.82.00.00</td>
</tr>
<tr>
<td>Hitachi Virtualization Manager Navigator</td>
<td>V02-03 (2.3.0.13)</td>
</tr>
<tr>
<td>Microsoft Windows Server</td>
<td>2008 R2 SP1</td>
</tr>
<tr>
<td>Microsoft Exchange Server</td>
<td>2010 SP2</td>
</tr>
</tbody>
</table>
Hitachi Compute Blade 2000 Chassis and Server Blade Configuration

This reference architecture uses the following per chassis:

- Six X55A2 server blades
- Two 1 Gb/sec LAN switch modules
- Six Hitachi dual port 8Gb/sec PCIe HBA cards

Each blade has two onboard NICs. They are connected to LAN switch modules 0 and 1.

To run logical partitions, Hitachi HBAs are required. Each blade is partitioned to run two logical partitions with Hitachi Virtualization Manager Navigator mode enabled at the server blade level.

Figure 2 shows the front and back view of Hitachi Compute Blade 2000.
Processor Design

The mailbox, client access, and hub transport roles are the three most important roles in Microsoft Exchange 2010. Under sizing these roles has a dramatic performance effect on the server as well as the users. The mailbox processor design ratio is usually 1:1 with the client access and hub transport roles. The mailbox server, client access, and hub transport is configured for 6-core.

Processor design is based on the following factors:

- Number of mailboxes
- Whether the server will host active and passive database copies
- Number of database copies

A passive database copy requires CPU resources to perform the following tasks:

- Check or validate replicated logs
- Replay replicated logs into the database
- Maintain the content index associated with the database copy

Table 3 has guidelines from Microsoft to estimate how many CPU megacycles are needed for each mailbox database. For this solution, the row describing the profile of 100 messages per day was used.

Table 3. Per mailbox database cache, IOPS, and CPU estimates based on user profile and message activity (Microsoft Corporation 2011)

<table>
<thead>
<tr>
<th>Total Messages Sent or Received per Mailbox per Day</th>
<th>Database Cache per Mailbox (MB)</th>
<th>Standalone Estimated IOPS per Mailbox</th>
<th>Mailbox Resiliency Estimated IOPS per Mailbox</th>
<th>Megacycles for Active or Standalone Mailbox</th>
<th>Megacycles for Passive Mailbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3</td>
<td>0.06</td>
<td>0.05</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>100</td>
<td>6</td>
<td><strong>0.12</strong></td>
<td><strong>0.10</strong></td>
<td>2</td>
<td><strong>0.30</strong></td>
</tr>
<tr>
<td>150</td>
<td>9</td>
<td>0.18</td>
<td>0.15</td>
<td>3</td>
<td>0.45</td>
</tr>
<tr>
<td>200</td>
<td>12</td>
<td>0.24</td>
<td>0.20</td>
<td>4</td>
<td>0.60</td>
</tr>
<tr>
<td>250</td>
<td>15</td>
<td>0.30</td>
<td>0.25</td>
<td>5</td>
<td>0.75</td>
</tr>
<tr>
<td>300</td>
<td>18</td>
<td>0.36</td>
<td>0.30</td>
<td>6</td>
<td>0.90</td>
</tr>
<tr>
<td>350</td>
<td>21</td>
<td>0.42</td>
<td>0.35</td>
<td>7</td>
<td>1.05</td>
</tr>
<tr>
<td>400</td>
<td>24</td>
<td>0.48</td>
<td>0.40</td>
<td>8</td>
<td>1.20</td>
</tr>
<tr>
<td>450</td>
<td>27</td>
<td>0.54</td>
<td>0.45</td>
<td>9</td>
<td>1.35</td>
</tr>
<tr>
<td>500</td>
<td>30</td>
<td>0.60</td>
<td>0.50</td>
<td>10</td>
<td>1.50</td>
</tr>
</tbody>
</table>

For more information about processor planning, see the Microsoft TechNet article “Mailbox Server Processor Capacity Planning.”
Physical Memory Design

Optimum memory sizing for the Exchange mailbox server is critical to reduce the I/O workload presented by the server to the storage platform. Increasing the amount of memory on the mailbox server results in fewer I/Os to the storage system.

This reference architecture supports 48,000 mailboxes which send and receive 100 messages per day. Based on the information in Table 3 on page 10, the mailbox resiliency estimated IOPS per mailbox is 0.10. With a 20 percent overhead, there is a total standalone estimate of 0.12 IOPS per mailbox with 6 MB for the database cache per mailbox.

The database cache size is 48 GB.

Total Database Cache = (Number of Mailboxes) × \( \frac{\text{Database Cache}}{\text{Mailbox}} \)

Total Database Cache = (48,000 Mailboxes) × \( \frac{6 \text{ MB}}{\text{Mailbox}} \)

Total Database Cache = 48 GB

After determining the database cache size of 48 GB, Table 4 gives the server physical memory size as 64 GB, based on the mailbox count and user profile, taking a failover into account.

**Table 4. Default Mailbox Database Cache Sizes (Microsoft Corporation 2011)**

<table>
<thead>
<tr>
<th>Server Physical Memory</th>
<th>Database Cache Size</th>
<th>Database Cache Size: Multiple-role (For Example, Mailbox + Hub Transport)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 GB</td>
<td>512 MB</td>
<td>Not supported</td>
</tr>
<tr>
<td>4 GB</td>
<td>1 GB</td>
<td>Not supported</td>
</tr>
<tr>
<td>8 GB</td>
<td>3.6 GB</td>
<td>2 GB</td>
</tr>
<tr>
<td>16 GB</td>
<td>10.4 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>24 GB</td>
<td>17.6 GB</td>
<td>14 GB</td>
</tr>
<tr>
<td>32 GB</td>
<td>24.4 GB</td>
<td>20 GB</td>
</tr>
<tr>
<td>48 GB</td>
<td>39.2 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>64 GB</td>
<td>53.6 GB</td>
<td>44 GB</td>
</tr>
<tr>
<td>96 GB</td>
<td>82.4 GB</td>
<td>68 GB</td>
</tr>
<tr>
<td>128 GB</td>
<td>111.2 GB</td>
<td>92 GB</td>
</tr>
</tbody>
</table>

For more information about database cache planning, see the Microsoft TechNet article "Understanding the Mailbox Database Cache."
This reference architecture uses this logical partition configuration on each server blade:

- **Mailbox server**—LPAR 1
- **Client access server and hub transport server**—LPAR 2

The primary reasons for this configuration are the following:

- Minimize the number of servers to be managed
- Optimize performance for planned or unplanned failover scenarios

Table 5 shows the server blade configuration in detail. The host names are the names used in the Hitachi Data System laboratory.

<table>
<thead>
<tr>
<th>Chassis</th>
<th>Blade</th>
<th>LPAR</th>
<th>Host Name</th>
<th>Role</th>
<th>vCPU</th>
<th>Memory (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blade 2</td>
<td>LPAR 1</td>
<td>BS-MBX1</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT1</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Blade 3</td>
<td>LPAR 1</td>
<td>BS-MBX2</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT2</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Blade 4</td>
<td>LPAR 1</td>
<td>BS-MBX3</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT3</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Blade 5</td>
<td>LPAR 1</td>
<td>BS-MBX4</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT4</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Blade 6</td>
<td>LPAR 1</td>
<td>BS-MBX5</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT5</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Blade 7</td>
<td>LPAR 1</td>
<td>BS-MBX6</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT6</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>
### Active Directory Design

In this multiple data center design, place two Active Directory domain controllers with DNS and global catalog installed in each site for redundancy. Do not span Active Directory across the WAN link, as this increases bandwidth and latency. Add the primary and secondary data center TCP/IP subnets to Active Directory Sites and Services for replication and authentication.

For more information about Active Directory, see Microsoft’s TechNet article "Active Directory Services."

### Client Access Load Balancing Design

In a multiple data center design, use a hardware load balancer to properly configured all the client access servers to point to a single virtual IP (VIP) address and a fully qualified domain name (FQDN). This does the following for the client access servers:

- Provides redundancy
- Increases performance

---

**Table 5. Hitachi Compute Blade 2000 Configuration (Continued)**

<table>
<thead>
<tr>
<th>Chassis</th>
<th>Blade</th>
<th>LPAR</th>
<th>Host Name</th>
<th>Role</th>
<th>vCPU</th>
<th>Memory (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Blade 2</td>
<td>LPAR 1</td>
<td>BS-MBX7</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT7</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Blade 3</td>
<td>LPAR 1</td>
<td>BS-MBX8</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT8</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Blade 4</td>
<td>LPAR 1</td>
<td>BS-MBX9</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT9</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Blade 5</td>
<td>LPAR 1</td>
<td>BS-MBX10</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT10</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Blade 6</td>
<td>LPAR 1</td>
<td>BS-MBX11</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT11</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>Blade 7</td>
<td>LPAR 1</td>
<td>BS-MBX12</td>
<td>Mailbox server</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LPAR 2</td>
<td>BS-CASHT12</td>
<td>Client access and hub transport server</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>
Client Access Namespace Design

Namespace design is an important topic when deploying Microsoft Exchange with multiple data centers. Each data center in a site-resilient architecture is considered to be active to ensure successful switchovers between data centers. Use a split DNS model where the same namespace is used in primary and secondary data centers.

For more information about understanding client access namespace, see Microsoft's TechNet article "Understanding Client Access Server Namespaces."

Database Distribution Design

This reference architecture defines a database distribution design for 36 databases to support 48,000 mailboxes on 12 mailbox servers. The DAG configuration stretches across the WAN to support both data centers.

When it comes to using a DAG stretched between two data centers, pre-configure an alternate witness server for redundancy. If a data center fails, the other witness server takes control and handles all 48,000 users.

Table 6 shows the database distribution design detail.

Table 6. Database Distribution Design

<table>
<thead>
<tr>
<th>Database</th>
<th>Primary Data Center</th>
<th>Secondary Data Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Active</td>
<td>Pass</td>
</tr>
<tr>
<td>4-6</td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>7-9</td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>10-12</td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>13-15</td>
<td>Active</td>
<td>Passive</td>
</tr>
</tbody>
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Table 6. Database Distribution Design (Continued)

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<td>Passive</td>
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</tr>
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<td>Active</td>
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<td>Active</td>
</tr>
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<td>Active</td>
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<td>Active</td>
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<td>mbx1</td>
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<td>Active</td>
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<tr>
<td>mbx2</td>
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</tr>
<tr>
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<td>Active</td>
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<td>Passive</td>
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</tr>
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<td>mbx10</td>
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<td>mbx11</td>
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<td>Active</td>
</tr>
<tr>
<td>mbx12</td>
<td>Passive</td>
<td>Active</td>
</tr>
</tbody>
</table>
Storage Area Network Architecture

The storage area network configuration uses two Brocade 8 Gb/sec Fibre Channel switches and dual-port host bus adapters.

For redundancy, this reference architecture uses storage Port 0A, Port 1A, Port 0B, Port 1B, Port 0C, Port 1C, Port 0D, and Port 1D.

Figure 3 shows the physical SAN architecture detail.
Network Architecture

The local area network configuration uses the following for redundancy and performance reasons:

- Two 1 Gb/sec LAN switch modules per chassis
- Two 1 Gb/sec VNICs per LPAR

This enables the Microsoft Exchange mailbox servers to distinguish between a server failure and a network failure on these networks.

- **MAPI network**—Used for communication between Exchange servers and client access
- **Replication network**—Used for log shipping and seeding

Figure 4 shows the network configuration for the LAN switch modules 0/1 on each Hitachi Compute Blade 2000. Each logical partition has the following mapping:

- Network adapter 0 is mapped to switch module 0
- Network adapter 1 is mapped to switch module 1

All eight network switch ports are configured as link aggregation control protocol (LACP) for maximum performance and redundancy. For performance enhancement and security, the MAPI and replication networks are isolated using different VLANs.

![Figure 4](image-url)
Storage Architecture

Sizing and configuring storage for use with Microsoft Exchange 2010 can be complicated. The design is driven by many factors, including I/O and capacity requirements. This information tells you what factors to consider when designing your storage infrastructure as well as how to size it appropriately.

Determine I/O Requirements (I/O Profile)

When designing the storage architecture for Microsoft Exchange 2010, always start by calculating the I/O requirements. Another name for this step is to determine the I/O profile.

You must determine how many IOPS each mailbox needs. Microsoft has guidelines and tools available to help you determine the number of IOPS.

Use the following two factors to estimate the I/O profile:

- How many messages a user sends and receives per day
- The amount of database cache available to the mailbox

Extensible Storage Engine from Microsoft uses the database cache to reduce the number of I/O operations. Generally, having a larger cache means there are fewer I/O operations for the storage system.

Table 7 has the guidelines from Microsoft for IOPS per mailbox. The row used in this reference architecture is the one for 100 messages sent/received per day.

Table 7. Estimated IOPS per Mailbox Based on Message Activity and Mailbox Database Cache (Microsoft Corporation 2011)

<table>
<thead>
<tr>
<th>Messages Sent/Received per Mailbox per Day (~75 KB Average Message Size)</th>
<th>Database Cache per User (MB)</th>
<th>Single Database Copy (Stand-alone): Estimated IOPS per Mailbox</th>
<th>Multiple Database Copies (Mailbox Resiliency): Estimated IOPS per Mailbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3</td>
<td>0.06</td>
<td>0.05</td>
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<tr>
<td><strong>100</strong></td>
<td><strong>6</strong></td>
<td><strong>0.12</strong></td>
<td><strong>0.10</strong></td>
</tr>
<tr>
<td>150</td>
<td>9</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>200</td>
<td>12</td>
<td>0.24</td>
<td>0.20</td>
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<tr>
<td>250</td>
<td>15</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
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<td>18</td>
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<td>350</td>
<td>21</td>
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<td>27</td>
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<tr>
<td>500</td>
<td>30</td>
<td>0.60</td>
<td>0.50</td>
</tr>
</tbody>
</table>
For this reference architecture, using an I/O profile of 100 messages a day with multiple database copies means planning for 0.10 IOPS per mailbox. To make sure that the architecture can provide sufficient overhead for periods of extremely high workload, Hitachi Data Systems recommends adding 20 percent overhead for production scenarios, for a total of 0.12 IOPS.

To calculate the total number of host IOPS for an Exchange environment, use the following formula:

\[
\text{Total Required IOPS} = \text{Number of Mailboxes} \times \frac{\text{Estimated IOPS}}{\text{Mailbox}}
\]

This calculation provides the number of application IOPS required by the host to service the environment. For example, for this reference architecture:

\[
5760 \text{ Required IOPS} = 48,000 \text{ Mailboxes} \times \frac{0.12 \text{ IOPS}}{\text{Mailbox}}
\]

For more information about IOPS planning, see the Microsoft TechNet article "Understanding Database and Log Performance Factors."

**Determine Capacity Requirements**

In addition to the requirement for mailbox quota capacity, you must consider the following:

- **The amount of likely white space in the database**
  
  The database always has free pages (white space) throughout it. During online maintenance, the deletion of items marked for removal frees those pages.
  
  Estimate the amount of white space in the database by knowing the number of megabytes of mail sent and received by the users with mailboxes in the database.

- **The size of the database dumpster**
  
  Each database has a dumpster that stores items deleted from a user’s mailbox. By default, these items are stored for 14 days (Exception: calendar items are stored for 120 days).

  In addition to the dumpster, Exchange Server 2010 includes single item recovery, which prevents the purging of data before the deleted item retention window has passed. While normally it is not available, when it is available you must consider its effect when determining capacity requirements, as single item recovery increases the size of the mailbox.

- **Capacity of content indexing**

  Allow capacity for content indexing, which performs a search of email items.

  This contributes an additional overhead of about 10 percent to the total database size.
- **Deploy lagged copies**
  
  If you plan to deploy lagged copies, determine the capacity for the database copy and the logs.
  
  This feature provides a delay for when logs are played in the lagged database copies. This delay can protect against replicating undesirable content to all database copies.
  
- **Transaction logs generated per day**
  
  Each transaction log file in Exchange 2010 is 1 MB in size. As the message size increases, the number of log files generated per day grows. The message size and I/O profile (based on the number of messages per mailbox per day) can help estimate how many transaction logs are generated per day.
  
  The transaction log files maintain a record of every transaction and operation performed by the Exchange 2010 database engine. Transactions are written to the log first, and then written to the database.
  
  Table 8 has the guidelines from Microsoft for estimating the number of transaction logs generated per mailbox profile. This reference architecture uses the 100 message profile row.

<table>
<thead>
<tr>
<th>Message Profile (75 KB Average Message Size)</th>
<th>Number of Transaction Logs Generated per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td><strong>100</strong></td>
<td><strong>20</strong></td>
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<td>150</td>
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<td>450</td>
<td>90</td>
</tr>
<tr>
<td>500</td>
<td>100</td>
</tr>
</tbody>
</table>

For more information about logs planning, see the Microsoft TechNet article "Understanding Mailbox Database and Log Capacity Factors."

**Design the Dynamic Provisioning Pool and RAID Group**

To satisfy 48,000 mailboxes needing a 1 GB mailbox size and an I/O profile of 0.12 IOPS, this reference architecture uses 2 TB SAS drives in a RAID-10 (2D+2D) configuration.
RAID-10 is the preferred RAID configuration for Microsoft Exchange for the following reasons:

- It offers the best in performance and reliability.
- It can sustain double drive failure without affecting the data.

The following describes the provisioning of the dynamic provisioning pools:

- One dynamic provisioning pool with four drives for the SAN OS boot
- Two dynamic provisioning pools with 120 drives each for the active and passive databases
- Two dynamic provisioning pools with 16 drives each for the active and passive logs

Table 9 lists the detailed configuration for the dynamic provisioning pools for this reference architecture.

### Table 9. Dynamic Provisioning Pool and RAID Group Design

<table>
<thead>
<tr>
<th>Site</th>
<th>Dynamic Provisioning Pool</th>
<th>Number of RAID Groups</th>
<th>Number of Drives</th>
<th>Usable Pool Capacity (TB)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Data Center</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3.5</td>
<td>SAN OS Boot</td>
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<tr>
<td></td>
<td>1</td>
<td>30</td>
<td>120</td>
<td>106.6</td>
<td>Database (active)</td>
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<tr>
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<td>2</td>
<td>30</td>
<td>120</td>
<td>106.6</td>
<td>Database (passive)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>14</td>
<td>Log (active)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>14</td>
<td>Log (passive)</td>
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<tr>
<td>Secondary Data Center</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3.5</td>
<td>SAN OS Boot</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>30</td>
<td>120</td>
<td>106.6</td>
<td>Database (active)</td>
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<tr>
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<td>2</td>
<td>30</td>
<td>120</td>
<td>106.6</td>
<td>Database (passive)</td>
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<td>14</td>
<td>Log (active)</td>
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<tr>
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<td>4</td>
<td>4</td>
<td>16</td>
<td>14</td>
<td>Log (passive)</td>
</tr>
</tbody>
</table>

**Volume Design**

Based on the I/O and capacity requirements, and adding the recommended 20 percent overhead, this reference architecture uses the following volume sizes:

- 2000 GB for the databases
- 200 GB for the logs

When creating the volumes, isolate the database and log on different volumes for better performance. The log volume is 10% of the total database volume.

Table 10 shows the detailed volumes configuration used in this solution.
<table>
<thead>
<tr>
<th>Site</th>
<th>Host</th>
<th>DP Pool</th>
<th>Volume</th>
<th>Size</th>
<th>Purpose</th>
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<td>21</td>
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<td></td>
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<td>22</td>
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<td>23</td>
<td>2000</td>
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<td>Site</td>
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<td>Size</td>
<td>Purpose</td>
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<td>------</td>
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<td>LOG30 (passive)</td>
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</table>
Table 10. Volume Design (Continued)

<table>
<thead>
<tr>
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<th>Host</th>
<th>DP Pool</th>
<th>Volume</th>
<th>Size</th>
<th>Purpose</th>
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</thead>
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|                       |      | 1       | 141    | 2000 | DB16 (active)        |
|                       |      |         | 142    | 2000 | DB17 (active)        |
|                       |      |         | 143    | 2000 | DB18 (active)        |
|                       |      | 2       | 144    | 2000 | DB19 (passive)       |
|                       |      |         | 145    | 2000 | DB20 (passive)       |
|                       |      |         | 146    | 2000 | DB21 (passive)       |
|                       |      | 3       | 147    | 200  | LOG16 (active)       |
|                       |      |         | 148    | 200  | LOG17 (active)       |
|                       |      |         | 149    | 200  | LOG18 (active)       |
|                       |      | 4       | 150    | 200  | LOG19 (passive)      |
|                       |      |         | 151    | 200  | LOG20 (passive)      |
|                       |      |         | 152    | 200  | LOG21 (passive)      |</p>
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</table>
Engineering Validation

This is the description of the test tools and test methodology used for validating the Microsoft Exchange environment documented in this reference architecture guide.

A standalone server was deployed as a Microsoft Hyper-V server with the following virtual machine roles:

- **Active Directory**—2 virtual machines
- **Hitachi Storage Navigator Modular 2 and Hitachi Virtualization Manager Navigator**—One virtual machine to manage the storage and servers
- **Microsoft Exchange databases for Exchange Load Generator testing**—20 virtual machines.

Test Methodology

This methodology was used to validate the architecture in the Hitachi Data System laboratory.

**Verify Achieved IOPS Meet Target IOPS**

The purpose of Microsoft Exchange Server Jetstress 2010 is to prove the performance and stability of a disk subsystem prior to putting an Exchange 2010 server into production. The program verifies disk performance by simulating Exchange database and log file I/O loads. You use Performance Monitor, Event Viewer, and Exchange Server Database Utilities with Jetstress 2010 to see that the storage system meets or exceeds the performance criteria.

Jetstress generates I/O based on the IOPS per mailbox user profile, as estimated by Microsoft.

These are the two testing objectives:

- The first objective tested the **disk subsystem performance** using a worst-case scenario.
- The second objective tested the **Exchange mailbox profile** using a worst-case scenario.

During testing for both objectives, 8,000 mailboxes ran simultaneously on each of the 12 mailbox servers for eight hours. Each server configuration used six databases and two database copies. This is the Microsoft recommended test method for a worst-case scenario. The testing goal was to verify that the achieved IOPS met or exceeded the target IOPS with latency less than 20 msec.
Table 11 lists the Jetstress parameters used in this test.

Table 11. Jetstress Parameters

<table>
<thead>
<tr>
<th>Jetstress Parameter</th>
<th>Value</th>
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<tr>
<td>Number of mailboxes per host</td>
<td>8,000</td>
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<tr>
<td>Mailbox size</td>
<td>1 GB</td>
</tr>
<tr>
<td>Number of users per database</td>
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<td>IOPS/mailbox</td>
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<td>Number of databases per host</td>
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<td>Number of copies per database</td>
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<tr>
<td>Thread count</td>
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</tr>
<tr>
<td>Duration</td>
<td>8 hours</td>
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</table>

**Verify Peak Load Performance**

Microsoft Exchange Load Generator introduces various types of workloads into a non-production Exchange environment to benchmark, pre-deployment validate, and stress test. This tool simulates the delivery of multiple MAPI client messaging requests to an Exchange server.

To simulate the delivery of these messaging requests, run Exchange Load Generator tests on client computers. These tests send multiple messaging requests to the Exchange server, which causes a mail load.

These are the two objectives:

- The first objective tested system performance while **simulating a peak load on both data centers**. Each data center has 24,000 mailboxes. A total of 48,000 mailboxes ran simultaneously on both data centers for eight hours.

- The second objective tested system performance during a **DAG failover test**. All 48,000 mailboxes ran a peak load simultaneously on the primary data center with the secondary data center offline for eight hours.

Table 12 lists the Load Generator parameters used in these tests.

Table 12. Load Generator Parameters

<table>
<thead>
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<th>Load Generator Parameter</th>
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<td>Number of users per database</td>
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<td>Action Profile</td>
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<td>Duration</td>
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</table>
Test Results

These are the Jetstress and Load Generator test results from the Hitachi Data Systems laboratory.

Verify Achieved IOPS Meets Target IOPS: Disk Subsystem Performance

All tests passed without errors. Table 13 and Table 14 show the detailed Jetstress disk subsystem throughput test results for 12 servers.

Table 13. Jetstress Disk Subsystem Performance Results

<table>
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<tr>
<th>Host</th>
<th>DB</th>
<th>I/O DB Reads Average Latency (msec)</th>
<th>I/O DB Writes Average Latency (msec)</th>
<th>I/O DB Reads/sec</th>
<th>I/O DB Writes/sec</th>
<th>I/O Log Writes Average Latency (msec)</th>
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Table 13. Jetstress Disk Subsystem Performance Results (Continued)

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<th>I/O DB Reads/sec</th>
<th>I/O DB Writes/sec</th>
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### Table 13. Jetstress Disk Subsystem Performance Results (Continued)

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### Table 14. Jetstress Disk Subsystem Performance Targeted and Achieved Results

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Verify Achieved IOPS Meets Target IOPS: Exchange Mailbox Profile

All tests passed without errors. Table 15 and Table 16 show the detailed Jetstress Exchange mailbox profile test results for 12 servers.

Table 15. Jetstress Exchange Mailbox Profile Results

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<th>I/O DB Writes Average Latency (msec)</th>
<th>I/O DB Reads/sec</th>
<th>I/O DB Writes/sec</th>
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Table 15. Jetstress Exchange Mailbox Profile Results (Continued)

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<th>Host</th>
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<th>I/O DB Reads Average Latency (msec)</th>
<th>I/O DB Writes Average Latency (msec)</th>
<th>I/O DB Reads/sec</th>
<th>I/O DB Writes/sec</th>
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### Table 15. Jetstress Exchange Mailbox Profile Results (Continued)

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<th>I/O DB Writes Average Latency (msec)</th>
<th>I/O DB Reads/sec</th>
<th>I/O DB Writes/sec</th>
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### Table 16. Jetstress Exchange Mailbox Profile Targeted and Achieved Results

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<th>Achieved Transactional IOPS</th>
<th>Test Status</th>
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<td>MBX4</td>
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<tr>
<td>MBX5</td>
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<td>1051</td>
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Verify Peak Load Performance: System Performance while Simulating a Peak Load on Both Data Centers

All 48,000 mailboxes were simulated on 12 servers with 4,000 mailboxes per server. All tests passed without any errors with CPU utilization less than 50%. Table 17 shows the detailed test results.

Table 17. Verify Peak Load Performance Peak Load Simulation Targeted and Achieved Results

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<th>Test Status</th>
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<td>MBX3</td>
<td>4,000</td>
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<td>passed</td>
</tr>
<tr>
<td>MBX4</td>
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</tr>
<tr>
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<td>4,000</td>
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<td>passed</td>
</tr>
<tr>
<td>MBX12</td>
<td>4,000</td>
<td>0</td>
<td>passed</td>
</tr>
</tbody>
</table>

Verify Peak Load Performance: DAG Failover Test

Secondary data center was powered off to simulate an outage. All 48,000 mailboxes were activated on six servers with 8,000 mailboxes per server. All tests passed without any errors with CPU utilization less than 65%. Table 18 shows the test results.

Table 18. Verify Peak Load Performance Peak Load DAG Failover Test Results

<table>
<thead>
<tr>
<th>Host</th>
<th>Total Number of Users</th>
<th>Task Exceptions</th>
<th>Test Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBX1</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
<tr>
<td>MBX2</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
<tr>
<td>MBX3</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
<tr>
<td>MBX4</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
<tr>
<td>MBX5</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
<tr>
<td>MBX6</td>
<td>8,000</td>
<td>0</td>
<td>Passed</td>
</tr>
</tbody>
</table>
Conclusion

Testing confirms that this reference architecture delivers the IOPS and capacity requirements needed to support high availability and site resiliency for 48,000 mailboxes on two Hitachi Compute Blade 2000 servers and two Hitachi Unified Storage 150 storage systems.

The solution outlined in this document does not include data protection components or mobile users support. Adding these additional requirements can affect performance and capacity requirements of the underlying storage configuration. When designing your solution, factor these needs into your storage design accordingly.
Works Cited


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