EMC Infrastructure for Microsoft Private Cloud

EMC VNX5300, Replication Manager, Microsoft Hyper-V, Microsoft Exchange, SharePoint, SQL Server, System Center

- Optimize infrastructure performance
- Cloud-ready infrastructure
- Automate and simplify management and monitoring

EMC Solutions Group

Abstract

This white paper presents a solution that explores the scalability and performance for mixed application workloads on a Microsoft Hyper-V virtualized platform using an EMC® VNX5300 storage array. It also highlights the ease of management with Microsoft System Center Operations Manager and EMC Storage Integrator.

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Executive summary

Business case Today, many organizations have made a decisive move to revamp the existing storage strategy by running critical applications like Microsoft Exchange Server, SharePoint Server, and SQL Server on a virtualized infrastructure. By consolidating application servers on a virtualized platform, customers can achieve significant cost reductions and increase the environment’s ability to scale.

At the same time, it is a constant critical business challenge for IT departments to maintain or improve the performance of a company’s mixed Microsoft applications, while providing an easy-to-manage environment. This solution provides a simplified architecture to host different business applications, ensuring that each business line’s information is separated from that of the others. It greatly simplifies the environment and reduces operational and management costs. In accordance with the best practices for Microsoft applications, this solution also showcases a comprehensive design methodology to run consolidated workloads across the EMC® VNX5300 storage platform powered by the Intel® Xeon® processor.

Solution overview There is a growing need among customers to run multiple workloads/applications on a shared infrastructure and meet expected performance levels at lower costs as dictated by the business service-level agreement (SLA). This solution shows a mixed Microsoft workload of Exchange Server 2010, SharePoint Server 2010, SQL Server 2008 R2, and features an element of high availability (HA) in all application environments.

Furthermore, this solution architecture includes the following components to demonstrate a private cloud solution for customers who are looking for enterprise consolidation with management simplicity:

- Microsoft System Center Virtual Machine Manager (SCVMM) and System Center Operations Manager (SCOM) to manage and monitor the whole environment
- Different Microsoft application workloads running on the Hyper-V platform with VNX5300 integrated with EMC Storage Integrator (ESI) for easy storage provisioning to the platform
- Protection of application data provided by EMC Replication Manager using SnapView™ snapshots
- Brocade® FCX Series network switches delivering high performance and low latency network connectivity for both the iSCSI based IP SAN and end user access to the applications services running in virtual machines.

Key results The solution offers the following key benefits:

- Easy-to-use and simple management features for administrators to provision and manage the infrastructure. It saves 13 steps to create CSV in a windows cluster by integrating with EMC Storage Integrator.
• Excellent performance results achieved during the combined workload of all Microsoft applications for:
  ▪ 2,500 concurrent Exchange users, with a 2 GB mailbox size and 0.20 IOPS user profile.
  ▪ 16,440 SharePoint users with 10% user concurrency on the virtualized SharePoint farm.
  ▪ 45,000 users configured for a SQL TPC-E environment with sustained high disk utilization, considering acceptable user response time and saved storage capacity.

• Minimal performance impact during catastrophic, component-level, hardware failure.

• Robust high performance and low latency IP networking from Brocade, that is easy to configure, manage, and monitor.

• Protection of all three Microsoft applications through Replication Manager with SnapView snapshots, with minimal impact on the production environment. The VNX SnapView snapshots job was completed successfully to protect a 1 TB SharePoint farm:
  ▪ Over 3.5 TB Exchange databases
  ▪ Over a 500 GB SQL Server database

• A typical SQL and SharePoint content databases and Exchange database restore takes only a few minutes.
  ▪ The restore of five Exchange databases, including log files (1.8 TB in total), took around 13 minutes. A 250 GB SQL Server database restore took less than four minutes.
  ▪ Five SharePoint content databases (1 TB in total) restore took 7 minutes, 28 seconds.
Introduction

Purpose
The purpose of this document is to describe a validated reference architecture and provide design guidelines for a mixed Microsoft application solution, including Exchange, SQL, and SharePoint Servers, on the EMC VNX5300 storage system. Microsoft Hyper-V is used as the hypervisor platform and the hosts are connected to the storage via iSCSI, with a cost-effective connectivity infrastructure.

Scope
The scope of this paper is to describe:

- The design methodology and considerations for Microsoft applications on a Hyper-V and VNX5300 platform
- Performance testing methodology and test results
- The impact of a hardware failure on Microsoft applications
- The use of Replication Manager to manage the backup and the design considerations
- The performance impact on applications when using Replication Manager snapshots and the instant restore of the applications
- Easy storage provisioning using ESI

Audience
The intended audience for the white paper is:

- Customers
- EMC partners
- Internal EMC personnel

Terminology
Table 1 provides a description of terminology used in this paper.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background Database Maintenance (BDM)</td>
<td>The process of Exchange 2010 database maintenance that involves check summing both active and passive database copies.</td>
</tr>
</tbody>
</table>
| Building block                            | A building block represents the amount of disk and server resources required to support a specified number of Exchange 2010 users. The required resources depend on:  
  • A specific user profile type  
  • Mailbox size  
  • Disk requirements |
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSV</td>
<td>Without CSV, a failover cluster allows a given disk (LUN) to be accessed by only one node at a time. Given this constraint, each Hyper-V virtual machine in the failover cluster requires its own set of logical units (LUNs) in order to be migrated or fail over independently of other virtual machines. In contrast, on a failover cluster that uses CSV, multiple virtual machines that are distributed across multiple cluster nodes can all access their Virtual Hard Disk (VHD) files at the same time, even if the VHD files are on a single disk (LUN) in the storage. The clustered virtual machines can all fail over independently of one another.</td>
</tr>
<tr>
<td>Database availability group (DAG)</td>
<td>A DAG is the base component of the HA and site resilience framework built into Microsoft Exchange Server 2010. A DAG is a group of up to 16 Mailbox servers that hosts a set of databases and provides automatic database-level recovery from failures that affect individual servers or databases.</td>
</tr>
<tr>
<td>Pass-through disk</td>
<td>A pass-through disk is where virtual machines have direct access to disks. It is only applicable to block devices such as iSCSI or Fabre Channel (FC).</td>
</tr>
<tr>
<td>Recovery time objective (RTO)</td>
<td>RTO is the period of time within which systems, applications, or functions must be recovered after an outage. This defines the amount of downtime that a business can endure.</td>
</tr>
<tr>
<td>Virtual Hard Disk (VHD)</td>
<td>This is a publicly available image format specification that allows encapsulation of the hard disk into an individual file for use by the operating system as a virtual disk, in all the same ways that physical hard disks are used. These virtual disks are capable of hosting native file systems (NTFS, FAT, exFAT, and UDFS) while supporting standard disk and file operations.</td>
</tr>
<tr>
<td>Volume Shadow Copy (VSS)</td>
<td>The Volume Shadow Copy Service in Windows Server 2008 provides an infrastructure that enables third-party storage management programs, business programs, and hardware providers to cooperate to create and manage shadow copies. VSS coordinates communication between VSS requestors (for example, backup applications), VSS writers (for example, the Exchange 2010 VSS Writer), and VSS providers (system, software, or hardware components that create the shadow copies).</td>
</tr>
</tbody>
</table>
Overview of components

Overview

The solution is validated with the following hardware and software components:

- EMC VNX5300, part of EMC VNX family of unified storage platforms
- EMC Storage Integrator (ESI)
- EMC Replication Manager
- Brocade FCX Series IP switches
- Microsoft Windows Server 2008 R2 Hyper-V
- Microsoft System Center Virtual Machine Manager
- Microsoft System Center Operations Manager

EMC VNX family of unified storage platforms

The EMC VNX™ family delivers industry-leading innovation and enterprise capabilities for file, block, and object storage in a scalable, easy-to-use solution. This next-generation storage platform combines powerful and flexible hardware with advanced efficiency, management, and protection software to meet the demanding needs of today’s enterprises.

All of this is available in a choice of systems ranging from affordable entry-level solutions to high-performance, petabyte-capacity configurations servicing the most demanding application requirements. The VNX family includes:

- The VNXe™ series: purpose-built for the IT manager in entry-level environments
- The VNX series: designed to meet the high-performance, high-scalability requirements of midsize and large enterprises

Figure 1. EMC VNX family of unified storage platforms
The VNX series delivers uncompromising scalability and flexibility for the mid-tier and enterprise space while providing market-leading simplicity and efficiency to minimize total cost of ownership.

EMC VNX family utilize the Intel Xeon 5600 series processors, which help make it 2-3x faster overall than its predecessor. The VNX quad-core processor supports demands of advanced storage capabilities such as virtual provisioning, compression, and deduplication. Furthermore, performance of the Xeon 5600 series enables EMC to realize its vision for FAST on the VNX, with optimized performance and capacity, without tradeoffs, in a fully automated fashion.


**EMC VNX5300**

The VNX5300 model is a member of the VNX series next-generation storage platform, providing the industry’s highest bandwidth. The VNX5300 model provides high-performing, unified storage with unsurpassed simplicity and efficiency. Organizations will achieve new levels of performance, protection, compliance, and ease-of-management.

The VNX5300 storage array delivers a single-box block and file solution, which offers a centralized point of management for distributed environments. This makes it possible to dynamically grow, share, and cost-effectively manage multiprotocol file systems and provide multiprotocol block access.


**EMC Storage Integrator**

EMC Storage Integrator (ESI) for Windows is a tool targeted at Windows and Microsoft applications administrators. The user interface for ESI is based on Microsoft Management Console (MMC). Therefore, customers can run ESI as a standalone tool or as part of an MMC snap-in on a Windows platform. Also, administrators can create a customer console with multiple MMC snap-ins to keep all frequently used tools in one place or customers can run them as separate consoles. ESI provides the ability to provision block and file storage for Microsoft Windows or for Microsoft SharePoint sites. ESI supports the EMC VNX series, the EMC VNXe series, EMC CLARiiON®, EMC Symmetrix® VMAX™, and EMC Symmetrix VMAXe™.

**EMC Replication Manager**

EMC Replication Manager manages EMC point-in-time replication technologies through a centralized-management console. Replication Manager coordinates the entire data replication process—from discovery and configuration to the management of multiple application-consistent, disk-based replicas. Auto-discover your replication environment and enable streamlined management by scheduling, recording, and cataloging replica information, including auto-expiration. With Replication Manager, you can put the right data in the right place at the right time—on-demand or based on schedules and policies that you define. This application-centric product allows you to simplify replica management with application consistency.
## Brocade FCX Series IP switches

Brocade FCX Series switches provide the high level of performance, scalability, and flexibility required for today’s enterprise networks. It also boasts some unique capabilities to optimize performance and enhance resiliency of an iSCSI-based storage network. Brocade FCX Series switches can be stacked to seamlessly scale the network when more servers and storage are needed. The Brocade FCX is a wire-speed, non-blocking switch that offers 24 or 48 x 10/100/1000 megabits per second (Mb/s) Ethernet ports. It also provides an option for a redundant power supply and offers reversible airflow. The Brocade FCX switch offers 4-port, 10 gigabit per second (Gb/s) modules, which can be used for uplink connectivity or for stacking multiple FCX switches.

Utilizing Brocade IronStack technology, organizations can stack up to eight switches into a single logical switch with up to 384 ports, simplifying management in the network-access layer. With the advanced capabilities, these switches deliver performance and intelligence to the network edge in a flexible 1U form factor that helps reduce infrastructure and administrative costs.

## Microsoft Windows Server 2008 R2 with Hyper-V

Hyper-V, the Microsoft hypervisor-based server virtualization technology, provides the cost savings of virtualization that enables customers to make the best use of their server hardware investments by consolidating multiple server roles as separate virtual machines running on a single physical machine.

Windows Server 2008 R2 introduces a new version of Hyper-V. It includes several core improvements for creating dynamic virtual data centers, including increased availability and improved management for virtualized data centers, increased performance and hardware support for Hyper-V virtual machines, and improved virtual-networking performance.

## Microsoft System Center Virtual Machine Manager

SCVVM 2008 R2 with Service Pack 1 (SP1) helps enable centralized management of physical and virtual IT infrastructure, increased server utilization, and dynamic resource optimization across multiple virtualization platforms. It includes end-to-end capabilities such as planning, deploying, managing, and optimizing the virtual infrastructure.

## Microsoft System Center Operations Manager

SCOM 2007 R2 is Microsoft’s end-to-end service-management product for Windows environments. It works seamlessly with Microsoft infrastructure servers, such as Windows Server, and application servers, such as Microsoft Exchange, helping to increase efficiency while enabling greater control of the IT environment.
Solution architecture and design

Solution architecture

The solution deploys all Exchange, SQL, and SharePoint servers as virtual machines on a Hyper-V cluster. The Failover Clustering feature provides the HA for virtual machines; furthermore, the Exchange Mailbox servers are configured in a database availability group (DAG) to provide HA from Exchange application and service level.

From the network perspective, all hosts connect to 1 GbE ports on the IP switches, and the iSCSI ports on the VNX5300 storage array connect to 10 GbE ports. The solution team configured redundant network connections on all hosts and storage systems to avoid a single point of failure.

Figure 2 shows the high-level architecture of the solution environment.

Figure 2. Architectural diagram

Environment profile

Table 2 details the environment profile used to validate this solution.

Table 2. Environment profile

<table>
<thead>
<tr>
<th>Application</th>
<th>Requirements</th>
<th>Quantity/Type/Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Server</td>
<td>Exchange Mailbox count (total)</td>
<td>2,500</td>
</tr>
<tr>
<td></td>
<td>Exchange Mailbox size</td>
<td>2 GB</td>
</tr>
<tr>
<td></td>
<td>Number of sent/received messages per user per day</td>
<td>200</td>
</tr>
</tbody>
</table>
Table 3 details the hardware components used to validate this solution.

**Table 3. Hardware environment**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
</table>
| EMC VNX5300                   | 1        | Block and file
Block OE Code: 5.31.000.5.502
SAS and NL-SAS disks
10 GbE iSCSI ports            |
| Server                        | 4        | CPU: 8 cores and dual processors per core, at 1.87 GHz
Hyper-threading is disabled
RAM: 128 GB                    |
| Brocade FCX Series IP switches| 2        | 48 GbE ports with 4 additional 10 GbE ports for uplinks and stacking          |
Table 4 lists the software components used to validate this solution.

**Table 4. Software environment**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyper-V cluster nodes</td>
<td>3</td>
<td>Windows Server 2008 R2 with SP1</td>
</tr>
<tr>
<td>Virtual machine operation system</td>
<td>11</td>
<td>Windows Server 2008 R2 with SP1</td>
</tr>
<tr>
<td>PowerPath</td>
<td>4</td>
<td>5.5 SP1</td>
</tr>
<tr>
<td>EMC Storage Integrator</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>SCOM</td>
<td>1</td>
<td>2007 R2</td>
</tr>
<tr>
<td>SCVMM</td>
<td>1</td>
<td>2008 R2 SP1</td>
</tr>
<tr>
<td>SharePoint Server</td>
<td>3</td>
<td>2010 Enterprise Edition with SP1</td>
</tr>
<tr>
<td>SQL Server</td>
<td>1</td>
<td>2008 R2 Enterprise Edition</td>
</tr>
<tr>
<td>Exchange Server</td>
<td>4</td>
<td>2010 Enterprise Edition</td>
</tr>
<tr>
<td>EMC Replication Manager</td>
<td>1</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Table 5 lists the virtual machine configurations to support the application workload.

**Table 5. Virtual machine configurations**

<table>
<thead>
<tr>
<th>Role</th>
<th>Virtual machine configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Server</td>
<td>2 x Mailbox servers (4 vCPUs/16 GB RAM)</td>
</tr>
<tr>
<td></td>
<td>2 x HUB/CAS servers (4 vCPUs/8 GB RAM)</td>
</tr>
<tr>
<td>SQL Server</td>
<td>1 x SQL Server (4 vCPUs/16 GB RAM)</td>
</tr>
<tr>
<td>SharePoint Server</td>
<td>2 x web front-end (WFE) servers (4 vCPUs/8 GB RAM)</td>
</tr>
<tr>
<td></td>
<td>1 x application server (2 vCPUs/4 GB RAM)</td>
</tr>
<tr>
<td></td>
<td>1 x SQL Server (4 vCPUs/16 GB RAM)</td>
</tr>
<tr>
<td>Active directory</td>
<td>2 x domain controllers (2 vCPUs/4 GB RAM)</td>
</tr>
<tr>
<td>Total virtual machine requirements</td>
<td>38 vCPUs/108 GB RAM</td>
</tr>
</tbody>
</table>
Component design and configuration

Overview
This solution provides a comprehensive design methodology aimed at creating a scalable building block for Microsoft Exchange Server 2010, SharePoint Server 2010, and SQL Server 2008 R2.

The following section also discusses design and configuration guidelines for the Hyper-V virtualization platform, network switches, and management tools implemented in this environment.

Hyper-V cluster design and configuration
This solution deploys a Hyper-V cluster consisting of three nodes to increase the availability of virtual machines and applications. The cluster is configured in Node Majority mode, which allows up to one node failure.

Virtual machine deployment design
When determining where to place virtual machines, it is important that you consider load balancing and failure protection in the plan. You should distribute virtual machines with the same application roles to different Hyper-V root servers. For example, this solution separates Domain Controller 01 and 02 virtual machines into Hyper-V Node 01 and 02, so if a Hyper-V node fails, only one of domain controllers will be affected and the other one will continue to provide Active Directory service. The same rule also applies to SharePoint WFE servers, Exchange Mailbox servers, Exchange HUB/CAS servers, and SQL servers (including the one for SharePoint).

Furthermore, if one Hyper-V node fails, the Hyper-V cluster moves the virtual machines from this node to another available node. In this situation, it is still necessary to separate the virtual machines with the same application role into different Hyper-V nodes. For example, this solution deploys Exchange Mailbox 01 on Node 02 and Exchange Mailbox 02 on Node 03. If Node 03 fails, it is better to move Exchange Mailbox 02 to Node 01 rather than Node 02. The solution team controlled this by setting the correct order of preferred owners for each virtual machine. Figure 3 shows this setting for Exchange Mailbox 02.
In addition, we disabled the automatic failback feature on all the virtual machines. Therefore, the virtual machines did not automatically move back to the original node. This is because failback uses Quick Migration in essential (the cluster shuts down the virtual machine first before moving it) but not Live Migration (the cluster moves virtual machine while keeping it online). Disabling failback prevents virtual machines from shutting down again.

Table 6 describes the virtual machine placement on each of this solution’s three Hyper-V nodes, along with the preferred owners of each virtual machine.

Table 6. Virtual machine distribution in Hyper-V cluster nodes

<table>
<thead>
<tr>
<th>Hyper-V Node</th>
<th>Virtual machines</th>
<th>Preferred owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node 01</td>
<td>Domain Controller 01</td>
<td>Node 01, 03, 02</td>
</tr>
<tr>
<td></td>
<td>SharePoint Application Server</td>
<td>Node 01, 02, 03</td>
</tr>
<tr>
<td></td>
<td>SQL Server (OLTP)</td>
<td>Node 01, 03, 02</td>
</tr>
<tr>
<td></td>
<td>SharePoint WFE 01</td>
<td>Node 01, 02, 03</td>
</tr>
<tr>
<td>Node 02</td>
<td>Domain Controller 02</td>
<td>Node 02, 03, 01</td>
</tr>
<tr>
<td></td>
<td>Exchange Mailbox 01</td>
<td>Node 02, 01, 03</td>
</tr>
<tr>
<td></td>
<td>Exchange HUB/CAS 01</td>
<td>Node 02, 01, 03</td>
</tr>
<tr>
<td></td>
<td>SharePoint SQL Server</td>
<td>Node 02, 03, 01</td>
</tr>
<tr>
<td>Node 03</td>
<td>Exchange Mailbox 02</td>
<td>Node 03, 01, 02</td>
</tr>
<tr>
<td></td>
<td>Exchange HUB/CAS 02</td>
<td>Node 03, 01, 02</td>
</tr>
<tr>
<td></td>
<td>SharePoint WFE 02</td>
<td>Node 03, 02, 01</td>
</tr>
</tbody>
</table>

The following list shows some other configurations on the Hyper-V virtual machines:

- Starting from Exchange 2010 SP1, Exchange server virtual machines, including Exchange Mailbox virtual machines that are part of a DAG, can be combined with host-based failover clustering and migration technology, such as Hyper-V
cluster, as long as the virtual machines are configured so that they do not save and restore state on disk when moved or taken offline.

For more information about this, visit:


Therefore, it is important to adjust the default setting for Hyper-V cluster to move virtual machines in the event of a resource going offline, from the default Save to Shut Down, as shown in Figure 4.

![Virtual Machine EX-MBX02 Properties](image)

**Figure 4. Virtual machine settings for cluster to move**

- Configure each virtual machine to use the correct network for Hyper-V cluster Live Migration, as shown in Figure 5. Live Migration is not in a dedicated network in this solution because the other NICs on Hyper-V hosts are configured for iSCSI, as well as network teaming for the production and cluster network to avoid a single point of failure.

![Virtual Machine EX-MBX02 Properties](image)

**Figure 5. Virtual machine network for Live Migration**

The boot disks for all the virtual machines are configured as fixed size VHD disks through CSV, and Hyper-V pass-through disks are used for all application databases and logs.
For CPU and memory resources, here are some recommendations in design:

- It is always better to be a bit conservative rather than overly aggressive during the resource capacity planning portion of the design process. Do not oversubscribe memory, and do not go over the 2:1 virtual processor-to-logical processor ratio.

  In this solution, each Hyper-V host contains a total of 16 logical processors (eight cores and dual processors per core). Therefore, do not allocate more than a total of 32 virtual processors to all guest virtual machines combined on a single Hyper-V host.

- Remember to reserve some room on the Hyper-V host for the potential virtual machine failover. For example, in the event of node failure, Hyper-V Node 1 will host not only its original four virtual machines, but also an Exchange Mailbox Server virtual machine and an Exchange HUB/CAS Server virtual machine from the failed node. In this case, Hyper-V Node 1 should have enough memory and CPU resources to serve these six VMs in total.

The following application sections describe the detailed CPU, memory, and storage requirements for each virtual machine.

**Hyper-V network design**

On each node of the Hyper-V cluster, more than one network adapter is utilized and separate dedicated networks are configured for production, cluster and iSCSI connections. As Exchange DAG is implemented in this solution, the EMC solution team created an additional replication network for Exchange log shipping and seeding traffic only.

To provide redundancy, Network Interface Card (NIC) teaming on each Hyper-V node is configured for production, cluster, and replication networks respectively. We used an additional two NICs on Hyper-V nodes to connect to VNX5300 storage array via iSCSI: we configured NIC1 to connect to two iSCSI ports on VNX5300, one on each of the storage processors (SPs) — SPA-1 and SPB-1 — and NIC2 to connect to SPA-2 and SPB-2. NIC1, SPA-1, and SPB-1 were on one network subnet, while NIC2, SPA-2 and SPB-2 were on a different subnet, which is a recommended configuration. Therefore, we created four separate paths for the iSCSI connection between the Hyper-V hosts and VNX5300 array. We configured the Microsoft iSCSI Initiator on the Hyper-V hosts to log into the targets on storage, and installed EMC PowerPath® to provide multipathing functionality.

To optimize performance, we made the following modifications to the iSCSI NICs of each Hyper-V host:

- Set all iSCSI NIC speeds to 1 GB full
- Disabled Client for Microsoft Networks
- Disabled File and Printer Sharing for Microsoft Networks
- Disabled IPv6 if not being used
On each of the Hyper-V hosts, we modified the TCP/IP settings for the network interfaces carrying iSCSI traffic to immediately acknowledge incoming TCP segments by setting the following registry key:

- HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters\Interfaces\<Interface GUID>
- TcpAckFrequency=DWORD:1 (Decimal)

For more information about this, visit: [http://support.microsoft.com/kb/2020559](http://support.microsoft.com/kb/2020559)

In this solution, two Brocade FCX Series IP switches provide all the network services. From the Hyper-V hosts, each of the two teamed NICs is connected to one switch to avoid a single point of failure on a switch. The same is true for the iSCSI connections. Each of the two iSCSI NICs connects to a separate switch.

Also, the solution team configured several VLANs on the switch to isolate network traffic. Table 7 shows the VLAN configuration on each IP switch.

**Table 7. Brocade FCX Series IP switch VLAN configuration**

<table>
<thead>
<tr>
<th>Switch</th>
<th>VLAN 1</th>
<th>VLAN 2</th>
<th>VLAN 3</th>
<th>VLAN 4</th>
<th>VLAN 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch 1</td>
<td>Production network</td>
<td>Cluster network</td>
<td>DAG replication network</td>
<td>iSCSI network</td>
<td>N/A</td>
</tr>
<tr>
<td>Switch 2</td>
<td>Production network</td>
<td>Cluster network</td>
<td>DAG replication network</td>
<td>N/A</td>
<td>iSCSI network</td>
</tr>
</tbody>
</table>

From the iSCSI performance perspective, Brocade FCX Series switches boasts unique capabilities to optimize performance and enhance resiliency of an iSCSI-based storage network.

- **Symmetric flow control:** In addition to asymmetric flow control, Brocade FCX Series switches support symmetric flow control, which means that they can both receive and transmit 802.3x PAUSE frames based on values that are pretested for optimal iSCSI performance. Symmetric flow control, supported on standalone as well as on all Brocade FCX switches in an IronStac addresses the requirements of a lossless service class in a dedicated iSCSI SAN environment. This feature ensures that large sequential data transfer is accomplished reliably, efficiently, and with lowest latency through the dedicated iSCSI SAN network. By default, Brocade IronWare software allocates a certain number of buffers to the outbound transmit queue for each port, based on Quality of Service (QoS) priority (traffic class). The buffers control the total number of packets permitted in the port’s outbound transmit queue. For each port, the Brocade device defines the maximum outbound transmit buffers, also called queue depth limits.

- **Total transmit queue depth limit:** This refers to the total maximum number of transmit buffers allocated for all outbound packets on a port. Packets are added to the port’s outbound queue as long as the number of buffers currently
used is less than the total transmit queue depth limit. All ports are configured with a default number of buffers and PAUSE thresholds.

- **Intelligent buffer management**: Brocade FCX stackable switches provide the capability to allocate additional egress buffering and descriptors to handle momentary burst traffic, especially when other priority queues may not be in use or may not be experiencing heavy levels of traffic. This allows users to allocate and fine-tune the depth of priority buffer queues for each packet processor. In instances of heavy traffic bursts to aggregation links, such as the traffic in stacking configurations or mixed-speed environments, this capability mitigates momentary oversubscription of buffers and descriptors, and reduces the possibility of dropped frames during the egress queuing.

Furthermore, to optimize iSCSI performance, the solution team:
- Disabled the spanning-tree for each VLAN on the switch.
- Disabled the port buffer allocation limit on the switch by using the following commands.

```
Switch (config)#buffer-sharing-full
Switch (config)#write mem
```

This setting permits all available buffers in a port region to be used on a first-come-first serve basis by any of its ports, regardless of priority. This change does not reset the ports or the switch. However, because of high production activity, EMC recommends that you make this change during non-production hours.

**Exchange Server 2010**

This solution deployed all the Exchange 2010 servers as Hyper-V virtual machines. The solution team configured two Exchange 2010 Mailbox Servers in a DAG to provide HA for databases. Each Mailbox server was set up on a separate Hyper-V host server for additional redundancy.

From the HUB/CAS server's perspective, the HUB/CAS combined role has a 1:1 CPU core ratio to the Mailbox Server. Therefore, the solution included two HUB/CAS servers as virtual machines and they were separated into different Hyper-V hosts.

**Exchange Server 2010 storage design for the EMC VNX5300**

The following list details the storage sizing guidelines for deploying Exchange 2010 on the VNX storage platform:

- When calculating the storage requirement, always calculate the I/O spindle requirements before calculating capacity requirements.
- When calculating the IOPS requirements, apply I/O overhead factors like antivirus, BDM, and other applications such as mobile device applications to your user profile.
- Consider additional bandwidth requirements imposed by BDM to make sure that there are no throughput bottlenecks on the back-end buses for a specific array model. The more databases are deployed, the more BDM bandwidth will be required.

- Isolate the Exchange Server database workload to a different set of spindles from other I/O-intensive applications or workloads such as SQL Server. This ensures the highest level of performance for Exchange and simplifies troubleshooting in the event of a disk-related Exchange performance issue.

- Either storage pools or RAID groups work well with Exchange Server 2010. Use the correct multiplier for best performance when designing and expanding storage pools: eight (4+4) drives for RAID 1/0 pools, five (4+1) drives for RAID 5 pools, and eight (6+2) drives for RAID 6 pools.

- In a mailbox resiliency deployment, you do not have to place the database files and logs from the same mailbox database onto different physical disks. However, you can separate database and log volumes into different storage pools or RAID groups for optimal performance.

- Balance LUNs across the array SPs to take best advantage of VNX5300 performance and HA, and distribute the I/O load evenly across VNX5300 front-end ports and back-end buses for failover and load balancing.

- Always format Windows volumes (housing Exchange database and log files) with an allocation unit size of 64 k to optimize Exchange performance on VNX systems.

**Exchange Server 2010 storage design methodology – Building block**

Sizing and configuring storage for use with Exchange Server 2010 can be a complicated process, driven by many variables and factors, which vary from organization to organization. Properly configured Exchange storage, combined with properly sized server and network infrastructure, can guarantee smooth Exchange operations and the best user experience.

One of the methods that can simplify the sizing and configuration of large Microsoft Exchange Server 2010 environments is to define a unit of measure called a building block. A building block represents the required amount of resources needed to support a specific number of Exchange 2010 users on a single virtual machine. You derive the number of required resources from a specific user profile type, mailbox size, and disk requirement.

Using the building block approach removes the guesswork and simplifies the implementation of Exchange virtual machines. After designing the initial Exchange Mailbox Server virtual machine building block, you can easily reproduce it to support all of the users in your organization that share similar user profile characteristics. You can apply this methodology when deploying Exchange in either a physical or a virtual environment. EMC’s best practices involving the building block approach for an Exchange Server design has been very successful for many customer implementations.
Table 8 lists the user profile to be simulated in this solution.

### Table 8. Exchange user profile

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Exchange 2010 users</td>
<td>2,500</td>
</tr>
<tr>
<td>Number of Mailbox Server virtual machines</td>
<td>2</td>
</tr>
<tr>
<td>Number of DAGs and database copies</td>
<td>1 DAG with 2 copies</td>
</tr>
<tr>
<td>User profile (in DAG configuration)</td>
<td>200 messages/user/day (0.20 IOPS)</td>
</tr>
<tr>
<td>Read: Write ratio</td>
<td>3:2 in a DAG configuration</td>
</tr>
<tr>
<td>Mailbox size</td>
<td>2 GB</td>
</tr>
</tbody>
</table>

Based on the user requirements in Table 6, the Mailbox Server building block is made up of eighteen 2 TB NL-SAS drives to support 2,500 active users in a single Exchange Mailbox Server under a switchover situation, with a 2 GB mailbox size and 0.2 IOPS per user. The building block includes a single RAID 1/0 (8+8) storage pool, which consists of 16 NL-SAS drives to house the Exchange database files (for both active and passive users), and a RAID 1/0 (1+1) storage pool of two NL-SAS drives for the Exchange Mailbox Server logs.

A storage pool is a single repository of physical disks on which LUNs are created. Pools can contain a few disks or hundreds of disks, whereas RAID groups are limited to 16 disks. Because of the large number of disks supported in a pool, pool-based provisioning provides the similar benefits of meta LUN striping across many drives. However, unlike meta LUNs, it requires minimal planning and management effort.

For more information about the building block and storage pool design for Exchange 2010, refer to the EMC white paper *Microsoft Exchange Server 2010 Performance Review Using the EMC VNX5300 Unified Storage Platform* at:


From the DAG database layout perspective, Exchange Mailbox Server 01 hosts Database 01 to 05 as active and Database 06 to 10 as passive. Conversely, Exchange Mailbox Server 02 is configured with Database 06 to 10 as active and Database 01 to 05 as passive. In the event of a server failure, databases on this failed server will fail over to the other server and the original passive databases will be activated.
Table 9 shows the detailed building block information for this solution.

### Table 9. Exchange building block

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Exchange users per Mailbox Server</td>
<td>1,250 active/1,250 passive (2,500 active under a switchover situation)</td>
</tr>
<tr>
<td>Number of databases per Mailbox Server</td>
<td>10 (5 active/5 passive)</td>
</tr>
<tr>
<td>User count per database</td>
<td>250</td>
</tr>
<tr>
<td>Database LUN size</td>
<td>1 TB</td>
</tr>
<tr>
<td>Log LUN size</td>
<td>50 GB</td>
</tr>
<tr>
<td>Disk size and type</td>
<td>2 TB 7.2k rpm NL-SAS disks</td>
</tr>
<tr>
<td>RAID type and disks required</td>
<td>RAID 1/0, 18 disks in two storage pools</td>
</tr>
</tbody>
</table>

**Hyper-V virtual machine design for Exchange Server 2010**

According to the storage design described above, all the database and log LUNs for the Exchange Mailbox Server virtual machine are configured as pass-through disks in Hyper-V.

After computing the disk calculations for Exchange, we calculated the virtual machine and Hyper-V requirements. The memory and CPU requirements are based on Microsoft best practices. For more information, visit the following websites:


Table 10 shows the detailed Exchange virtual machine configuration for this solution.

### Table 10. Exchange 2010 virtual machine configuration

<table>
<thead>
<tr>
<th>Server role</th>
<th>Quantity</th>
<th>vCPU</th>
<th>Memory (GB)</th>
<th>Boot disk VHD (GB)</th>
<th>Pass-through disks (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUB/CAS</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>100</td>
<td>N/A</td>
</tr>
</tbody>
</table>
| Mailbox     | 2        | 4    | 16          | 100                 | For each Mailbox Server virtual machine:   
  - 10 x 1 TB for databases  
  - 10 x 50 GB for logs      |
Storage design verification–Jetstress performance test

The solution team used Microsoft Jetstress 2010 to validate the storage design and verify the performance and stability of the VNX5300. Jetstress helps verify storage performance by simulating the Exchange I/O load. Specifically, Jetstress simulates the Exchange database and log file loads produced by a specified number of users. It tests the performance of the Exchange storage subsystem before placing it in the production environment.

While the Jetstress tool tests the performance of the Exchange storage subsystem before placing it in the production environment, it does not test the impact of the server CPU and memory configuration of Messaging Application Programming Interface (MAPI) user activity.


The solution team used Jetstress version 14.01.0225.017 to simulate the Exchange 2010 user I/O profile and the Exchange 2010 ESE file in a version of 14.01.0322.000 (Exchange 2010 SP1 with Rollup Update 5). We ran Jetstress in a 2-hour performance mode to verify Exchange 2010 building block performance.

During the Jetstress performance tests, we used one Hyper-V host server with one Exchange Mailbox Server virtual machine to support all 2,500 active user mailboxes. This is to simulate a worst-case scenario, where all databases are active on one Mailbox Server virtual machine in a switchover situation; in this way, we verified that the storage can meet performance requirements even when a failover occurs.

Table 11 provides the Jetstress test results including IOPS and disk response time. For a single Exchange Mailbox Server, this test achieved 20% more IOPS over the target of 600. This additional headroom provides a buffer against I/O spikes and peak load. At the same time, disk latencies are all within the acceptable parameters compared with Microsoft’s best practices for Exchange 2010 performance.

<table>
<thead>
<tr>
<th>Database I/O</th>
<th>Target</th>
<th>Test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieved Exchange transactional IOPS</td>
<td>600 (2,500 users x 0.2 + 20% overhead)</td>
<td>696</td>
</tr>
<tr>
<td>Average database disk read latency (ms)</td>
<td>&lt;20</td>
<td>17.1</td>
</tr>
<tr>
<td>Average database disk write latency (ms)</td>
<td>&lt; 20 and &lt; Average DB read latency</td>
<td>9.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transaction log I/O</th>
<th>Target</th>
<th>Test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average log disk write latency (ms)</td>
<td>&lt; 10</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Storage design overview

To maintain the flexibility, performance, and granularity of recovery, it is necessary to optimize the storage sizing and back-end configuration for SQL server. This section outlines the approach the solution team adopted when sizing the SQL Server.

Environment characteristics

The environment characteristics for SQL Server are outlined in Table 12.

Table 12. SQL environment characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of users</td>
<td>45,000</td>
</tr>
<tr>
<td>Total IOPS</td>
<td>800</td>
</tr>
<tr>
<td>Number of databases</td>
<td>1</td>
</tr>
<tr>
<td>RTO</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Read response times - data/logs</td>
<td>&lt; 20 millisecond (ms)</td>
</tr>
<tr>
<td>Write response times - data/logs</td>
<td>&lt; 20 ms</td>
</tr>
<tr>
<td>Read/write Ratio</td>
<td>90:10 OLTP</td>
</tr>
<tr>
<td>Backup/restore required</td>
<td>Yes (hardware VSS)</td>
</tr>
</tbody>
</table>

Design the storage architecture based on environment characteristics

EMC recommends to first calculate the spindles for the SQL Server to satisfy I/O requirements, and then for space requirements. The sizing calculation for this solution is listed below.

IOPS calculation

The IOPS calculation is:

- Total I/O for 45,000 users = 800 + 20%*800 = 800 + 160 = 960 IOPS
- Calculate backend I/O for RAID 1/0 SAS:
  - Total backend I/O for RAID 1/0 SAS = (960*0.9) + 2 (960*0.1) = 1056
- SAS disks required to service 1056 I/Os in a RAID 1/0 configuration:
  1056/130 =~ 8

From an I/O sizing perspective, the environment requires the following disks, based on the policy settings: eight 10k rpm 600 GB SAS drives.
Capacity calculation

The capacity calculation is:

- User database size: 500 GB
- Calculate the database LUN size based on the user database sizes:
  - Database LUN size = Database Size + Free Space Percentage Requirement (20 percent)
  - Data size = 500 + 20%*500 = 600 GB
- Calculate the tempdb and log LUN sizes for each of the databases as twenty percent the size of the database.
  - Log and tempdb size = 600*20% = 120 GB
- Total database size = Sum of the sizes of all the databases = 840 GB
- Usable capacity available per 600 GB 10k rpm SAS drive = 536 GB
- Spindle requirement = Total capacity / Usable Capacity
- Spindles required is: SAS (RAID1/0 2+2) = 4

Table 13. Configuration based on both I/O and capacity requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>500 GB SQL Server database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of spindles required to satisfy both I/O and capacity</td>
<td>Eight 10K 600 GB SAS drives</td>
</tr>
<tr>
<td>LUN size (database)</td>
<td>600 GB</td>
</tr>
<tr>
<td>LUN size (log)</td>
<td>120 GB</td>
</tr>
</tbody>
</table>

The solution team created four tempdb data files with the same initialization default size and the same growth settings for the SQL instance on the virtual machine.

SQL Server database design overview

The SQL Server test configuration is based on the following profile:

- Number of SQL Server users supported: 45,000
- Simulated user workload with one percent concurrency rate and zero think time, consistent with Microsoft testing methodologies.
- User data: 500 GB

SQL Server profile and SQL Server LUN design data is shown in Table 14 and Table 15 respectively.
Table 14. SQL Server Profile

<table>
<thead>
<tr>
<th>Profile</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total SQL Server database capacity</td>
<td>500 GB</td>
</tr>
<tr>
<td>Number of SQL Server instances</td>
<td>1</td>
</tr>
<tr>
<td>Number of user databases per instance</td>
<td>1</td>
</tr>
<tr>
<td>Number of virtual machine</td>
<td>1</td>
</tr>
<tr>
<td>Type of data store</td>
<td>Pass-through</td>
</tr>
<tr>
<td>SQL Server virtual machine configuration</td>
<td>4 virtual processors (vCPUs) with 16 GB memory (no over-commitment)</td>
</tr>
<tr>
<td>Concurrent users</td>
<td>Mixed workloads</td>
</tr>
</tbody>
</table>

Table 15. SQL Server LUN Design

<table>
<thead>
<tr>
<th>SQL Server</th>
<th>Number</th>
<th>RAID type</th>
<th>LUN size (GB)</th>
<th>Total size</th>
</tr>
</thead>
<tbody>
<tr>
<td>User data</td>
<td>3</td>
<td>R10</td>
<td>250</td>
<td>750 GB</td>
</tr>
<tr>
<td>Log</td>
<td>1</td>
<td>R10</td>
<td>250</td>
<td>250 GB</td>
</tr>
<tr>
<td>Tempdb Data</td>
<td>4</td>
<td>R10</td>
<td>200</td>
<td>800 GB</td>
</tr>
<tr>
<td>Tempdb Log</td>
<td>1</td>
<td>R10</td>
<td>200</td>
<td>200 GB</td>
</tr>
</tbody>
</table>

**SharePoint Server 2010**

**Mid-sized SharePoint 2010 design overview**

In this mid-sized SharePoint 2010 environment design, the major configuration includes the following highlights:

- The SharePoint farm uses three Hyper-V servers with four virtual machines and two WFE servers as query servers for query redundancy and better performance.
- The environment contains one SharePoint crawl server with a central administration site, and two WFE servers with a query role and one SQL Server.
- The farm is fully virtualized and deployed on VNX5300 with IP storage (iSCSI technology).
- The query components have two partitions. Each query server contains a part of the index partition and a mirror of another index partition for better query performance and fault tolerance.

**Storage design and SharePoint considerations**

The storage design uses all 600 GB 10k rpm SAS Disks to store all the SharePoint data including content databases, search databases, and tempdb on VNX5300.
Table 16 lists the volume layout for the SharePoint data on the VNX5300 array.

### Table 16. SharePoint volume layout

<table>
<thead>
<tr>
<th>Volume</th>
<th>Disk configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system volume</td>
<td>2 TB 7,200 rpm NL-SAS disks</td>
<td>All the virtual machine boot LUNs</td>
</tr>
<tr>
<td></td>
<td>RAID 1/0 (2+2)</td>
<td></td>
</tr>
<tr>
<td>Tempdb</td>
<td>600 GB 10,000 rpm SAS disks</td>
<td>tempdb data and log LUNs</td>
</tr>
<tr>
<td></td>
<td>RAID 1/0 (2+2)</td>
<td></td>
</tr>
<tr>
<td>SharePoint configuration databases</td>
<td>600 GB 10,000 rpm SAS disks</td>
<td>SharePoint configuration databases LUN</td>
</tr>
<tr>
<td></td>
<td>RAID 1/0 (2+2)</td>
<td></td>
</tr>
<tr>
<td>Index volume</td>
<td></td>
<td>Index LUN to store the temporary index on the crawl server</td>
</tr>
<tr>
<td>Query volume</td>
<td></td>
<td>Query LUNs to store indexes on each WFE server</td>
</tr>
<tr>
<td>Property databases and log</td>
<td></td>
<td>Property database data and log</td>
</tr>
<tr>
<td>Content databases data volume</td>
<td>600 GB 10,000 rpm SAS disks</td>
<td>Content databases data LUN</td>
</tr>
<tr>
<td></td>
<td>RAID 5 (9+1)</td>
<td></td>
</tr>
<tr>
<td>Content databases log volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawl databases and log</td>
<td>600 GB 10,000 rpm SAS disks (1+1)</td>
<td>Crawl database data and log LUNs</td>
</tr>
<tr>
<td></td>
<td>RAID 1/0 (1+1)</td>
<td></td>
</tr>
</tbody>
</table>
SharePoint 2010 farm Hyper-V and virtual machine design

The solution team added all the SharePoint LUNs as pass-through disks of the SharePoint. Table 17 details the virtualization allocation in this solution.

Table 17. Virtualization allocation

<table>
<thead>
<tr>
<th>Server role</th>
<th>Quantity</th>
<th>vCPUs</th>
<th>Memory (GB)</th>
<th>Boot disk VHD (GB)</th>
<th>Pass-through disks (GB)</th>
<th>Quantity of Pass-through</th>
<th>Pass-through device</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFE</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>100</td>
<td>50</td>
<td>1</td>
<td>Query volume</td>
</tr>
<tr>
<td>Index (Central Administration)</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>100</td>
<td>50</td>
<td>1</td>
<td>Index volume</td>
</tr>
<tr>
<td>SQL Server 2008 R2 Enterprise</td>
<td>1</td>
<td>4</td>
<td>16</td>
<td>100</td>
<td>250</td>
<td>5</td>
<td>Content database log volume</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>10</td>
<td>Content database log volume</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>1</td>
<td>Configuration database volume</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 + 50</td>
<td>2 (100 GB disk x1 and 50 GB disk x1)</td>
<td>SharePoint property data and log volumes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 + 50</td>
<td>2 (100 GB disk x1 and 50 GB disk x1)</td>
<td>SharePoint crawl data and log volumes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>5</td>
<td>SQL temp database and log volumes</td>
</tr>
</tbody>
</table>

EMC recommends that the SQL Server and SharePoint Server virtual machines are distributed evenly across the three Hyper-V servers. EMC also recommends laying out the different servers with the specific server role to different Hyper-V hosts. The request is easily served by other virtual machines in the farm, while the specific virtual machine fails over to another Hyper-V host and resumes their roles.

SharePoint farm configuration

The SharePoint farm is designed as a publishing portal. This solution has 1 TB of user content consisting of five SharePoint site collections (document centers) with five content databases, each populated with 200 GB of unique user data.
SharePoint search configuration

The search server consists of crawl servers that crawl and propagate the indexes on the query server and update the property stores on the SQL server. In SharePoint 2010, the crawl server no longer stores a copy of the index files. They are propagated to the query component during the crawl operation. Because of this, the crawl server is no longer a single point of failure.

The query servers split the content between them so that each of the query servers holds only a subset of the content index files and queries. The property store is the authoritative source for all indexed content properties and does not need to be synchronized with the crawl servers.

In this solution, the team enabled the query function on the WFE server and scaled out the query components to two partitions for load balancing. Each query component also holds a mirror of another index partition for fault tolerance consideration.

We provisioned a 150 GB iSCSI LUN that stores the index partition to each query server. We attached a 50 GB iSCSI LUN to the crawl server to store the temporary index files during the crawl operation.

SharePoint 2010 property and crawl database data and log files reside on separated RAID 1/0 LUNs using eight SAS disks.

For further information on scaling and sizing search architecture for the SharePoint Server 2010 farm, refer to Plan the topology for enterprise search on Microsoft Technet.

Design consideration for tempdb

Microsoft SQL Server performance best practices recommend that the number of tempdb data files should be the same number of core CPUs, and each of the tempdb data files should be the same size in the mid-size configuration.

In this solution, we created four tempdb data files because there are four SQL server core CPUs. We placed the tempdb data and log files on five iSCSI RAID 10 LUNs enabled for better performance.

Refer to Optimizing tempdb performance on Microsoft Technet for more information about the tempdb best practices for SQL Server 2008 R2.

SCOM

SCOM 2007 R2 delivers integrated management across the entire service lifecycle using a common toolset across physical, virtual, and cloud environments. It can help administrators to find and solve IT environment problems quickly and respond to mission-critical business applications faster within the required SLA.

This solution uses Microsoft SCOM 2007 R2 to discover and monitor the health, performance, and availability of the whole virtual infrastructure across the Exchange, SQL, and SharePoint applications, operation system, storage arrays, and hypervisors. The following management packs are imported into SCOM 2007 R2 to monitor the whole infrastructure:

- Microsoft SharePoint 2010 Products Monitoring Management Pack
Administrators use this software to monitor SharePoint 2010 products events, collect SharePoint component-specific performance counters in one central location, and to raise alerts that require operator intervention as necessary.

- **SQL Server Management Pack**
  SQL Server Management Packs provides the ability for Operations Manager 2007 SP1 and R2 to discover SQL Server 2005, 2008, and 2008 R2 systems. It monitors SQL Server components such as database engine instances, databases, and SQL Server agents.

- **Microsoft Exchange Server 2010 Management Pack**
  This software pack monitors Exchange 2010 events and raises alerts for operator intervention as necessary.

- **System Center Virtual Machine Manager (VMM) 2008 R2 Management pack**
  This software pack monitors availability of all components of VMM 2008 and the availability, health, and performance of all virtual machines and virtual machine hosts that VMM manages.

- **Microsoft Windows Server Operating System Management pack**
  This software pack consists of the following five management packs:
  - Microsoft Windows Server Library
  - Microsoft Windows Server 2008 Discovery
  - Microsoft Windows Server 2008 Monitoring
  - Microsoft Windows Server 2003
  - Microsoft Windows 2000 Server
  

Figure 6 shows the SharePoint 2010 farm from the SCOM. It shows two warnings (yellow exclamation symbols) triggered by an upgrade suggestion for the content databases after applying SharePoint server 2010 SP1. The different management packs require specific configurations and settings. Refer to [Microsoft System Center Market place](#) to find more information about the different system packs.
Microsoft SCVMM

SCVMM 2008 R2 with Service Pack 1 (SP1) helps administrators to centrally manage their physical and virtual IT infrastructures, increase server utilization, and dynamically improve resources optimization across multiple virtualized platforms.

This solution uses Microsoft SCVMM to provide unified management for an environment of Hyper-V servers hosting SQL, SharePoint, and Exchange virtual machines. VMM also helps to consolidate physical servers in a virtual environment and monitor all clusters, hosts, and virtual machines in this environment. Also, administrators can use Microsoft SCVMM to rapidly provision and the virtual machines and to dynamically optimize virtual resources through management packs that integrate with SCOM.

Figure 7 shows the virtual machine environment, including the host, CPU average, memory, disk inputs, and disk outputs of a virtual machine with a heavy load.
Figure 7. Virtual machine environment
ESI greatly simplifies managing, viewing, and provisioning of EMC storage in a Hyper-V environment. Moreover, ESI is a free product available to EMC customers. ESI for Windows provides storage viewing and provisioning capabilities. With ESI’s viewing capability, you can see the storage mapping information in Windows. As part of the storage provisioning, ESI simplifies the various steps involved in creating a LUN, preparing the LUN through the steps of partitioning, formatting, and creating a drive letter. ESI also enables the user to create a file share and mount that file share as a network-attached drive in a Windows environment.

ESI supports VMAX, VNX, VNXe, CX4, and NS Series for both block and file. It also provides an agentless architecture so that administrators do not need to install agents on the hosts. ESI further supports application provisioning tools, like Windows SharePoint Foundation 2010. It can map the SharePoint farm to storage infrastructure and provide best practices for the storage layout of the SharePoint farm.

This white paper describes the features available in the current ESI version at the time of this solution validation. EMC constantly improves and updates its products and technology with new features and functionalities. For the latest features and updates, visit www.emc.com or Powerlink.

In this solution, ESI is installed on the Hyper-V hosts and is used to provision the Cluster Shared Volume for the Hyper-V clusters environment. Figure 8 shows the Hyper-V hosts and VNX5300 across the entire environment. It also shows the storage pool capacity on the VNX5300 and all LUNs in that storage pool from the ESI.

Figure 8. ESI simplifier view of Hyper-V hosts and VNX5300

Consider the following aspects when installing EMC ESI:

- Install PowerShell 2.0 on the hosts; download and install it from the Microsoft website to each Hyper-V server.
- Install VNX Adapter on the hosts to support the VNX series.
- Enable the remote PowerShell on the controller hosts. To enable the remote PowerShell, run the following PowerShell cmdlet on the controller host:
  ```powershell
  Enable-PSRemoting -force
  ```

- When using iSCSI transport for SAN connectivity, make sure the iSCSI initiator can log on to the storage systems.

While configuring the cluster node in ESI, it is very easy to add a cluster system. Click **Add Cluster System** and input the cluster name and IP address of the cluster node. Figure 9 shows the ESI user interface when adding a cluster node.

Figure 9.  Add Cluster System Wizard in the ESI 1.2

After you add the cluster node to ESI, ESI shows all the cluster disks and its relative information. As seen from Figure 10, ESI provides insight into cluster disk resources on the storage arrays.

Figure 10.  ESI user interface showing cluster disk resources on storage arrays
By clicking **Create Cluster Disk**, an administrator can easily create a cluster disk and cluster shared volume (CSV) directly from VNX5300. This wizard simplifies the various steps involved in creating a LUN in a specific storage pool, mapping a LUN to all the cluster nodes, and adding storage into the cluster node. Figure 11 shows the first step of the **Create Cluster Disk wizard** in the ESI 1.2 to select the storage array for a cluster disk.

![Create Cluster Disk](image)

**Figure 11.** The first step of Create Cluster Disk wizard

Generally, it takes at least 17 steps to create a Cluster Shared Volume from VNX5300 to the Windows clusters. With ESI, storage administrators can complete this task in four steps using the **Create Cluster Disk wizard**.

For detailed steps on how to use ESI, refer to *Storage Integrator for Windows 1.2 Product Guide*.

ESI also supports PowerShell commands. For a large environment deployment, storage administrators can also use ESI PowerShell commands to deploy multiple volumes in Windows platform at the same time.

Features described in this document are based on the ESI version available at the time of this solution validation. EMC constantly improves and updates its products and technology with new features and functionalities. Visit [http://www.emc.com/](http://www.emc.com/) for the latest features and updates.
Data replication and recovery design

Overview

This solution uses EMC Replication Manager with the VNX SnapView snapshots technology to automate the creation of mountable production-data snapshots without taking application production offline for local protection. Replication Manager provides an easy-to-use user interface to manage, schedule, and monitor replication jobs.

The solution team installed Replication Manager Agent software on each virtual machine involved in the replication process, including the Exchange servers, SQL Server, and SharePoint servers. This enabled the integration of Replication Manager agents with these Microsoft applications.

To configure VNX5300 SnapView snapshots, allocate a reserved LUN pool with the proper number and size of LUNs (also known as a snapshot cache) for the snapshot function. Due to the dynamic nature of reserved LUN assignment per source LUN, we used several small LUNs that were the same size as the pool of individual resources. This snapshot pool consisted of 104 x 30 GB LUNs on two RAID 5 (4+1) storage pools. To ensure minimum disruption to the production environment during snapshot operations, this solution used 600 GB 10k rpm SAS disks for the reserved LUN pool.

Hyper-V considerations

Because the solution uses pass-through disks, we enabled SCSI filtering for the parent partition in the Hyper-V, and used PowerShell scripts on the Hyper-V parent partition to achieve this. See the Additional information section for detailed information about the scripts.

SharePoint farm considerations

When configuring Replication Manager, the solution team:

• Used Replication Manager 5.4 to create full replicas of an entire SharePoint 2010 farm (including content databases, configuration database, administration database, search database, and search index files).

• Suggests regularly scheduling snapshots backups when the SharePoint farm is least busy at non-business hour.

• Recommends using EMC SnapView clones over snapshots in some large SharePoint environment with high IOPS or where the application change rate is expected to be high.

• Disabled SCSI filtering for the parent partition in Hyper-V. See the Additional information section for the scripts to do this.

• Installed EMC Solutions Enabler on the servers as a prerequisite to ensure that the application LUNs can be backed up using SnapView snapshots technology.

• Installed Replication Manager agent on all the SharePoint Servers for replication jobs.

• Installed SharePoint on a separate device rather than the operating system as a better practice. All the SharePoint data LUNs are accessed through the Hyper-V pass-through device. Local storage (like the C drive) is not supported.

• Registered the Windows SharePoint Services (WSS) VSS writer service on the application server at the SharePoint center administration site by running the
following command:
stsadm .exe –o registerwsswriter

- Configured the Replication Manager Server as a mount host to enable data accessibility for data repurposing, Business Intelligence (BI), integrity checking, streaming backups, and so on.

When designing the Replication Manager backup environment:

- Each Replication Manager job is directly associated with an application set and is configured to take a snapshot of that database.
- The local replication technology used for this solution is SnapView snapshots.
- The job can be scheduled using Replication Manager to minimize administrative tasks and automate the solution. Since the databases and logs are located on separate LUNs, it also provides a roll-forward restore capability and no-data-loss solution when the logs are intact.

For Exchange Server 2010, Replication Manager supports both the standalone servers and DAG. For the DAG copies used in this solution, Replication Manager can replicate data from native Exchange DAGs with both active and passive copies. The Replication Manager agent on the Exchange Server communicates with the Microsoft Exchange Information Store service and Exchange VSS writer to discover the mailbox database information and create application-consistent replicas using VSS.

For more information, refer to *EMC Replication Manager Support for Microsoft Exchange 2010 — Technical Notes*.

The best practice guidelines for designing a Replication Manager backup environment for Exchange Server 2010 are listed as follows:

- In a DAG environment, it is a good practice to take snapshots of the passive copy to lessen any potential performance impact.
- EMC recommends that you separate the database and logs onto different LUNs to take advantage of Replication Manager’s ability to provide no data loss roll-forward recovery.
- If possible, use a physical mount even in a virtual environment as this reduces the time it takes to mount the volumes.
- In Exchange Server 2010, it is no longer required to run consistency checks on the mounted snapshot copy. However, EMC recommends that you do this once a week.
- Do not share spindles between the production volumes and snapshot copies. Always dedicate spindles for the snapshot cache for better performance.

In this solution, Replication Manager is configured to back up the passive database copies on the Exchange Mailbox Servers to reduce the performance impact on the client access to active database copies. Figure 12 shows how we configured Replication Manager to back up Exchange Server data.
Replication Manager design considerations for Microsoft SQL Server in a virtual environment are similar to those in a physical environment.

The best practice guidelines for designing a Replication Manager backup environment for SQL Server 2008 R2 are listed as follows:

- EMC recommends that you separate the database and logs onto different LUNs to allow for individual restore of different components.
- All system database data and log files should not be on any of the user database or log LUNs.
- Use EMC PowerPath on the mount host for optimal multipathing and load balancing.
- When planning to use the replica for testing and reporting purposes, mount the replica to an alternate host and also considering using EMC SnapView Clones over Snapshots when the I/O load on the replicas is expected to be high.

In this solution, the following components comprise the environment that is part of the Replication Manager design for Microsoft SQL 2008 R2:

- Microsoft SQL Server 2008 R2 virtual machines in a stand-alone configuration
- VNX5300 array
- All the database data and log LUNs that are going to be replicated need to be on pass-through LUNs
- SnapView that takes a snapshot of SQL Server database for local protection
- A single standalone virtual machine to run Replication Manager Server software. This Replication Manager Server also manages the replication of the SharePoint farm and Exchange Servers in this environment.

**Note:** This is a guideline only. Environment requirements will vary based on customer requirements.
Replication Manager performs the following high-level steps when taking a snapshot of the SQL Server 2008 R2 databases:

1. Configures one Replication Manager job for the TPC-E like database that Online Transaction Processing (OLTP) runs on.

2. The Replication Manager job takes a SnapView snapshot copy of the database defined in the application set. This copy is an application-consistent VSS copy of the source databases.

3. Optionally, the Replication Manager job mounts the database replica on the mount host for potential tape backup needs (these snapshots will be unmounted when the next replication starts).

Consider the following items when designing the Replication Manager backup environment:

- Configure Replication Manager to take a snapshot of the database. Each Replication Manager job is directly associated with an application set and the database is defined in the application set.

- You can schedule the job using Replication Manager to minimize administrative tasks and to automate the solution. Since the databases and logs are located on separate LUNs, it also provides a roll-forward restore capability and no-data-loss solution when the logs are intact.
Test methodology

Overview

To simulate a client workload for Exchange Server, SQL Server, and SharePoint Server, this solution uses the following tools:

- Microsoft Exchange Load Generator
- SQL Server TPC-E like workload
- SharePoint 2010 Microsoft Visual Studio Team System (VSTS)-generated custom workload

Microsoft Exchange Load Generator

Microsoft Exchange Load Generator (LoadGen) is a simulation tool used to measure the impact of MAPI, OWA, ActiveSync, IMAP, POP, and SMTP clients on Exchange Server 2010 and 2007. LoadGen allows customers to test how a server running Exchange 2010 or 2007 responds to e-mail loads. These tests send multiple messaging requests to the Exchange server, which causes a mail load. LoadGen is a useful tool for administrators who are sizing servers and validating a deployment plan. Specifically, LoadGen helps organizations to determine if each of their servers can handle the load they are intended to carry.

LoadGen requires full deployment of the Exchange environment for validation testing. Customers should perform all LoadGen validation testing in an isolated lab environment where there is no connectivity to production data.

To get a copy of LoadGen tool, visit:


In this solution, we used the LoadGen tool to simulate the Exchange client user load. The solution team measured Exchange performance in normal and environment failure scenarios, as well as when testing Replication Manager.

SQL Server TPC-E like workload

The test environment uses a Microsoft Benchcraft TPC-E testing tool. It generates a TPC-E-like workload (OLTP). The testing environment is composed of a set of transactional operations that simulate the activity of a brokerage firm, such as managing customer accounts, executing customer trade orders, and other transactions within the financial markets.

SharePoint 2010 VSTS-generated custom workload

To populate the data in the content database and file share we downloaded from various sources and used each document to generate hundreds of unique documents by inserting a keyword and timestamp into the original document. We also changed the document name for the generated file to include the timestamp. In this way, we ensured that the documents in the testing environment were unique. We used keywords and timestamps in the search testing to ensure the uniqueness of the search results. We spread the data evenly across the five sites (each collection is a unique content database).
VSTS test client and test mechanism

The solution team used VSTS with custom code developed by EMC and ratified by Microsoft to simulate the SharePoint load. We used a client load emulation tool to ensure that the SharePoint farm was operating at the optimal performance level.

We built up the testing environment with a VSTS team test rig that consisted of a single controller and two agents.

SharePoint user profiles

The user profiles consist of a mix of three user operations: browse, search, and modify.

During validation, a Microsoft heavy-user load profile was used to determine the maximum user count that the Microsoft SharePoint 2010 server farm could sustain, while ensuring the average response times remained within acceptable limits. Microsoft standards state that a heavy user performs 60 requests in each hour; that is, a request every 60 seconds.

The user profiles in this testing consist of three user operations:

- 80 percent browse
- 10 percent search
- 10 percent modify

Note Microsoft publishes default SLA response times for each SharePoint user operation. Common operations (such as browse and search) should be completed within 3 seconds or less, and uncommon operations (such as modify) should be completed within 5 seconds or less. The response times in the testing should meet or exceed these SLAs.
Performance test results

Overview
In the performance test, the tools described in the Test Methodology section generated the client workload for Exchange Server, SQL Server, and SharePoint Server simultaneously and the application performance was monitored. The solution team ran each test for 8 hours to simulate a normal working day. This section provides the detailed performance results.

Notes
- Benchmark results are highly dependent upon workload, specific application requirements, and system design and implementation. Relative system performance will vary as a result of these and other factors. Therefore, this workload should not be used as a substitute for a specific customer application benchmark when critical capacity planning and/or product evaluation decisions are contemplated.
- All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly.
- EMC Corporation does not warrant or represent that a user can or will achieve similar performance expressed in transactions per minute.

Hyper-V root server
Table 18 lists the performance counters that we monitored on the Hyper-V root servers. These counters show the average percentage of processor time spent in guest code, in hypervisor code, and in both, which we used to measure the total processor utilization for all virtual machines running on the host server and the total processor utilization of the hypervisor for the entire system. The processor utilization remained in a healthy state on all Hyper-V nodes and there was sufficient space for any potential virtual machine failover.

<table>
<thead>
<tr>
<th>Performance counter</th>
<th>Target</th>
<th>Node 1</th>
<th>Node 2</th>
<th>Node 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyper-V Hypervisor Logical Processor% Guest Run Time</td>
<td>&lt;65%</td>
<td>29.4%</td>
<td>35.1%</td>
<td>36.0%</td>
</tr>
<tr>
<td>Hyper-V Hypervisor Logical Processor% Hypervisor Run Time</td>
<td>&lt;5%</td>
<td>1.9%</td>
<td>2.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Hyper-V Hypervisor Logical Processor% Total Run Time</td>
<td>&lt;70%</td>
<td>31.3%</td>
<td>37.3%</td>
<td>37.7%</td>
</tr>
</tbody>
</table>

IP switch
We also monitored the IP switch’s performance, including CPU utilization, memory utilization, and iSCSI port utilization during the performance test, as displayed in Table 19. These utilizations were not very high, which means the switch still had sufficient room to provide for other workloads or future growth.
Table 19. IP switch utilization in performance test

<table>
<thead>
<tr>
<th>Switch</th>
<th>CPU utilization</th>
<th>Memory utilization</th>
<th>Average GbE iSCSI port utilization</th>
<th>Average 10 GbE iSCSI port utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rx</td>
<td>Tx</td>
</tr>
<tr>
<td>01</td>
<td>1%</td>
<td>5%</td>
<td>9.2%</td>
<td>17.5%</td>
</tr>
<tr>
<td>02</td>
<td>1%</td>
<td>5%</td>
<td>9.0%</td>
<td>17.5%</td>
</tr>
</tbody>
</table>

One of the key benefits of Brocade FCX switches in an iSCSI SAN environment is its lossless Ethernet capabilities. If the future level of network utilization increases to the point of congesting the network, this feature relies on flow control capabilities as defined by IEEE 802.3x to signal the sender (iSCSI initiator or target) to stop sending data for a brief period of time. During this time, the Brocade FCX switch quickly takes care of the congestion, which enables the iSCSI traffic to resume to a full performance quickly. Since iSCSI datagram is encapsulated on TCP, this mechanism avoids the slow start problem of TCP, where the loss of packets causes the flow to slow down.

The following LoadGen tests were performed on the Exchange Server to measure the performance of Exchange infrastructure when combined with the SQL Server and SharePoint Server workload in the entire environment as shown in Table 20.

Table 20. LoadGen test scenarios

<table>
<thead>
<tr>
<th>Test scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>8 hours, 100% concurrency test under normal operating conditions with 200 messages MAPI profile. The objective was to validate the entire Exchange environment under normal operating conditions.</td>
</tr>
<tr>
<td>Failover scenario</td>
<td>8 hours, 100% concurrency test for the scenario if one Mailbox Server and one HUB/CAS server fail so that the other Mailbox Server and HUB/CAS server assumes the load for all 2,500 active users. The objective was to validate the environment's performance when one Mailbox Server and one HUB/CAS server are lost.</td>
</tr>
</tbody>
</table>

**Exchange performance results**

Table 21 shows the detailed LoadGen test results on the Exchange Mailbox Server and HUB/CAS server. Performance data was collected at 15-second intervals for the duration of each 8-hour test run. The results of the first and the last hours were discarded and were averaged over the rest of the test duration.

As indicated in Table 21, the performance results were all within the acceptable parameters even in a failover scenario, though the processor utilization on the remaining servers increased due to the loss of one Mailbox Server and one HUB/CAS server.
### Table 21. LoadGen test results

<table>
<thead>
<tr>
<th>Server</th>
<th>Performance counter</th>
<th>Target</th>
<th>Normal</th>
<th>Failover</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBX server</td>
<td>Processor%Processor time</td>
<td>&lt;80%</td>
<td>40.1%</td>
<td>66.1%</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O database reads (attached) average latency</td>
<td>&lt;20 ms</td>
<td>12.1</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O database writes (attached) average latency</td>
<td>&lt;20 ms</td>
<td>5.1</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O database reads (recovery) average latency</td>
<td>&lt;200 ms</td>
<td>7.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O database writes (recovery) average latency</td>
<td>&lt;200 ms</td>
<td>6.8</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O log read average latency</td>
<td>&lt;10 ms</td>
<td>4.0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MSEExchange database\I/O log writes average latency</td>
<td>&lt;10 ms</td>
<td>2.3</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>MSEExchange Replication(*)\ReplayQueueLength</td>
<td>&lt;2</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MSEExchange\RPC averaged latency</td>
<td>&lt;70</td>
<td>2.7</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>MSEExchange\RPC requests</td>
<td>&lt;10 ms</td>
<td>1.4</td>
<td>4.9</td>
</tr>
<tr>
<td>HUB/CAS server</td>
<td>Processor%Processor time</td>
<td>&lt;80%</td>
<td>13.3%</td>
<td>28.8%</td>
</tr>
<tr>
<td></td>
<td>MSEExchange RpcClientAccess\RPC Averaged Latency</td>
<td>&lt;40</td>
<td>7.0</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td>MSEExchange RpcClientAccess\RPC Requests</td>
<td>&lt;250ms</td>
<td>1.1</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>MSEExchangeTransport Queues(_total)\Aggregate Delivery Queue Length (All Queues)</td>
<td>&lt;3000</td>
<td>1.2</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>MSEExchangeTransport Queues(_total)\Active Remote Delivery Queue Length</td>
<td>&lt;250</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MSEExchangeTransport Queues(_total)\Active Mailbox Delivery Queue Length</td>
<td>&lt;250</td>
<td>1.0</td>
<td>10.1</td>
</tr>
</tbody>
</table>

**Storage performance results of Exchange database disks**

The utilization of disks in an Exchange database pool is shown in Figure 13 during the LoadGen test in normal scenario. The average utilization is around 25 percent for some disks and 40 percent for the others, all with a healthy status.
On average, the SQL Server processed over 120 database transactions per second during the 8-hour test. Microsoft’s acceptable user response times were comfortably met at all times.

**Note** We configured this 8-hour test with realistic user values and user load concurrency counts. The aim of this test was not to run the SQL Server at maximum performance capacity, but to run the test at maximum disk capacity with acceptable I/O response times. The average test response time stayed well within acceptable parameters.

Throughout the duration of the 8-hour load tests, the SQL Server performance remained stable. Due to checksum activity, some peaks and dips were seen.

**Storage performance results**

We analyzed the disk utilization and disk response time counters.

As shown in Figure 14, four disks were used to store TPC-E data. Two data disks’ utilization is around 70 percent, and the other two disks’ utilization is around 45 percent.
As shown in Figure 15, the data storage pool for TPC-E contained four SAS disks. The average disk response time was about 16 milliseconds (ms) with spikes of up to 24 ms.

**SQL Server results**

We recorded the SQL Server response times for client requests to determine the amount of time it took the SQL Server to respond to a client request and gauge the overall client experience. The transaction per second (transaction/sec) average response time per request should not exceed 20 ms. The following performance counter on the SQL Server was tracked to monitor the response time.

We tracked the following performance monitor counters on SQL Server to monitor the disk I/O activities:

- **Latency**
  - Reads: Average disk sec/read
  - Writes: Average disk sec/write
- **IOPS**
  - Read IOPS: disk reads/sec
  - Write IOPS: disk writes/sec
- **Total IOPS: disk transfers/sec**
From a SQL Server client perspective, each test was validated by comparing the results of select performance counters to the allowed Microsoft-specified criteria. We collected performance counter data at one-second interval for the duration of each test run. The results of the first and last hours were discarded and the results were averaged over the remaining duration of the test.

The combined test ran under heavy load on the Exchange Server, SQL Server, and SharePoint Server. The SQL Server results are shown in Table 22.

### Table 22. SQL Server results

<table>
<thead>
<tr>
<th>Counter</th>
<th>Target</th>
<th>Actual test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average disk sec/read</td>
<td>&lt;20 ms</td>
<td>19 ms</td>
</tr>
<tr>
<td>Average disk sec/write</td>
<td>&lt;20 ms</td>
<td>6 ms</td>
</tr>
<tr>
<td>Disk reads/sec</td>
<td>N/A</td>
<td>160</td>
</tr>
<tr>
<td>Disk writes/sec</td>
<td>N/A</td>
<td>15</td>
</tr>
<tr>
<td>Disk Transfers/sec</td>
<td>N/A</td>
<td>175</td>
</tr>
<tr>
<td>Transaction/sec</td>
<td>N/A</td>
<td>121</td>
</tr>
</tbody>
</table>

The baseline performance test indicated the maximum user load on the production SharePoint farm when combined with a SQL and SharePoint workload in the entire environment. This test was run for 8 hours with a full user load.

**SharePoint Server 2010**

**SharePoint Performance Results**

The test result shows that the maximum user capacity is 16,440 as displayed in Table 23.

### Table 23. Test result of baseline VSTS performance

<table>
<thead>
<tr>
<th>Test scenario</th>
<th>Requests per second (RPS)</th>
<th>Concurreny (%)</th>
<th>Maximum user capacity</th>
<th>Average user response time (per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-hour combine tests</td>
<td>27.4</td>
<td>10</td>
<td>16,440</td>
<td>0.47, 0.47, 2.23</td>
</tr>
</tbody>
</table>

Because of the full user load, CPU utilization on the WFE servers was the bottleneck. EMC suggests that you scale out more WFE servers to achieve more user capacity.

Table 24 lists the CPU, memory, and network usage of the production virtual machine.

### Table 24. CPU, memory usage, and network usage of the production virtual machine

<table>
<thead>
<tr>
<th>Server types</th>
<th>Average CPU process time (%)</th>
<th>Average memory usage (%)</th>
<th>Network Usage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL server</td>
<td>38.5</td>
<td>99</td>
<td>42.9</td>
</tr>
<tr>
<td>WFE01</td>
<td>77.697</td>
<td>40</td>
<td>18.4%</td>
</tr>
</tbody>
</table>
EMC Infrastructure for Microsoft Private Cloud
EMC VNX 5300, Replication Manager, Microsoft Hyper-V, Microsoft Exchange, SharePoint, SQL Server, System Center

<table>
<thead>
<tr>
<th>Server types</th>
<th>Average CPU process time (%)</th>
<th>Average memory usage (%)</th>
<th>Network Usage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFE02</td>
<td>74.141</td>
<td>37.5</td>
<td>18.1%</td>
</tr>
<tr>
<td>Application server</td>
<td>15.21</td>
<td>36</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 16 shows the number of passed tests per second (passed tests/sec) in the VSTS performance test. The average number of passed tests per second was 27.8 with two WFEs. The fluctuating passed tests per second was influenced by the incremental crawl of the SharePoint sites every two hours, which we allowed to provide performance illustration in a real-world customer environment.

![Graph showing passed tests/sec in the VSTS performance test]

**Figure 16. Passed tests/sec in the VSTS performance test**

**Storage performance results of SharePoint**

Figure 17 shows the disk utilization of the SharePoint content database during the test in VNX5300. During this test, the peak of the disk utilization was caused by the incremental crawl every two hours. The average disk utilization of SharePoint content databases was 36.69 percent when running the heavy load of mixed application.

![Graph showing disk utilization of SharePoint content database]

**Figure 17. Disk utilization of SharePoint content database**
Figure 17. Average disk utilization of content databases on the VNX5300

Table 25 lists the disk performance counters on the SharePoint content databases when performing the combined tests.

Table 25. Disk latency on the SharePoint content databases

<table>
<thead>
<tr>
<th>Disk latency of LUNs</th>
<th>Counter</th>
<th>Combine test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk latency of each content database data LUN</td>
<td>Avg disk reads/sec</td>
<td>9 ms</td>
</tr>
<tr>
<td></td>
<td>Avg disk writes/sec</td>
<td>8 ms</td>
</tr>
<tr>
<td></td>
<td>Average IOPS</td>
<td>215</td>
</tr>
<tr>
<td>Disk latency of each content database log LUN</td>
<td>Avg disk reads/sec</td>
<td>0 ms</td>
</tr>
<tr>
<td></td>
<td>Avg disk writes/sec</td>
<td>2 ms</td>
</tr>
<tr>
<td></td>
<td>Average IOPS</td>
<td>25</td>
</tr>
</tbody>
</table>
Failure simulation test results

**Test objective**
The objective of the failure simulation test was to validate the HA level that this solution provides when one of the following components failed in the environment:

- An IP switch
- A Hyper-V node
- One of the VNX5300 SPs
- One of the VNX5300 disks hosting database data (a disk failure for SQL server was tested in this solution)

**Overview**
The purpose of this test was to prove all Microsoft application workload requirements can still be met, even if there is hardware failure on one of the IP switches. In this test scenario, the client workload started to be generated at around 12:15 p.m. When it became stable after 1 hour and 20 minutes, we shut down one of the IP switches to simulate a failure. Because the IP switches were redundant, the remaining switch continued to handle all the network traffic. However, there was some impact on disk performance as half of the iSCSI channels were down from hosts to storage. In the event of a connectivity failure, EMC PowerPath enables continuity to storage from Hyper-V, ensuring the remaining paths to storage are utilized seamlessly.

After the workload was stable for one hour in the single-switch working model, we powered on the switch that was shut down previously.

Table 26 shows the timeline of each action in the process of this test.

**Table 26. Switch failure test process**

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:15 p.m.</td>
<td>Test started</td>
</tr>
<tr>
<td>13:32 p.m.</td>
<td>An IP switch was shut down to simulate a failure</td>
</tr>
<tr>
<td>14:35 p.m.</td>
<td>The IP switch was powered back on</td>
</tr>
<tr>
<td>15:10 p.m.</td>
<td>Test completed</td>
</tr>
</tbody>
</table>

**Exchange Server 2010 impact**
On examining the performance logs on Exchange Mailbox Servers and HUB/CAS servers, we found that the CPU utilization remained stable through the testing duration, with a spike only at the moment when the switch was turned off.

On the Exchange HUB/CAS Servers, the Remote Procedure Call (RPC) client access performance (RPC Averaged Latency and RPC Requests counters) was not affected by the switch shutdown.

On the Exchange Mailbox Servers, the Exchange read performance dropped a little with only one switch working, as shown in Table 27.
Table 27. Exchange read performance in switch failure test

<table>
<thead>
<tr>
<th>Performance counter</th>
<th>Target</th>
<th>Before switch shutdown</th>
<th>After switch shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS Exchange database\I/O database reads (attached) average latency</td>
<td>&lt;20 ms</td>
<td>11.2 ms</td>
<td>13.0 ms</td>
</tr>
<tr>
<td>MS Exchange database\I/O log read average latency</td>
<td>&lt;10 ms</td>
<td>3.6 ms</td>
<td>4.3 ms</td>
</tr>
</tbody>
</table>

Shutting down the IP switch had some impact on the Exchange write performance. As shown in Figure 18, shutting down the IP switch triggered a spike on the latency of the Exchange database and log write operations. Compared with the performance when the two switches were both working properly (from 12:15 p.m. to 13:30 p.m.), the disk write latencies increased after one switch was down (from 13:35 p.m. to 14:30 p.m.). However, both of the Exchange read and write performance results were still within the thresholds recommended by Microsoft even when there was only one switch handling all network traffic.

Figure 18. Exchange write performance during the switch failure test
**SQL Server 2008 R2 impact**

By analyzing the performance logs on SQL Server, we found that the average transactions per second of the SQL Server instance dropped to zero when the switch was shut down. Then, the performance recovered to average within one minute, as shown in Figure 19.

![Figure 19. Transactions per second in switch failure testing](image)

Because of the downtime, the value of the average duration per disk read dropped to zero when the switch was shut down. A spike to around 100 ms occurred when the performance was being recovered. Afterwards, the average duration per disk read went back to normal.

![Figure 20. Average duration per disk read in switch failure testing](image)

**SharePoint Server 2010 impact**

As shown in Figure 21, shutting down the IP switch triggered a downtime of all the SharePoint requests, and then all the requests recovered in seconds.
Table 28. Performance impact during switch failure

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Browse (sec)</th>
<th>Search (sec)</th>
<th>Modify (sec)</th>
<th>Pass tests/sec</th>
<th>Number of users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine testing</td>
<td>0.47</td>
<td>0.47</td>
<td>2.23</td>
<td>27.4</td>
<td>16,440</td>
</tr>
<tr>
<td>Combine testing when IP switch was down</td>
<td>0.47</td>
<td>0.52</td>
<td>3.00</td>
<td>24.6</td>
<td>14,760</td>
</tr>
</tbody>
</table>

Overview

In this test scenario, we directly powered off one of the three Hyper-V cluster nodes (Node 3) that hosts the following virtual machines to simulate a server failure:

- One SharePoint WFE server
- One Exchange Mailbox Server
- One Exchange HUB/CAS server

If a Hyper-V node experiences hardware failure, the virtual machines originally hosted on this node will also be dropped, and Hyper-V Failover Cluster will move them quickly to another node and then be powered on automatically. As defined in the Hyper-V cluster design and configuration section, when the Hyper-V Node 3 was down, the SharePoint WFE server moved to Hyper-V Node 2, and the Exchange Mailbox Server and HUB/CAS server moved to Hyper-V Node 1. Table 29 shows the virtual machine status before and after we shut down the Hyper-V node 3.
Table 29. Virtual machine status in Hyper-V node failure test

<table>
<thead>
<tr>
<th>Hyper-V Node</th>
<th>Normal situation</th>
<th>After node 3 was down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node 1</td>
<td>Domain Controller 01</td>
<td>Domain Controller 01</td>
</tr>
<tr>
<td></td>
<td>SharePoint Application Server</td>
<td>SharePoint Application Server</td>
</tr>
<tr>
<td></td>
<td>SQL Server (OLTP)</td>
<td>SQL Server (OLTP)</td>
</tr>
<tr>
<td></td>
<td>SharePoint WFE 01</td>
<td>SharePoint WFE 01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exchange Mailbox 02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exchange HUB/CAS 01</td>
</tr>
<tr>
<td>Node 2</td>
<td>Exchange Mailbox 01</td>
<td>Exchange Mailbox 01</td>
</tr>
<tr>
<td></td>
<td>Exchange HUB/CAS 01</td>
<td>Exchange HUB/CAS 01</td>
</tr>
<tr>
<td></td>
<td>Domain Controller 02</td>
<td>Domain Controller 02</td>
</tr>
<tr>
<td></td>
<td>SharePoint SQL Server</td>
<td>SharePoint SQL Server</td>
</tr>
<tr>
<td></td>
<td>SharePoint WFE 02</td>
<td>SharePoint WFE 02</td>
</tr>
<tr>
<td>Node 3</td>
<td>Exchange Mailbox 02</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Exchange HUB/CAS 02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SharePoint WFE 02</td>
<td></td>
</tr>
</tbody>
</table>

Table 30 shows the timeline of each action in the process of this test. The Hyper-V Node 3 failure had no direct impact on the SQL Server because it assumed activity on another node. The impact on Exchange and SharePoint is discussed in detail in each of the following application sections.

Table 30. Hyper-V node failure test

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:45 a.m.</td>
<td>Test started</td>
</tr>
<tr>
<td>11:45 a.m.</td>
<td>Hyper-V Node 3 powered off to simulate a failure</td>
</tr>
<tr>
<td>1:40 p.m.</td>
<td>Hyper-V Node 3 powered on</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Test completed</td>
</tr>
</tbody>
</table>
Figure 22 shows the available memory on Hyper-V Node 1 when the issue occurred. It is obvious that the available memory dropped.

Figure 22. Available memory on Hyper-V node 1

**Exchange Server 2010 impact**

When the Hyper-V Node 3 was down at 11:45 a.m., the Exchange Mailbox 02 and HUB/CAS 02 virtual machines were shut down as the disk resources were offline, moved to Hyper-V Node 1 and started there. Databases 06 through 10, which were originally hosted on Exchange Mailbox 02, automatically became active on Exchange Mailbox 01 and caused zero downtime to client users. As seen from Figure 23 and Figure 24, the database failover process triggered the spike on the CPU and Exchange database performance. After the failover completed, the average CPU utilization and Exchange database latencies increased because all the databases were then on the Mailbox 01 virtual machine.

At 11:51 a.m., the Mailbox 02 virtual machine came back online on Hyper-V Node 1. DAG detected this event and started to perform database seeding. This is the reason why the CPU utilization and Exchange database latencies remained a bit high for a while. At 12:06 p.m., when the seeding was finished, we manually activated Database 06 through 10 on the Mailbox 02 server again to return to the normal DAG operation.
Figure 23. CPU utilization on Mailbox 01 in the Hyper-V node failure test

Figure 24. Exchange performance on Mailbox 01 in Hyper-V node failure test
When the Hyper-V Node 3 was recovered later, there was no impact on the applications because automatic failback was disabled to avoid shutting down another virtual machine. Hyper-V cluster failback uses quick migration rather than live migration. Administrators can use live migration to cause virtual machines to fail over to another node and back to the original one without service downtime.

**SharePoint Server 2010 impact**

When the Hyper-V Node 3 was powered off to simulate a failure, one of the WFE servers was shut down and restarted on the other Hyper-V server. During that period, the number of passed tests per second (passed tests/sec) in the VSTS performance test dropped to half and returned back to normal when the virtual machine was up on another Hyper-V node. It took only 10 minutes for the whole SharePoint farm performance to return back to normal. Figure 25 demonstrates the VSTS performance tests when the Hyper-V Node 3 was down.

![Figure 25. Hyper-V node failure impact on the SharePoint farm](image)

Average passed tests per second dropped when Node 3 was down because all the SharePoint virtual machines were hosted on only two Hyper-V servers now.

Table 31 lists the performance impact caused by the Hyper-V Node 3 failure while running the mixed application load.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Browse (sec)</th>
<th>Search (sec)</th>
<th>Modify (sec)</th>
<th>Pass tests/sec</th>
<th>Number of users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine testing</td>
<td>0.47</td>
<td>0.47</td>
<td>2.23</td>
<td>27.4</td>
<td>16,440</td>
</tr>
<tr>
<td>Combine testing with Hyper-V node failure</td>
<td>0.58</td>
<td>0.52</td>
<td>2.27</td>
<td>25.2</td>
<td>15,120</td>
</tr>
</tbody>
</table>

**Overview**

To simulate the impact of a SP failure on applications, we removed one of the two SPs from the VNX5300 (SPB). As a result, all LUNs that were previously owned by SPB automatically transferred to SPA and none of the services was interrupted during this SP failure event. When the SPB was brought back online, all of the LUNs that transferred from SPB to SPA returned from SPA to SPB automatically.

Table 32 shows the timeline of each action in the process of this test.
Table 32. VNX5300 SP failure test process

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 p.m.</td>
<td>Test started</td>
</tr>
<tr>
<td>13:30 p.m.</td>
<td>VNX5300 SPB was removed from the array</td>
</tr>
<tr>
<td>17:05 p.m.</td>
<td>VNX5300 SPB was brought back online</td>
</tr>
<tr>
<td>20:00 p.m.</td>
<td>Test completed</td>
</tr>
</tbody>
</table>

**VNX5300 impact**

After SPB was removed from the VNX, SPA continued to serve the I/O requests from all the hosts so its utilization increased. Figure 26 shows the VNX5300 SPA utilization during the test, indicating the spike that was caused by the failure of SPB.

![VNX5300 SPA utilization during the test](Figure 26)

**Exchange Server 2010 impact**

During this test, the CPU utilization remained stable through testing on the Exchange Mailbox Servers and HUB/CAS servers. A spike occurred when SPB was removed from the VNX system. The RPC client access performance (RPC averaged latency and RPC requests counters) was not affected by the SP shutdown on the Exchange HUB/CAS servers.

On the Exchange Mailbox Servers, the Exchange read performance dropped a little with only one SP working as shown in Table 33.
Table 33. Exchange read performance in SP failure test

<table>
<thead>
<tr>
<th>Performance counter</th>
<th>Target</th>
<th>Before SPB went down</th>
<th>After SPB went down</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS Exchange database\I/O database reads (attached) average latency</td>
<td>&lt;20 ms</td>
<td>10.0</td>
<td>10.7</td>
</tr>
<tr>
<td>MS Exchange database\I/O log read average latency</td>
<td>&lt;10 ms</td>
<td>4.3</td>
<td>4.6</td>
</tr>
</tbody>
</table>

As shown in Figure 27, shutting down SPB triggered a spike in the latency of the Exchange writes operations, and Exchange writes latencies increased when there was only one SP serving all I/O requests. However, performance numbers were still within Microsoft-recommended thresholds.

Figure 27. Exchange Writes performance in SP failure test

**SQL Server 2008 R2 impact**

By analyzing the performance logs on the SQL Server, there was an obvious performance downgrade when SPB was removed. The average transactions/sec of the SQL instance dropped from 120 to 60 at that time. Then, the performance recovered to the normal state within 2 minutes.
There was a slight impact on performance when placing SPB back online as shown in Figure 28.

**Figure 28.** Transactions per second in SP failure testing

The average duration per disk read has a spike to about 90 ms on the logical disk because the corresponding LUN was assigned to SPB, and SPB was removed from VNX. Afterwards, the averaged duration per disk read went back to normal as shown in Figure 29.

**Figure 29.** Average duration per disk read in SP failure testing

There was a slight impact on the average duration per disk write. The periodic write spikes were caused by checkpoint processing as shown in Figure 30.
Figure 30. Average duration per disk write in SP failure testing

SharePoint Server 2010 impact

During the test, overall performance remained the same, while the passed test per second dropped for a second because some SharePoint data LUNs that were previously owned by SPB automatically transferred to SPA when the SPB was pulled out of the array. As shown in Figure 31, two browse connections were lost because of the VNX5300 SPB failure. Afterwards, all the requests recovered to normal.

Figure 31. SharePoint Server 2010 impact on VNX5300 SP failure test

Overview

The solution team removed one of the disks that store the TPC-E data to see the disk failure impact on the SQL Server performance. In this scenario, the data on the removed disk was automatically rebuilt from the mirrored data on the hot spare disk. Read and write operations to this disk were redirected to the hot spare disk and the SQL Server Service was not interrupted during the disk failure event. When the disk was placed back into the disk array, the data was copied back from hot spare disk onto the original disk. During the entire period, the SQL Server service continued to run the workload without interruption.
Table 34. Disk failure for SQL database pool test process

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 a.m.</td>
<td>Test started</td>
</tr>
<tr>
<td>10:58 a.m.</td>
<td>One of the disks from SQL database pool was removed to simulate a failure</td>
</tr>
<tr>
<td>15:10 p.m.</td>
<td>The disk was returned to the VNX5300 array</td>
</tr>
<tr>
<td>18:00 p.m.</td>
<td>Test completed</td>
</tr>
</tbody>
</table>

**SQL Server 2008 R2 impact**

By analyzing the performance logs on the SQL Server, there was a period with performance degradation about 2.5 hours after the disk was removed from the array. The average transactions per second of the SQL Server instance dropped from 120 to 100 during that period. This degradation occurred because the data on the failed disk was being rebuilt from the mirrored data onto the hot spare disk, which is a read-intensive operation. The rebuild process took around 2.5 hours to recover 250 GB of data. When the disks rebuild was completed, the performance returned to normal.

In the second part of this test scenario, we put the disk back into the array and saw that performance degraded after the disk was returned to the array. The average transactions per second dropped from 120 to 113 because the data on the hot spare disk was being copied back to the inserted disk, and this is a read-intensive process. Meanwhile, SQL Server was running under workloads because VNX was reading data from hot spare disk as shown in Figure 32.

![Figure 32. Transactions per second during the disk failure testing](image)

The average disk read latency increased after we removed the disk from the array due to the performance degradation during the disk rebuild process.

After the rebuild was complete, the performance returned to normal.

When the disk was returned to the array, the average duration per disk read increased while the data was being copied from the hot spare disk back to the original disk as shown in Figure 33.
Figure 33.  Average duration per disk read during the disk failure testing

There was little impact on the write operations. After the disk was removed from the array, the write operations to the original disk were redirected to the hot spare disk. After the disk was returned to the array, the writes were redirected back to the disk so this caused little impact on write performance as shown in Figure 34. The spikes illustrated in this graph are caused by natural SQL Server Database checkpoints which result in burst-writes for uncommitted buffer pool datafile writes.

Figure 34.  Avg disk sec/write performance counter
Replication Manager test results

Overview

The objective of this test was to protect all the applications using Replication Manager with SnapView snapshots. The solution team performed Replication Manager test using a full client workload from all the applications, including Exchange Server, SQL Server, and SharePoint Server.

Table 35 shows the time when Replication Manager started to create snapshots for each of the three applications.

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 p.m.</td>
<td>Started to generate client workload</td>
</tr>
<tr>
<td>1:30 p.m.</td>
<td>SharePoint farm replication job started</td>
</tr>
<tr>
<td>2:56 p.m.</td>
<td>SQL server database replication job created</td>
</tr>
<tr>
<td>3:30 p.m.</td>
<td>Exchange databases replication job started</td>
</tr>
</tbody>
</table>

Exchange Server 2010

Figure 35 shows the Exchange reads and writes performance during the whole Replication Manager test. Though the VNX SnapView snapshot job started to take a snapshot at 3:30 p.m., Exchange performance was not affected. The job completed successfully in 10 minutes 44 seconds to take a snapshot on five Exchange passive databases.

Figure 35. Exchange performance during the Replication Manager test
To verify the snapshot LUN size needed for each of the Exchange database LUNs and log LUNs, we ran an additional 24-hour LoadGen test against two servers, with 250 users per database and 0.20 IOPS user profile. Table 36 shows the snapshot LUN usage result based on snapshots against 10 passive copies.

Table 36. Exchange Snapshot LUN usage result in 24-hour LoadGen testing

<table>
<thead>
<tr>
<th>Time</th>
<th>Total database and log space</th>
<th>Total snapshot space used</th>
<th>Snapshot space per database and log</th>
<th>Percentage of single database and log size needed for snapshot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test started</td>
<td>3,590 GB</td>
<td>0 GB</td>
<td>0 GB</td>
<td>0%</td>
</tr>
<tr>
<td>12 hours later</td>
<td>3,690 GB</td>
<td>222.6 GB</td>
<td>22.26 GB</td>
<td>6.0%</td>
</tr>
<tr>
<td>24 hours later</td>
<td>3,790 GB</td>
<td>396.6 GB</td>
<td>39.66 GB</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

Exchange database restore

After the data change with 24-hour LoadGen testing, we performed a restore of one Exchange database using Replication Manager. The total size of a database and its logs is around 360 GB and the restore from snapshot took 4 minutes 41 seconds.

Furthermore, we performed a restore of five Exchange databases to recover a whole set of passive database copies on one Exchange Mailbox Server. The total size of the data restored was around 1.8 TB and the restore from snapshot took 13 minutes 3 seconds.

The SQL server test has two purposes:

- To validate the impact on the running workload caused by the job that created a SnapView snapshot.
- To ensure that the restore time meets the RTO requirement.

Performance impact on the running workload

It took about 7 minutes to run the job that created a SnapView snapshot. The performance of the SQL Server snapshot session was slightly impacted, as shown in Figure 36. The average transactions per second had no change.

![Figure 36. Transactions per second during the Replication Manager test](image-url)
There was little impact on the average duration per disk read while creating the SQL Server snapshot, as shown in Figure 37. The spikes illustrated in this graph are caused by natural SQL Server Database checkpoints which result in burst-writes for uncommitted buffer pool datafile writes.

![Figure 37. Average duration per disk read during the Replication Manager test](image1)

There was little impact on the average duration per disk write while creating the SQL Server snapshot, as shown in Figure 38.

![Figure 38. Average duration per disk write during the Replication Manager test](image2)

**Snapshot restore of SQL Server database**

After creating the snapshot to the source LUN, a big data change happened to the source LUN. Table 37 shows the reserved LUN pool usage on SQL Server.
Table 37. Reserved LUN Pool usage of SQL Server

<table>
<thead>
<tr>
<th>Source LUN name</th>
<th>Source LUN size</th>
<th>Snapshot LUN size</th>
<th>Snapshot LUN usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data LUN 1</td>
<td>250 GB</td>
<td>30 GB</td>
<td>68%</td>
</tr>
<tr>
<td>Data LUN 2</td>
<td>250 GB</td>
<td>30 GB</td>
<td>58%</td>
</tr>
<tr>
<td>Data LUN 3</td>
<td>250 GB</td>
<td>30 GB</td>
<td>67%</td>
</tr>
<tr>
<td>Log LUN</td>
<td>250 GB</td>
<td>7 * 30 GB</td>
<td>93%</td>
</tr>
</tbody>
</table>

**Note**  VNX snapshot technology automatically consumes an additional reserved snapshot LUN from the reserved LUN pool so there is no danger when you reach 100 percent on that particular snapshot LUN.

We used Replication Manager to restore the snapshot. The snapshot data size was approximately 253 GB. The restore duration was about 3 minutes and 45 seconds.

Table 38 describes the two scenarios we used to validate that Replication Manager can protect the whole SharePoint farm.

Table 38. Test scenarios using Replication Manager to protect the SharePoint farm

<table>
<thead>
<tr>
<th>Test scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full farm replication</td>
<td>Replicate a full SharePoint farm using EMC Replication Manager and EMC Snapshot technology with a mixed workload using the SharePoint Server, Exchange Server, and SQL Server</td>
</tr>
<tr>
<td>Content database restore</td>
<td>Restore a 200 GB content database from a replica using Replication Manager and validate the RTO.</td>
</tr>
</tbody>
</table>

**SharePoint Full Farm replication**

In this test, the SharePoint 2010 farm replication synchronized 21 source LUNs to snapshots in a single job during a full user load. The VNX SnapView snapshot job completed successfully in 21 minutes and 20 seconds. The job included the snapshot preparation, a SQL virtual device interface (VDI) online backup session across all 28 data volumes, and one VSS replica job.

During the full-farm replication, the crawl operation was also running. As shown in Figure 39, there was a slight performance impact on the SharePoint farm with the replication jobs.
Figure 39. Performance impact on the SharePoint farm with the replication jobs

Table 39 shows the performance impact caused by Replication Manager with VNX SnapView snapshots while running the mixed application user load.

Table 39. Performance impact with Replication Manager snapshots

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Browse (sec)</th>
<th>Search (sec)</th>
<th>Modify (sec)</th>
<th>Pass tests/sec</th>
<th>Number of users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine testing</td>
<td>0.47</td>
<td>0.47</td>
<td>2.23</td>
<td>27.4</td>
<td>16,440</td>
</tr>
<tr>
<td>Combine testing with Replication Manager snapshots</td>
<td>0.46</td>
<td>0.52</td>
<td>2.90</td>
<td>25.7</td>
<td>15,420</td>
</tr>
</tbody>
</table>

Table 40 shows the reserved LUN pool usage before the next snapshot job after running combined test with SnapView snapshots for 8 hours.

Table 40. Reserved LUN pool usage

<table>
<thead>
<tr>
<th>LUN Name</th>
<th>Usage</th>
<th>Reserved LUNs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawl database log LUN</td>
<td>1%</td>
<td>1* 30 GB</td>
</tr>
<tr>
<td>Index LUNs for index server</td>
<td>2%</td>
<td>1* 30 GB</td>
</tr>
<tr>
<td>Search property database data LUN</td>
<td>3%</td>
<td>1* 30 GB</td>
</tr>
<tr>
<td>Search property database log LUN</td>
<td>0%</td>
<td>1* 30 GB</td>
</tr>
<tr>
<td>Index partitions LUN for the query server</td>
<td>54%</td>
<td>1* 30 GB</td>
</tr>
<tr>
<td>Content database data LUNs</td>
<td>59%</td>
<td>2* 30 GB</td>
</tr>
<tr>
<td>Content database log LUNs</td>
<td>33%</td>
<td>1* 30 GB</td>
</tr>
</tbody>
</table>
Content database restore

After the content database replica was created using Replication Manager, the single content database was easily restored to the production SQL Server. It took only 4 minutes and 22 seconds to restore a 200 GB content database. We also tested to restore 5 content databases in a size of 1 TB. It took only 7 minutes 28 seconds to complete.

During the restore, there was an impact on the other content databases and the farm stayed in production for the duration of the restore.

Before restoring the content database, we stopped all SharePoint timer services on the SharePoint servers.
Conclusion

Summary
The consolidated Microsoft applications mixed-workload approach adopted in this solution provides a private cloud solution for customers who are looking for mid-size deployment with the VNX array powered by the Intel Xeon processor. This solution offers simple storage management and provisioning of an entire IT environment, using EMC System Integrator. This solution also leverages Microsoft System Center Virtual Machine Manager and System Center Operations Manager to monitor the performance and availability of the entire private cloud infrastructure across Exchange, SQL, and SharePoint servers, as well as the operating systems, and Microsoft Hyper-V.

Integrated with Replication Manager, this solution can provide rapid protection of the virtualized Microsoft environment.

Findings
The solution provides the following benefits:

- You can achieve 4:1 server consolidation ratio by incorporating Microsoft Hyper-V as the server virtualization platform. The sustained application user capacities were:
  - SharePoint: 16,440 Heavy Users at 10 percent concurrency
  - SQL Server: 120 transactions per second at 60 percent disk utilization
  - Exchange: 2,500 concurrent users with 0.20 IOPS profile

- With ESI, storage administrators and application owners can simplify storage management to provision and manage the infrastructure. By integrating with ESI, you can save 13 steps when creating a CSV in a Windows cluster.

- SCVMM and SCOM can be used to manage your private cloud infrastructure across the Exchange, SQL, and SharePoint applications, operation system, and Microsoft Hyper-V hypervisors automatically. Cloud components can be discovered and their health monitored to ensure that the desired level of availability and performance is delivered.

- Minimal performance impact during the hardware failure.

- EMC Replication Manager enabled significant improvements in reducing protection overhead, extreme recovery performance, and reduced complexity in setup.

- Minimal backup window and minimal application interruptions as shown in Table 41.
Table 41. Minimal backup window and minimal application quiescence periods

<table>
<thead>
<tr>
<th>Applications protected</th>
<th>Data</th>
<th>Replication Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
<td>3.5 TB (10 databases)</td>
<td>Less than 11 minutes</td>
</tr>
<tr>
<td>SQL Server</td>
<td>500 GB</td>
<td>Less than 8 minutes</td>
</tr>
<tr>
<td>SharePoint Farm</td>
<td>1 TB SharePoint farm</td>
<td>Less than 22 minutes</td>
</tr>
</tbody>
</table>

- Minimal, simplified, and orchestrated recovery of application data as shown in Table 42

Table 42. Minimal, simplified, and orchestrated recovery of application data

<table>
<thead>
<tr>
<th>Microsoft Applications</th>
<th>Data</th>
<th>Restore Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
<td>1.8 TB (5 databases)</td>
<td>Around 13 minutes</td>
</tr>
<tr>
<td>SQL Server</td>
<td>250 GB</td>
<td>Less than 4 minutes</td>
</tr>
<tr>
<td>SharePoint Farm</td>
<td>1TB (5 content databases)</td>
<td>Less than 8 minutes</td>
</tr>
</tbody>
</table>
References

White papers
For additional information, see the white papers listed below.
- Microsoft Exchange Server 2010 Performance Review Using the EMC VNX5300 Unified Storage Platform – An Architectural Overview
- EMC Automated Performance Optimization For Microsoft Applications – EMC VMAX, FAST VP, And Microsoft Hyper-V
- EMC CLARiiON SnapView Snapshots and Snap Sessions Knowledgebook – A Detailed Review

Product documentation
For additional product information, see the product documents listed below.
- Storage Integrator for Windows 1.2 Product Guide
- Storage Integrator 1.2 Readme First
- Storage Integrator 1.2 Release Notes
- Replication Manager Administrator’s Guide 5.4.0
- Replication Manager Product Guide 5.4.0

Other documentation
For additional information, see the documents listed below.
- Microsoft TechNet
- Microsoft System Center Market Place
- Configuring an ISCSI Storage Area Network Using Brocade FCX Switches
Supporting information

Disable SCSI filtering

In this solution, EMC Solutions Enabler was installed in a virtual machine hosted by Hyper-V with pass-through storage devices. EMC supports the installation of EMC Solutions Enabler on a child virtual machine with pass-through storage devices only when the parent partitions are running Windows Server 2008 R2, and when the appropriate settings for the virtual machine have been made.

EMC Solutions Enabler implements the usage of the extended SCSI commands, which are filtered by the parent partition by default. A bypass of the filtering is provided with Windows Server 2008 R2 Hyper-V. To disable the filtering of SCSI commands, the administrator can execute the following PowerShell script on the parent partition of all the Hyper-V hosts in which Exchange, SQL, and SharePoint virtual machines reside.

// PowerShell Script: Set_SCCI_Passthrough.ps1
$Target = $args[0]
$VSManagementService=gwmi MSVM_VirtualSystemManagementService -namespace "root\virtualization"
foreach($Child in Get-WmiObject -Namespace root\virtualization Msvm_ComputerSystem -Filter "ElementName='$Target'")
{
    $VMData=Get-WmiObject -Namespace root\virtualization -Query "Associators of {$Child} Where ResultClass=Msvm_VirtualSystemGlobalSettingData AssocClass=Msvm_ElementSettingData"
    $VMData.AllowFullSCSICommandSet=$true
    $VSManagementService.ModifyVirtualSystem($Child,$VMData.PSBase.Get Text(1))|out-null
}

The usage of the script under PowerShell execution environment is as follows.

.\Set_SCCI_Passthrough.ps1 ManagedVirtualMachineName

Use the script below to check the current value of the SCSI filtering. Provide the name of the virtual machine target on which you want to report.

// PowerShell Script: Get_SCCI_Passthrough.ps1
$Target=$args[0]
foreach ($Child in Get-WmiObject -Namespace root\virtualization Msvm_ComputerSystem -Filter "ElementName='$Target'")
{
    $VMData=Get-WmiObject -Namespace root\virtualization -Query "Associators of {$Child}" Where ResultClass=Msvm_VirtualSystemGlobalSettingData AssocClass=Msvm_ElementSettingData"
    Write-host "VirtualMachine:"$VMData.ElementName
    Write-Host "CurrentlyByPassingSCSIFiltering:"$VMData.AllowFullSCSICommandSet
}