Reference Architecture: Microsoft SharePoint Server 2013

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Microsoft SharePoint solution based on Lenovo x3550 M5 servers

Designed for medium to large sized organizations

Virtualized implementation of the presentation and business layers

Scalable, clustered, and flexible design that is highly available

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**Table of Contents**

1 **Introduction** ................................................................................................................. 1

2 **Business problem and business value** ................................................................. 2
   2.1 Business problem ........................................................................................................ 2
   2.2 Business value ............................................................................................................. 2

3 **Requirements** .................................................................................................. 3
   3.1 Functional requirements ............................................................................................ 3
   3.2 Non-functional requirements .................................................................................... 5

4 **Architectural overview** ...................................................................................... 6

5 **Component model** ............................................................................................ 7
   5.1 Key concepts and terminology ................................................................................ 7
   5.2 SharePoint 3-tier component model ....................................................................... 8
      5.2.1 Presentation layer ................................................................................................. 9
      5.2.2 Business layer ...................................................................................................... 10
      5.2.3 Data access layer ................................................................................................. 10

6 **Operational model** .............................................................................................. 12
   6.1 Hardware components ............................................................................................ 12
      6.1.1 Lenovo System x3550 M5 .................................................................................. 12
      6.1.2 IBM Storwize V3700 .......................................................................................... 13
      6.1.3 Emulex 10 GbE adapters ..................................................................................... 13
      6.1.4 Lenovo RackSwitch G8124E ............................................................................... 14
      6.1.5 Brocade 6505 Switch .......................................................................................... 15
   6.2 Compute servers ..................................................................................................... 16
      6.2.1 Presentation layer and business layer .................................................................. 16
      6.2.2 Data access layer ................................................................................................ 17
      6.2.3 Compute server sizing ......................................................................................... 18
   6.3 Shared storage ........................................................................................................ 18
      6.3.1 SharePoint SQL Server databases .................................................................... 18
      6.3.2 SQL Server system databases ............................................................................ 20
      6.3.3 SQL Server backups ............................................................................................ 20
      6.3.4 Storage for WSFC ................................................................................................ 21
6.3.5 Storage configuration for IBM Storwize V3700 ................................................................. 22

6.4 Networking ..................................................................................................................... 23
  6.4.1 Key networking concepts and terminology ............................................................... 23
  6.4.2 VLANs ...................................................................................................................... 25
  6.4.3 NIC teaming and VLAN assignment ......................................................................... 25
  6.4.4 Network configuration ............................................................................................. 27
  6.4.5 Network load balancer ............................................................................................ 28

6.5 Networking for shared storage ................................................................................... 29
  6.5.1 Key storage concepts and terminology .................................................................. 29
  6.5.2 SAN multi-pathing .................................................................................................. 29
  6.5.3 Storage zoning ........................................................................................................ 30

6.6 Deployment example ................................................................................................... 30

7 Deployment considerations ............................................................................................. 32
  7.1 Preparing SQL Server for SharePoint ....................................................................... 32
  7.2 Planning service deployment in SharePoint 2013 ....................................................... 32
  7.3 Best practices for installing SharePoint 2013 .............................................................. 32
  7.4 Best Practices for SQL Server AlwaysOn Availability groups .................................. 32

8 Appendix: Lenovo Bill of Materials .................................................................................... 33
  8.1 BOM for compute servers ......................................................................................... 33
  8.2 BOM for networking .................................................................................................. 34
  8.3 BOM for shared storage ............................................................................................. 34

Resources ............................................................................................................................ 35
1 Introduction

This document describes the reference architecture for a 3-tier, virtualized implementation of Microsoft® SharePoint® 2013 that is based on Lenovo® System x3550 M5 servers. The intended audience of this document is IT professionals, technical architects, sales engineers, and consultants to assist in planning, designing, and implementing Microsoft SharePoint Server 2013.

Microsoft SharePoint 2013 is the industry leader in enterprise content management. Organizations use SharePoint to create websites and to store, organize, share, and access information from almost any device. All that is needed to access shared resources is a web browser, such as Internet Explorer, Chrome, or Firefox. Social features, such as My Site, allow employees to connect across their enterprise and engage with people, share ideas, and reinvent the way they work together. Organizations have the option of subscribing to a cloud-based version of SharePoint (SharePoint Online 2013), which is part of Office 365™ or deploying SharePoint on-premises (SharePoint Server 2013). SharePoint Server 2013 gives you the flexibility to tailor your deployment to your unique needs and provides a simplified way to help keep shared resources continuously available.

This reference architecture targets organizations that are implementing Microsoft SharePoint Server 2013 in a virtual environment that uses Microsoft Hyper-V®. The solution that is described in this document provides a highly available, clustered infrastructure in which the web servers (presentation layer) and application servers (business layer) are virtualized and hosted on a 2-node Windows Server® Failover Clustering (WSFC) cluster that is running Microsoft Hyper-V. The SQL Server® 2012 back-end database servers (data access layer) are physical servers, which are also running in a WSFC cluster and configured as a highly-available, 2-node AlwaysOn Availability Group.

This document provides the planning, design considerations, and best practices for implementing the described architecture to support medium to large sized organizations with less than 10,000 employees. However, the principles and techniques that are described throughout this document can be expanded upon to support much larger user populations with the addition of storage and compute resources.

There also is an accompanying Installation and Configuration Guide that provides setup and configuration details for the highly available, clustered SharePoint environment that is described in this document. The Installation and Configuration Guide is available at this website:
lenovopress.com/tips1320-installation-configuration-guide-sharepoint-2013
2 Business problem and business value

This section describes the challenges organizations face and how this Reference Architecture for Lenovo System x3550 M5 and Microsoft SharePoint Server 2013 can help meet those challenges.

2.1 Business problem

In today's organizations, it is common to have teams spread across the globe. IT managers are looking for efficient ways to collaborate and share sensitive enterprise resources with dispersed teams while maintaining control and security. Good IT practices also recognize the need for high availability, scalability, and maximum resource utilization. Rapidly responding to changing business needs with simple, fast deployment and configuration, while maintaining healthy systems and services directly corresponds to the vitality of your business. Natural disasters, malicious attacks, and even simple software upgrade patches can cripple services and applications until administrators resolve the problems and restore any backed up data. The challenge of maintaining uptime only becomes more critical as businesses consolidate physical servers into a virtual server infrastructure to reduce data center costs, maximize utilization, and increase workload performance.

2.2 Business value

Microsoft Hyper-V technology can serve as a key cloud component in many customer virtualization environments. Hyper-V is included as a standard component in Windows Server® 2012 R2 Standard and Datacenter editions. Windows Server 2012 R2 Microsoft Hyper-V Virtual Machines (VMs) support up to 64 virtual processors and 1 TB of memory.

This Lenovo x3550 M5 solution for Microsoft SharePoint 2013 provides businesses with an affordable, interoperable and reliable industry-leading virtualization solution for their SharePoint infrastructure. Built around the latest Lenovo System x servers, storage, and networking, this offering removes the complexity of the solution by providing a step-by-step implementation guide. This reference architecture combines Microsoft software, consolidated guidance, and validated configurations for compute, network, and storage. The design provides a high level of redundancy and fault tolerance across the servers, storage, networking, and application layer to ensure high availability of resources and back-end databases.
3 Requirements

The functional and non-functional requirements for this reference architecture are described in this section.

3.1 Functional requirements

An enterprise content and document management system (such as Microsoft SharePoint) should fulfil the following requirements:

- **Collaboration Group (SharePoint term is a site):**
  - Add a collaboration group
  - Remove (or close) a collaboration group
  - Add a collaboration subgroup
  - Remove (or close) a collaboration subgroup
  - Add administrator (collaboration group owner)
  - Remove administrator (collaboration group owner)
  - Change administrator (collaboration group owner)
  - Add access control list
  - Edit access control list
  - Remove access control list
  - Set theme
  - Add web part (SharePoint term is an app)
  - Remove web part
  - Edit home page
  - Edit table of contents
  - Edit quick link area
  - Subscribe to a collaboration group
  - Manage subscriptions
  - Notify changes to subscribers
  - Search a collaboration group
  - Sync local copy of collaboration group
  - View user statistics
  - View page popularity

- **Web page:**
  - Create a web page
  - Edit web page
  - Remove web page
  - Insert web page into table of contents
  - Add an content application
  - Remove a content application
  - Edit view of content application
• Documents:
  o Create group of documents (SharePoint term is a library)
  o Remove library
  o Modify access permissions
  o Change library subscriptions
  o Modify library properties
  o Modify view of library (for example, which document fields to display and sort order)
  o Add a document
  o Remove a document
  o Edit a document
  o Check out a document
  o Check in a document

• Forum (web part):
  o Add a new forum
  o Remove a forum
  o Modify access permissions
  o Change forum subscriptions
  o Append to a forum
  o Respond to an append
  o Delete an append

• Wiki (web part):
  o Add a new wiki
  o Remove a wiki
  o Modify access permissions
  o Change wiki subscriptions
  o Create new wiki page
  o Remove wiki page
  o Edit wiki page

• Administration:
  o Add/Remove/Edit collaboration group template
  o Save collaboration group as a template
  o Change storage quota (administrator)
  o Extend collaboration group lifetime
  o Add/Remove/Edit master page
  o Add/Remove/Edit web part
  o Add/Remove/Edit theme
  o Add/Remove/Edit workflows
  o Export collaboration group to Extranet
### 3.2 Non-functional requirements

Table 1 lists the non-functional requirements for an enterprise content and document management system.

#### Table 1. Non-functional requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Supported by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalability</td>
<td>Solution components can scale for growth</td>
<td>Compute and storage can be scaled independently within a rack or across racks without service downtime.</td>
</tr>
<tr>
<td>Load balancing</td>
<td>Workload is distributed evenly across servers</td>
<td>Network interfaces are teamed and load balanced.</td>
</tr>
<tr>
<td>High availability</td>
<td>Single component failure will not lead to whole system unavailability</td>
<td>Hardware architecture ensures that computing, storage, and networking is automatically switched to remaining components; redundancy in hardware.</td>
</tr>
<tr>
<td>Physical footprint</td>
<td>Compact solution</td>
<td>Lenovo System x server, network devices, and software are integrated into one rack with validated performance and reliability.</td>
</tr>
<tr>
<td>Support</td>
<td>Available vendor support</td>
<td>• Hardware warranty and software support are included with component products.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Separately available commercial support from Microsoft.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Solution supports variable deployment methodologies</td>
<td>• Hardware and software components can be modified or customized to meet various unique customer requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provides local and shared storage for workload.</td>
</tr>
<tr>
<td>Robustness</td>
<td>Solution continuously works without routine supervision</td>
<td>Integration tests on hardware and software components.</td>
</tr>
<tr>
<td>Security</td>
<td>Solution provides means to secure customer infrastructure</td>
<td>• Security is integrated in the Lenovo System x hardware with System x Trusted Platform Assurance, which is an exclusive set of industry-leading security features and practices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Networks are isolated by virtual LAN (VLAN).</td>
</tr>
<tr>
<td>High performance</td>
<td>Solution components are high-performance</td>
<td>Reference architecture provides information for capacity and performance planning of typical deployments.</td>
</tr>
</tbody>
</table>
4 Architectural overview

Figure 1 shows the architectural overview of an intranet SharePoint deployment in a single data center that uses four servers, two 10 Gigabit Ethernet (GbE) network switches, one layer 4 network load balancer, two 8 Gb Fibre Channel (FC) switches, and one SAN storage system. Multiple paths connect the servers to the networking and storage infrastructure to provide high availability to critical resources if there is a planned or unplanned outage.

Deployments for Internet access to content, multi-site failover, firewalls, and security are outside the scope of this document.
5 Component model

This section describes the logical component view of Microsoft SharePoint Server 2013.

5.1 Key concepts and terminology

This section covers basic concepts and terminology.

**Web application** – A SharePoint 2013 web application is composed of an Internet Information Services (IIS) web site that acts as a parent container for the site collections that you create. Each web application is represented by a different IIS web site with a unique or shared application pool. You can assign each web application a unique domain name, which helps prevent cross-site scripting attacks. When you create a web application, you also create a content database and define the authentication method that is used to connect to the database. In addition, you define an authentication method to be used by the IIS Web site in SharePoint 2013.

**Service application** – SharePoint 2013 includes a set of services that can be deployed and shared across web applications. Services that are deployed are called *service applications*. A service application provides a resource that can be shared across sites throughout a farm and can be accessed by users through a hosting web application. Service applications are associated to web applications by service application connections. Some services can be shared across farms. You can manage service applications by using Central Administration or Windows PowerShell 3.0.

For more information about service applications in SharePoint 2013, see the TechNet article that is available at this website:


**Site collection** - A site collection consists of one top-level site and all of the sites that are below it, as shown in Figure 2.

![Figure 2. Site collection](image)

The number of site collections you can have in a single web application depends on the capacity of your server infrastructure. From an architecture standpoint, all the content of a site collection must be stored in a single content database rather than spread out across multiple databases.
User authentication - User authentication is the validation of a user's identity against an authentication provider, which is a directory or database that contains the user’s credentials and can confirm the user submitted them correctly. An example of an authentication provider is Active Directory Domain Services (AD DS).

Zones - SharePoint uses a concept called zones to provide multiple access points to the same web application and therefore the same content databases on the back end. That is, zones represent different logical paths (independent URLs with their own web.config file and IIS application scope) to gain access to the same sites in a web application. You can implement multiple authentication providers on a single zone. You can also use multiple zones (each web application can include as many as five zones).

Application pool - An application pool is a group of one or more URLs that are served by a worker process or a set of worker processes. Application pools set boundaries for the applications they contain, which means that any applications that are running outside a specific application pool cannot affect the applications in the application pool.

Application pools offer the following benefits:

- Improved server and application performance. You can assign resource-intensive applications to their own application pools so that the performance of other applications does not decrease.
- Improved application availability. If an application in one application pool fails, applications in other application pools are not affected.
- Improved security. By isolating applications, you reduce the chance that one application accesses the resources of another application.

5.2 SharePoint 3-tier component model

Figure 3 illustrates the high-level component model. SharePoint is implemented as a traditional 3-tier model; with a presentation layer, business layer, and data layer.

![SharePoint component diagram](image)
5.2.1 Presentation layer

At the presentation layer, the web servers host several low latency service applications and most of the site content (published intranet content, Team Sites, and My Sites). Figure 4 shows a more detailed view of the presentation layer.

The various service and web applications are isolated into three separate application pools. For example, application pool 3 houses the service applications that are hosted on the web servers; application pools 4 and 5 house web applications for intranet content, Team Sites, and My Sites.

Figure 4. Presentation layer
5.2.2 Business layer

Figure 5 shows a more detailed view of the business layer.

Similar to the presentation layer, the application servers host a number of service applications. The service applications that are hosted in the business layer require more throughput than the low-latency service applications in the presentation layer. As an example, application pool 2 houses the service applications.

To reduce the attack surface of the SharePoint environment, Lenovo recommends hosting the Central Administration site on the application servers rather than the web servers. Application pool 1 houses the Central Administration web application.

![Figure 5. Business layer](image)

5.2.3 Data access layer

Figure 6 shows the databases hosted in the data layer.

SharePoint databases can be divided into the following categories:

- SharePoint system databases that are always installed
- SharePoint service application databases (including those for searching)
- SQL Server system databases
- SQL Server reporting services databases

For more information about SharePoint 2013 databases, see the TechNet article that is available at this website: [technet.microsoft.com/en-us/library/cc678868.aspx](technet.microsoft.com/en-us/library/cc678868.aspx)
Figure 6. Data access layer
6 Operational model

This section describes the operational model for deploying Microsoft SharePoint Server 2013, that uses Lenovo System x3550 M5 servers clustered with Microsoft Windows Server 2012 R2 operating system. The servers are attached via Fiber Channel to an IBM® Storwize® V3700 storage system with multiple expansion enclosures.

Windows Server 2012 R2 Standard and Datacenter editions with Hyper-V provide the enterprise with a scalable and highly elastic platform for virtualization environments. It can support today’s largest servers with up to 4 TB of RAM, 320 logical processors, and 64 nodes per cluster. It also includes key features, such as high availability clustering, simultaneous live migration, in-box network teaming, and improved Quality of Service (QoS) features. With these capabilities, IT organizations can simplify resource pools that are used to support their cloud environments. Under Windows Server 2012 R2, Hyper-V also uses the operating system’s ability to better utilize resources that are presented to VMs by offering up to 64 virtual CPUs, 1 TB of RAM, and virtual Host Bus Adapter (vHBA) support.

The configuration that is described in this document supports up to 10,000 users and provides a solid foundation for a virtualized Microsoft SharePoint Server 2013 environment. It can be expanded to multiple servers and storage for more compute capacity or storage.

6.1 Hardware components

The following section describes the components in a SharePoint deployment.

6.1.1 Lenovo System x3550 M5

At the core of this reference architecture, the Lenovo System x3550 M5 server delivers the performance and reliability that is required for business-critical applications, such as SharePoint 2013. Lenovo System x3550 M5 servers can be equipped with up to two 18-core E5-2600 v3 series processors and up to 1.5 TB of TruDDR4 memory. Up to three PCIe 3.0 expansion slots, four integrated 1 GbE network ports, and an optional embedded dual-port 10/40 GbE network adapter provides ports for your data and storage connections.

The Lenovo System x3550 M5 includes an on-board RAID controller and the choice of spinning hot swap SAS or SATA disks and small form factor (SFF) hot swap solid-state drives (SSDs). The x3550 M5 supports a maximum of 24 TB of internal storage.

The x3550 M5 supports the following components:

- Up to 10 front and two rear SFF hard disk drives (HDDs) or SSDs
- Up to four 3.5-inch HDDs

The x3550 M5 also supports remote management via the Lenovo Integrated Management Module (IMM), which enables continuous management capabilities. All of these key features (including many that are not listed here) help solidify the dependability Lenovo customers are accustomed to with System x servers.

Figure 7 shows the Lenovo x3550 M5 server.
6.1.2 IBM Storwize V3700

The IBM Storwize V3700 combines best-of-breed storage development with leading iSCSI, Fibre Channel over Ethernet (FCoE), or FC host interfaces and SAS/NL-SAS/SSD drive technology. With its simple, efficient, and flexible approach to storage, the Storwize V3700 is a cost-effective complement to the Lenovo x3550 M5 solution for Microsoft SharePoint 2013. By offering substantial features at a price that fits most budgets, the Storwize V3700 delivers superior price-to-performance ratios, functionality, scalability and ease of use for the mid-range storage user.

The Storwize V3700 offers the following benefits:

- Simplified management with an integrated, intuitive user interface for faster system accessibility
- Reduced network complexity with FCoE and iSCSI connectivity
- Optimize costs for mixed workloads, with up to 200% better performance with SSDs by using IBM System Storage® Easy Tier®
- Thin provisioning, which supports business applications that must grow dynamically, while consuming only the space that is actually used
- Improved application availability and resource utilization for organizations of all sizes

IBM Storwize V3700 (as shown in Figure 8) is well-suited for Microsoft virtualized environments. The Storwize V3700 complements the Lenovo servers by delivering proven disk storage in flexible, scalable configurations. Connecting optional expansion units to a Storwize V3700 can scale up to 240 SAS and SSDs. The Storwize V3700 comes standard with 4 GB cache per controller (upgradable to 8 GB cache per controller) for a maximum of 16 GB cache for the entire system.

6.1.3 Emulex 10 GbE adapters

The Emulex Virtual Fabric Adapter 5 (VFA5) Network Adapter Family for System x builds on the foundation of previous generations of Emulex VFAs by delivering performance enhancements and new features that reduce complexity and cost and improve performance. An optional upgrade provides iSCSI and FCoE capability. The Emulex card takes a 10 Gb port and splits it into four virtual network interface cards (vNICs). This configuration
allows each vNIC or virtual channel to be 100 Mb - 10 Gb in increments of 100 Mb. The total of all four vNICs cannot exceed 10 Gb.

For more information, see this website: lenovopress.com/tips1142.html

6.1.4 Lenovo RackSwitch G8124E

The Lenovo RackSwitch™ G8124E is a 10 Gigabit Ethernet switch that is specifically designed for the data center and provides a virtualized, cooler, and easier network solution. The G8124E offers 24 10 GbE ports in a high-density, 1U footprint.

Designed with ultra-low latency and top performance in mind, the RackSwitch G8124E provides line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. Large data center grade buffers keep traffic moving. The G8124E also supports Converged Enhanced Ethernet (CEE) and Data Center Bridging for support of FCoE and can be used for NAS or iSCSI.

The G8124E is virtualized and supports VMready® technology, which is an innovative, standards-based solution to manage VMs in small to large-scale data center and cloud environments. VMready works with all leading VM providers. The G8124E also supports Virtual Fabric, which allows for the carving up of a physical NIC into 2 - 8 vNICs for improved performance, availability, and security, while reducing cost and complexity.

The G8124E is cooler and implements a choice of directional cooling to maximize data center layout and provisioning. Its superior airflow design complements the hot-aisle and cold-aisle data center cooling model.

The G8124E is easier, with server-oriented provisioning via point-and-click management interfaces. Its industry-standard CLI and easy interoperability simplifies configuration for those familiar with Cisco environments.

Figure 9 shows the Lenovo RackSwitch G8124E.

Figure 9. Lenovo RackSwitch G8124E

The RackSwitch G8124E includes the following benefits:

- A total of 24 SFP+ ports that operate at 10 Gb or 1 Gb Ethernet speeds
- Optimal for high-performance computing and applications that require high bandwidth and low latency
- All ports are nonblocking 10 Gb Ethernet with deterministic latency of 570 nanoseconds
- VMready® helps reduce configuration complexity and improves security levels in virtualized environments
- Variable-speed fans automatically adjust as needed, which helps to reduce energy consumption
- Easy, standards-based integration into Cisco and other networks helps reduce downtime and learning curve

For more information, see this website: lenovopress.com/tips0787.html
6.1.5 Brocade 6505 Switch

As the value and volume of business data continue to rise, organizations need technology solutions that are easy to implement and manage and that can grow and change with minimal disruption. Brocade Gen 5 Fibre Channel and Fabric Vision technology delivers the performance, reliability, and simplicity needed to meet the new requirements of today's data center. The Brocade 6505 Switch provides small to medium-sized enterprises with Storage Area Network (SAN) connectivity that simplifies their IT management infrastructures, improves system performance, maximizes the value of virtual server deployments, and reduces overall storage costs.

The 8/16 Gbps FC Brocade 6505 Switch provides a simple, affordable solution for both new and existing SANs. The EZSwitchSetup wizard and other usability and configuration enhancements can be used to simplify deployment. The switch also provides state-of-the-art performance and Ports on Demand (PoD) scalability to support SAN expansion and enable long-term investment protection.

The Brocade 6505 Switch is shown in Figure 10.

Figure 10. Brocade 6505 Switch

The Brocade 6505 Switch includes the following benefits:

- Install in three easy steps with Brocade EZSwitchSetup
- Delivers up to 24 ports of 8/16 Gbps performance in an energy-efficient, optimized 1U form factor to support the most demanding server and virtual server deployments
- Operate seamlessly with existing Brocade switches through E_Port connectivity
- “Pay as you grow” from 12 to 24 ports with Ports on Demand
- Offers dual functionality as a full-fabric SAN switch or as an NPIV-enabled Brocade Access Gateway that simplifies server connectivity in heterogeneous enterprise fabrics
- Maximize resiliency with an optional redundant power supply
- Protects device investments with auto-sensing 4, 8 and 16 Gbps capabilities and native operation with Brocade and Brocade M-Series fabrics
- Helps pinpoint problems faster and simplify SAN configuration and management with Brocade Network Advisor
- Future-proofs investments by enabling organizations to use 8 Gbps SFPs today and upgrade to 16 Gbps SFP+ when required

For more information about the Brocade 6505 Switch, see this website: shop.lenovo.com/us/en/systems/storage/san/fibre-channel-switches/brocade-6505/
6.2 Compute servers

In this section, the 3-tier logical component model for SharePoint 2013 is mapped onto physical servers and VMs.

6.2.1 Presentation layer and business layer

VMs are used for the presentation layer’s web servers and for the business layer’s application servers to provide isolation from the host operating system and other VMs. Each VM uses 24 GB of memory, 4 virtual processors, and 127 GB storage.

The VMs are deployed onto physical servers that are running Hyper-V under Microsoft Server 2012 R2. Lenovo recommends Windows Server 2012 R2 Datacenter edition because it allows unlimited VMs and is the preferred version for building virtualized configurations. Windows Server 2012 R2 Standard edition now supports clustering and has default licensing for up to two VMs. Windows Server 2012 R2 Standard edition is intended for physical servers that are hosting few or no VMs.

Figure 11 shows Lenovo x3550 M5 servers with the SharePoint VMs that uses WSFC to provide high availability.

![Virtualization host cluster running Hyper-V](image)

**Figure 11. WSFC cluster that is running Microsoft Hyper-V**

WSFC clusters provide high availability and scalability to many server workloads, including Microsoft SharePoint. If one or more of the clustered servers (nodes) fails, other nodes begin to provide service (a process known as failover). In addition, the clustered roles (formerly called clustered services and applications) are proactively monitored to verify that they are working properly. If they are not working, they restart or move to another node. Clusters also provide Cluster Shared Volume (CSV) functionality that provides a consistent, distributed namespace that clustered roles can use to access shared storage from all nodes.

In the virtualization host cluster, VM workloads should be balanced across the host servers and careful attention should be given to ensure that the combined resources of all VMs do not exceed those that are available on the cluster nodes. A policy of monitoring resource utilization, such as CPU, Memory, and Disk (space and I/O), helps keep the cluster running at optimal levels and allows for proper planning to add resources as needed. When any VM is used in a SharePoint 2013 farm, Microsoft recommends a ratio of 1:1 virtual-to-logical processor cores. Oversubscribing the CPU on the virtualization host can decrease performance.
To help prevent situations where all VMs migrate to a single cluster node when others are available, a highly-available VM can be configured with degrees of affinity for available nodes in the cluster. This affinity is called preferred owners. For example, a VM that is hosted on node-1 of the cluster and has preferred owners configured as node-1, node-2, and node-3 in descending priority order failover to node-2 if node-1 were to fail. If node-2 failed or was offline, the VM would failover to node-3. Lenovo recommends configuring the affinity for SharePoint presentation and business layer VMs.

For more information about configuring the WSFC clusters, see the accompanying *Installation and Configuration Guide*.

### 6.2.2 Data access layer

Microsoft SQL Server 2012 with native Windows Server 2012 R2 is used for the data access layer. Lenovo recommends SQL Server 2012 Enterprise edition to meet future growth requirements.

The physical servers that are running Microsoft SQL Server are clustered by using WSFC and use the AlwaysOn Availability Group feature to provide high availability and disaster recovery across the databases. This feature provides an enterprise-level alternative to database mirroring.

Figure 12 shows Lenovo x3550 M5 servers that are running Microsoft SQL Server by using WSFC to provide high availability.

![Database cluster running SQL Server](Image)

*Figure 12. WSFC cluster running Microsoft SQL Server*

Introduced in SQL Server 2012, AlwaysOn Availability Groups maximize the availability of a set of user databases for an enterprise. An availability group supports a failover environment for a discrete set of user databases (known as availability databases), which fail over together. An availability group supports a set of read-write primary databases and 1 – 8 sets of corresponding secondary databases. Optionally, secondary databases can be made available for read-only access or some backup operations.

Each set of availability databases is hosted by an availability replica. Two types of availability replicas are available: a single primary replica that hosts the primary databases, and 1 – 8 secondary replicas, each of which hosts a set of secondary databases and serves as a potential failover target for the availability group. An availability replica provides redundancy only at the database level for the set of databases in one availability group. Failovers are not caused by database issues, such as a database becoming suspect because of a loss of a data file or corruption of a transaction log.
Deploying AlwaysOn Availability Groups requires SQL Server be installed on a WSFC cluster. Each availability replica of a specific availability group must be on a different node of the same WSFC cluster. The only exception is that while being migrated to another WSFC cluster, an availability group can temporarily straddle two clusters.

A WSFC resource group is created for every availability group that you create. The WSFC cluster monitors this resource group to evaluate the health of the primary replica. The quorum for AlwaysOn Availability Groups is based on all nodes in the WSFC cluster, regardless of whether a specific cluster node hosts any availability replicas. In contrast to database mirroring, there is no witness role in AlwaysOn Availability Groups.

For more information about configuring the WSFC clusters and AlwaysOn Availability Groups, see the accompanying *Installation and Configuration Guide*.

### 6.2.3 Compute server sizing

The recommended compute server configuration is the Lenovo System x3550 M5 server that includes the following components:

- 128 GB RAM
- Two Intel Xeon E5-2660 v3 (Haswell) 2.1 GHz 12-core processors
- One dual-port Emulex 10 GbE adapter
- One dual-port Emulex 8 Gb FC HBA

A minimum of two compute servers are recommended for the virtualization host cluster and two compute servers for database cluster.

### 6.3 Shared storage

Shared storage is used for storing the SharePoint SQL server databases and the two WSFC clusters.

#### 6.3.1 SharePoint SQL Server databases

The storage requirements for SharePoint are highly dependent on the size of your organization, employee usage patterns, and the underlying purpose of the SharePoint environment (document sharing, social features, and so on).

There is no single storage configuration that is appropriate for every organization. Lenovo recommends gaining a thorough understanding of the capacity needs of your organization before implementing the storage design and then monitoring the solution for bottlenecks.

For more information about capacity planning, the TechNet article that is available at this website: [technet.microsoft.com/en-us/library/ff758645.aspx](technet.microsoft.com/en-us/library/ff758645.aspx)

Microsoft provides a comprehensive description of the databases that are required by SharePoint and typical sizes for each. For more information, see this website: [go.microsoft.com/fwlink/p/?LinkId=257370](go.microsoft.com/fwlink/p/?LinkId=257370)

Figure 13 shows an example configuration that provides the capacity for SharePoint databases near their potential maximum size. The design shown uses 900 GB, 10k RPM SFF SAS HDDs.
Figure 13. An example storage design for a large SharePoint environment
This example does not necessarily meet the storage requirements for your organization. Careful planning and analysis should be performed before moving any storage architecture into production.

The storage design that is shown in Figure 13 shows isolating various workloads into separate storage pools, and following Microsoft’s best practices for databases that require separate disks. This example shows the storage pools and volumes that are assigned to a single SQL Server. When AlwaysOn availability groups are used, the second SQL Server in the cluster needs the same storage design (in duplicate) to host the database replicas.

6.3.2 SQL Server system databases

SQL Server includes several system databases for recording system-level information. These system databases are used for the following purposes:

- Scheduling alerts
- Template for all databases
- Container for system objects
- Workspace for holding temporary objects or intermediate result sets

Most of the databases can be installed in the same location as the SQL Server system files (typically on the C: drive). However, as a best practice, the tempdb database should be placed on a separate array than the other system databases. Also, the associated log files of the tempdb database should be on their own separate array.

Lenovo recommends that two logical drives are created on the storage and assigned to each of the servers in the SQL Server cluster (that is, each server requires one 4-disk array and one 2-disk array). Figure 13 includes the arrays for the tempdb database and its associated log files, as shown in the following examples:

- 4-Disk, RAID10 array for the tempdb database
- 2-Disk, RAID1 array for the log files of the tempdb database

6.3.3 SQL Server backups

Back up your SQL Server database is essential for protecting your data. Backing up copies the data or log records from a SQL Server database or its transaction log to a backup device (such as a disk) to create a data backup or log backup. Backup can occur while the database is online and in use. However, the following restrictions exist:

- Any backup operation that implicitly or explicitly references data that is offline fails.
- SQL Server uses an online backup process to allow for a database backup while the database is still being used. During a backup, most operations are possible; for example, INSERT, UPDATE, or DELETE statements are allowed during a backup operation. However, if you try to start a backup operation while a database file is being created or deleted, the backup operation waits until the create or delete operation is finished or the backup times out.

SQL Server supports backup compression that greatly reduces the number of disks that are required to backup your data. Lenovo recommends a 3:1 compression ratio as sizing estimate for disk space.

Note: Storage controllers and disks for SQL Server backups are not included in the Bill of Materials for the reference architecture.

Reference architecture: Microsoft SharePoint Server 2013
6.3.4 Storage for WSFC

To increase the high availability of a cluster and the roles that are hosted on that cluster, it is important to set the cluster quorum configuration appropriately. The quorum for a cluster is determined by the number of voting elements that must be part of active cluster membership for that cluster to start properly or continue running. By default, every node in the cluster has a single quorum vote. Also, a quorum witness (when configured) has another single quorum vote. A quorum witness can be a designated disk resource or a file share resource. Each element can cast one “vote” to determine whether the cluster can run. Whether a cluster has quorum to function properly is determined by the majority of the voting elements in the active cluster membership.

As a general rule, the voting elements in the cluster should be an odd number when you configure a quorum. Therefore, if the cluster contains an even number of voting nodes, you should configure a disk witness or a file share witness. By adding a witness vote, the cluster continues to run if one of the cluster nodes goes down or is disconnected. A disk witness is usually recommended if all nodes can see the disk.

For this reference architecture, the virtualization host cluster and the SQL Server cluster use the disk witness method for maintaining quorum. Each cluster is assigned a small, logical drive that can be simultaneously accessed from both members of the cluster. If one server fails, the remaining server and the disk witness maintain majority and the remaining server stay online.

In addition to the quorum disk, the virtualization host cluster requires a larger logical drive for housing the VM system files and the VM virtual hard disks (VHDX) files.

Therefore, three logical volumes should be created initially: two small 5GB logical volumes for the cluster quorum disks and a larger logical volume for housing the VM VHDXs files. Figure 14 shows the logical volumes that are required for the virtualization host cluster and the SQL Server cluster.

![Figure 14. Logical volumes required for the virtualization host cluster and the SQL Server cluster](image)
6.3.5 Storage configuration for IBM Storwize V3700

Table 2 lists the recommended storage requirements in this reference architecture.

**Important**: The number of HDDs that is required by the storage pools for the SharePoint database volumes is listed for a *single* SQL Server. Each SQL Server in the cluster requires the volumes that are shown. Therefore, the number of HDDs is twice what is shown for the second copy that is used by the Microsoft SQL Server database cluster.

**Table 2: Storage requirements**

<table>
<thead>
<tr>
<th>Volumes for SharePoint Databases (each volume is required on each SQL Server)</th>
<th>Volume Description</th>
<th>Volume Size</th>
<th>Storage Pool HDDs</th>
<th>RAID Level</th>
<th>RAID space (900 GB HDDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SharePoint usage</td>
<td>2200 GB</td>
<td>6</td>
<td>RAID 10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>User profile services</td>
<td>4200 GB</td>
<td>8</td>
<td>RAID 5</td>
<td>5860 GB</td>
</tr>
<tr>
<td></td>
<td>Search link</td>
<td>1200 GB</td>
<td>6</td>
<td>RAID 10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>System databases</td>
<td>1100 GB</td>
<td>6</td>
<td>RAID10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>Service applications</td>
<td>2100 GB</td>
<td>6</td>
<td>RAID10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>SharePoint search</td>
<td>1400 GB</td>
<td>6</td>
<td>RAID10</td>
<td>2500 GB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volumes for SQL Server system databases (each volume is required on each SQL Server)</th>
<th>Volume Description</th>
<th>Volume Sizes</th>
<th>Storage Pool HDDs</th>
<th>RAID Level</th>
<th>RAID space (900 GB HDDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tempdb database</td>
<td>2200 GB</td>
<td>6</td>
<td>RAID 10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>tempdb log files</td>
<td>838 GB</td>
<td>2</td>
<td>RAID 1</td>
<td>838 GB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shared volumes for WSFC clusters (each volume is shared between the Hyper-V servers)</th>
<th>Volume Description</th>
<th>Volume Sizes</th>
<th>Storage Pool Drives</th>
<th>RAID Level</th>
<th>RAID space (900 GB HDDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• CSV</td>
<td>200 GB</td>
<td>6</td>
<td>RAID10</td>
<td>2500 GB</td>
</tr>
<tr>
<td></td>
<td>• Quorum for SharePoint cluster</td>
<td>5 GB</td>
<td>5 GB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quorum for SQL Server cluster</td>
<td>5 GB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The recommended configuration for the Storwize V3700 is 120 drives that fit in one control enclosure and four expansion enclosures. If 900 GB HDDs are used, this reference architecture requires 48 HDDs per SQL Server for SharePoint databases and SQL Server system databases (96 for the two SQL Servers) and six HDDs for the cluster shared volume and quorum volumes. Therefore, a total of 102 drives are required, which leaves up to 18 drives that can be used as hot spares or for backing up the SharePoint databases.
6.4 Networking

This section describes the networking topology and includes design guidance to correctly configure the network environment for redundancy and failover.

This reference architecture uses two ultra low-latency, high-performance Lenovo RackSwitch G8124 10 GbE network switches to provide primary data communication services. Lenovo recommends the use of Emulex Virtual Fabric Adapter 5 (VFA5) network adapters for System x servers. These adapters include built-in support for FCoE or iSCSI networking via a feature on demand (FoD).

For more information about configuring the network, see the accompanying *Installation and Configuration Guide*.

6.4.1 Key networking concepts and terminology

This section describes the following basic networking concepts and terminology that are used throughout the next sections:

**Inter-Switch Link (ISL)** – An ISL is a physical network connection from a physical network port on one switch to a physical network port on another switch that enables communication between the two switches. This reference architecture uses two physical connections between the two networking switches, which are aggregated by using a trunk group.

**Link Aggregation Control Protocol (LACP)** – LACP is an IEEE 802.3ad standard for grouping several physical ports into one logical port (known as a dynamic trunk group) with any device that supports the standard. The 802.3ad standard allows standard Ethernet links to form a single Layer 2 link that uses LACP. Link aggregation is a method of grouping physical link segments of the same media type and speed in full duplex and treating them as if they were part of a single, logical link segment. If a link in a LACP trunk group fails, traffic is reassigned dynamically to the remaining links of the dynamic trunk group.

**Trunk Group** – A trunk group creates a virtual link between two switches that operates with aggregated throughput of the physical ports that are used. Most networking switches support two trunk types: static trunk groups and dynamic LACP trunk groups. Lenovo’s recommendation (and the method that is used in this reference architecture) is to use dynamic trunk groups when available. Figure 15 shows a dynamic trunk group aggregating two ports from each switch to form an ISL.

![A dynamic trunk group using two ISL connections](image)

*Figure 15. A dynamic trunk group aggregating two ISL connections between two switches*

**Virtual Link Aggregation Group (vLAG)** - As shown in Figure 16, a switch or server in the access layer can be connected to more than one switch in the aggregation layer to provide for network redundancy. Typically,
Spanning Tree Protocol (STP) is used to prevent broadcast loops, which blocks redundant uplink paths. Therefore, there is the unwanted consequence of reducing the available bandwidth between the layers by as much as 50%. In addition, STP can be slow to resolve topology changes that occur during a link failure and can result in considerable MAC address flooding.

By using vLAGs, the redundant uplinks remain active and use all available bandwidth. To maintain maximum bandwidth over the multiple connections, vLAG is enabled on the LACP teams in this reference architecture.

**Figure 16. STP blocking implicit loops**

**Virtual LAN (VLAN)** – VLANs are a way to logically segment networks to increase network flexibility without changing the physical network topology. With network segmentation, each switch port connects to a segment that is a single broadcast domain. When a switch port is configured to be a member of a VLAN, it is added to a group of ports that belong to one broadcast domain. Each VLAN is identified by a VLAN identifier (VID). A VID is a 12-bit portion of the VLAN tag in the frame header that identifies an explicit VLAN.

**Tagged Port** – A tagged port is a port that is configured as a member of a specific VLAN. When an untagged frame exits the switch through a tagged member port, the frame header is modified to include the 32-bit tag that is associated with the port VLAN ID (PVID). When a tagged frame exits the switch through a tagged member port, the frame header remains unchanged (original VID remains).

**Untagged Port** – An untagged port is a port that is not configured as a member of a specific VLAN. When an untagged frame exits the switch through an untagged member port, the frame header remains unchanged. When a tagged frame exits the switch through an untagged member port, the tag is stripped and the tagged frame is changed to an untagged frame.
6.4.2 VLANs

A combination of physical and virtual isolated networks is configured on the servers and the switches to satisfy isolation best practices.

VLANs are used to provide logical isolation between the various types of data traffic. Table 3 lists the five VLANs that are required to support the two WSFC clusters and SharePoint workload as described in this reference architecture.

*Table 3: VLAN definitions*

<table>
<thead>
<tr>
<th>Network VLAN</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN 70</td>
<td>Management Network</td>
<td>A network that is used for host management, storage management, and out-of-band communication to IMM devices.</td>
</tr>
<tr>
<td>VLAN 61</td>
<td>Cluster Private Network (SQL Server)</td>
<td>A network that is reserved for cluster private (heartbeat) communication between clustered SQL Servers. There should be no IP routing or default gateways for cluster private networks.</td>
</tr>
<tr>
<td>VLAN 60</td>
<td>Cluster Private Network (virtualization host servers)</td>
<td>A network that is reserved for cluster private (heartbeat and cluster shared volume) communication between clustered virtualization host servers. There should be no IP routing or default gateways for cluster private networks.</td>
</tr>
<tr>
<td>VLAN 50</td>
<td>Live Migration Network</td>
<td>A network to support VM Live Migration for the Hyper-V cluster. There should be no routing on the Live Migration network.</td>
</tr>
<tr>
<td>VLAN 40</td>
<td>Cluster Public (Corporate Network)</td>
<td>A network that is reserved for connecting to the domain controller and the corporate network.</td>
</tr>
</tbody>
</table>

6.4.3 NIC teaming and VLAN assignment

Windows Server 2012 R2 NIC teaming is used to provide fault tolerance and load balancing for the communication networks and to provide the most efficient and optimized use of network resources. NIC teaming creates several virtual network adapters that are then assigned to appropriate VLANs. Lenovo recommends renaming the network interface ports in Windows to better document the network topology.

The virtual network adapter configuration is slightly different for the virtualization host cluster servers and the SQL Server AlwaysOn Availability Group cluster servers.
Virtualization host cluster network adapter configuration

Four virtual network adapters are created from within Windows on each virtualization host cluster server and are used for management (VLAN 70), cluster private traffic (VLAN 60), VM Live Migration (VLAN 50), and for access to the corporate intranet (VLAN 40). In addition to the virtual network adapters that are used by the virtualization host cluster servers, each VM that is hosted by the servers is assigned two more virtual network adapters from within Hyper-V. The first of the VM’s network adapters is assigned VLAN 70 for communication with the management infrastructure. The second network adapter is assigned VLAN 40 and is used to connect to the organization’s intranet and domain controllers.

Figure 17 shows the network adapters and their assigned VLANs.

Figure 17. vNIC configuration for the Hyper-V cluster servers
**SQL Server AlwaysOn Availability Group cluster network adapter configuration**

Three virtual network adapters are created from within Windows on each SQL Server AlwaysOn Availability Group cluster server. These adapters are used for management (VLAN 70), cluster private traffic (VLAN 61), and access to the corporate intranet (VLAN 40).

Figure 18 shows the virtual network adapters and their assigned VLANs for the SQL Server AlwaysOn Availability Group cluster servers.

![Figure 18. vNIC configuration for the SQL Server AlwaysOn Availability Group cluster servers](image)

**6.4.4 Network configuration**

Network switch ports should be configured to appropriately limit the scope of each of the VLANs. This configuration requires the appropriate switch ports to be set to tagged, and the VLAN definitions should include these ports for each switch.

To maintain VLAN information when multiple network switches are interconnected, an inter-switch link (ISL) is required. However, because a single ISL is limited in bandwidth to the 10 Gbps of a single connection and is
not redundant, two ISL connections are recommended. Link Aggregation Control Protocol (LACP) is used to combine the two physical ISL connections into a single virtual link, called a trunk group. LACP teams provide for higher bandwidth connections and redundancy between LACP team members.

Lenovo recommends enabling network health checking on networking switches that are configured as VLAG peers. Although the operational status of the VLAG peer is typically determined via the ISL connection, enabling network health checking provides an alternative means to check peer status if the ISL link fails. As a best practice, use an independent link between the two switches (for example, use the 1 Gb management port).

Not only are LACP teams formed on the ISLs between the switches, but LACP teams also are formed on the host connections to the switches, which provides for host connection redundancy. To maintain maximum bandwidth over the multiple connections, vLAGs also are configured on the LACP teams. Disabling Spanning Tree on the LACP teams helps avoid the wasted bandwidth that is associated with links that are blocked by spanning tree.

The recommended vLAG/LACP configuration is shown in Figure 19.

![Figure 19. LACP/vLAG recommended network design](image)

**6.4.5 Network load balancer**

For performance and resilience reasons, load balancing user connections to the presentation layer’s web servers is required for the SharePoint 2013 farm. Microsoft recommends the use of a layer 4 network load balancer, such as the Network Load Balancing feature in Windows Server 2012.

In SharePoint 2013, the network load balancer no longer must be configured to ensure persistence across web servers. The Distributed Cache service maintains authentication across all SharePoint 2013 web servers. Therefore, a client session is no longer required to persist to the same server.

For more information about network load balancing and configuration, see this website: [technet.microsoft.com/en-us/library/cc725691.aspx](technet.microsoft.com/en-us/library/cc725691.aspx)
6.5 Networking for shared storage

This section describes the networking topology for shared storage. Two 8 Gb FC switches provide primary data transfer services. Redundancy is achieved by using multiple switches and zoning to prevent the FC switch from being a single point of failure. Each server has one dual port Emulex 8Gb FC HBA that is used for connecting to the SAN. Each server maintains one 8 Gb connection to each of the two FC switches.

Figure 20 shows the fiber connections and zoning between the servers, switches, and the Storwize V3700 shared storage.

![Figure 20. SAN configuration](image)

For more information about configuring the SAN switches, zoning, and enabling multi-pathing, see the accompanying *Installation and Configuration Guide*.

6.5.1 Key storage concepts and terminology

This section describes the following basic concepts and terminology that is used throughout the next sections:

**World Wide Name (WWN)** – A WWN is a 64-bit identifier for devices or ports. All devices with multiple ports have WWNs for each port, which provides more detailed management. Because of their length, WWNs are expressed in hexadecimal numbers, which are similar to MAC addresses on network adapters.

**Zoning** – Zoning enables the isolation of a single server to a group of storage devices or a single storage device, or associate a grouping of multiple servers with one or more storage devices. This configuration might be needed in a server cluster deployment. Zoning is implemented at the hardware level (by using the capabilities of FC switches) and can usually be done on a port basis (hardware zoning) or on a WWN basis (software zoning). Zoning is configured on a per-target and initiator basis.

**Cluster Shared Volume (CSV)** – WSFC supports CSV. A CSV is a logical drive that is concurrently visible to all cluster nodes and allows for simultaneous access from each node.

6.5.2 SAN multi-pathing

The IBM Subsystem Device Driver Specific Module (SDDDSM) multi-path driver with the Windows Server 2012 R2 Multi-path I/O (MPIO) feature is used to provide fault tolerance and dynamic path management.
between hosts and storage. If one or more hardware component fails and causes a path to fail, multi-pathing logic chooses an alternative path for I/O so applications can still access their data. The SDDDSM uses a load-balancing policy to equalize the load across all preferred paths. No user intervention is required, other than the typical new device discovery on a Windows operating system.

For more information about the SDDDSM, see this website: pic.dhe.ibm.com/infocenter/svc/ic/index.jsp?topic=%2Fcom.ibm.storage.svc.console.doc%2Fsvc_w2kmpio_21oxvp.html

6.5.3 Storage zoning

When a WSFC cluster that is designed to host VMs is created, Lenovo recommends the use of WWN-based zoning (software zoning) rather than port-based zoning (hardware zoning) on the fibre switches. In port-based zoning, a port is placed into a zone and anything that is connecting to that port is included in the zone (or zones). In WWN-based zoning, zones are defined by using the WWNs of the connected interfaces. WWN-based zoning allows for a virtual SAN to be defined at the virtualization layer, which uses the same physical HBA ports the host uses while maintaining isolation between the host and VM's data traffic. For this reference architecture, WWN-based zoning is used for all SAN connections.

Lenovo recommends the use of single-initiator zoning for path isolation. In single-initiator zoning, zones are created that are based on a single initiator. Therefore, each zone contains a single HBA port WWN, or initiator. Multiple storage array WWNs can be added to the zone without violating the single initiator rule (storage arrays are the targets).

6.6 Deployment example

Figure 21 shows the example SharePoint environment (as described in this reference architecture) that is deployed in a 25U rack in a single data center.

The rack contains the two networking switches, two SAN switches, two compute servers for the virtualization host cluster, two compute servers for SQL server cluster, a Storwize V3700 dual controller, and four expansions drawers.
Figure 21. Hardware as deployed in the data center
7 Deployment considerations

This section describes some other deployment considerations for Microsoft SharePoint 2013.

7.1 Preparing SQL Server for SharePoint

The following configuration changes must be made to both SQL Servers before SharePoint is installed:

- The account that is used to install SharePoint should be given `dbcreator` and `securityadmin` privileges on the SQL Servers.
- Ports should be opened in the Windows Firewall.
- Memory usage by SQL Server should be limited so it uses 90% (at most) of the available memory.
- Backups should be compressed.

7.2 Planning service deployment in SharePoint 2013

A successful deployment and operation of a SharePoint Server 2013 enterprise solution can be significantly attributed to a set of test-proven planning and deployment techniques. Proper planning includes sizing the required server resources (CPU and memory), storage (capacity and IOPS), and networking (bandwidth and VLAN assignment) that is needed to support the infrastructure. This information can then be implemented by using industry standard best practices to achieve optimal performance and growth headroom that is necessary for the life of the solution.

This reference architecture follows the service deployment guidance that is outlined by Microsoft in Service applications and Services on Server for streamlined topologies, as described in the TechNet article that is available at this website: technet.microsoft.com/en-us/library/jj219591.aspx#Section1

7.3 Best practices for installing SharePoint 2013

The following best practices are recommended when SharePoint 2013 is installed:

- Lenovo recommends installing SharePoint on a drive other than the VM’s system drive. For this reference architecture, a second 80 GB drive is created and assigned to each VM for the SharePoint installation.
- The distributed cache service should run on the SharePoint web servers only. However, disabling the distributed cache service on the application servers requires careful attention. For more information about disabling the Distributed Cache service, see the TechNet article that is available at this website: technet.microsoft.com/en-us/library/jj219613.aspx#graceful
- The following TechNet article contains information about zones and authentication methods supported in SharePoint 2013: technet.microsoft.com/en-us/library/cc262350.aspx
- Hyper-Threading should be enabled on the virtualization host servers.

7.4 Best Practices for SQL Server AlwaysOn Availability groups

The Microsoft SQL Server maximum degree of parallelism (MAXDOP) configuration option controls the number of processors that are used for the execution of a query in a parallel plan. As of SharePoint 2013, the requirement is that max degree of parallelism (MAXDOP) is always set to 1.
8 Appendix: Lenovo Bill of Materials

This appendix features the Bill of Materials (BOMs) for Microsoft SharePoint Server 2013 reference architecture. The BOM lists in this appendix are not meant to be exhaustive and must always be re-checked with the configuration tools. Any information about pricing, support, and maintenance options is outside the scope of this document.

8.1 BOM for compute servers

This section contains BOM for the servers as described in "Compute servers" on page 16.

Table 4: Lenovo System x3550 M5

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5463AC1</td>
<td>System x3550 M5</td>
<td>1</td>
</tr>
<tr>
<td>ASCL</td>
<td>Intel Xeon Processor E5-2660 v3 10C 2.6GHz 25MB 2133MHz 105W</td>
<td>1</td>
</tr>
<tr>
<td>ASCX</td>
<td>Intel Xeon Processor E5-2660 v3 10C 2.6GHz 25MB 2133MHz 105W</td>
<td>1</td>
</tr>
<tr>
<td>A58X</td>
<td>System x3550 M5 8x 2.5&quot; Base Chassis</td>
<td>1</td>
</tr>
<tr>
<td>A59V</td>
<td>System x3550 M5 Planar</td>
<td>1</td>
</tr>
<tr>
<td>A5AG</td>
<td>System x3550 M5 PCIe Riser 1 (1x LP x16 CPU0)</td>
<td>1</td>
</tr>
<tr>
<td>A5B0</td>
<td>System x 900W High Efficiency Platinum AC Power Supply</td>
<td>2</td>
</tr>
<tr>
<td>6400</td>
<td>2.8m, 13A/125-10A/250V, C13 to IEC 320-C14 Rack Power Cable</td>
<td>2</td>
</tr>
<tr>
<td>A1ML</td>
<td>Lenovo Integrated Management Module Advanced Upgrade</td>
<td>1</td>
</tr>
<tr>
<td>A5AG</td>
<td>System x3550 M5 PCIe Riser 2, 1-2 CPU (LP x16 CPU1 + LP x16 CPU0)</td>
<td>1</td>
</tr>
<tr>
<td>A5AB</td>
<td>System x Advanced LCD Light Path Kit</td>
<td>1</td>
</tr>
<tr>
<td>A597</td>
<td>LCD OP Cable</td>
<td>1</td>
</tr>
<tr>
<td>A595</td>
<td>ODD Filler</td>
<td>1</td>
</tr>
<tr>
<td>A592</td>
<td>2.5&quot; 1x2 HDD Filler for empty bay</td>
<td>2</td>
</tr>
<tr>
<td>A59W</td>
<td>System x3550 M5 4x 2.5&quot; HS HDD Kit</td>
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<td>ServeRAID M5210 SAS/SATA Controller for System x</td>
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<td>ServeRAID M5200 Series 1GB Flash/RAID 5 Upgrade</td>
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<td>A5B8</td>
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<tr>
<td>A5UT</td>
<td>Emulex VFA5 2x10 GbE SFP+ PCIe Adapter</td>
<td>1</td>
</tr>
<tr>
<td>3581</td>
<td>Emulex 8Gb FC Dual-port HBA</td>
<td>1</td>
</tr>
<tr>
<td>9297</td>
<td>2U Bracket for Emulex 10GbE Server Adapter</td>
<td>1</td>
</tr>
<tr>
<td>4048</td>
<td>2U bracket for Emulex 8Gb FC Dual-port HBA for System x</td>
<td>1</td>
</tr>
<tr>
<td>90Y9430</td>
<td>3m Passive DAC SFP+ Cable</td>
<td>2</td>
</tr>
<tr>
<td>88Y6854</td>
<td>5m LC-LC fiber cable (networking)</td>
<td>2</td>
</tr>
</tbody>
</table>
8.2 BOM for networking

This section features the BOMs for the network switches, as described in "Networking" on page 23 and "Networking for shared storage" on page 29.

Table 5: Lenovo RackSwitch G8124E

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7159BR6</td>
<td>Lenovo System Networking RackSwitch G8124E (Rear to Front)</td>
<td>1</td>
</tr>
<tr>
<td>90Y9430</td>
<td>3m IBM Passive DAC SFP+ Cable</td>
<td>2</td>
</tr>
<tr>
<td>00D6185</td>
<td>Adjustable 19&quot; 4 Post Rail Kit</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6: Brocade 6505 Switch

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3873AR2</td>
<td>Brocade 6505 FC SAN Switch</td>
<td>1</td>
</tr>
<tr>
<td>00MY807</td>
<td>Brocade 6505 Redundant Power Supply</td>
<td>1</td>
</tr>
<tr>
<td>88Y6416</td>
<td>Brocade 8Gb SFP+ Optical Transceiver</td>
<td>12</td>
</tr>
</tbody>
</table>

8.3 BOM for shared storage

This section features the BOMs for the shared storage, as described in "Shared storage" on page 18.

Table 7: Storwize V3700 control enclosure

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>609924C</td>
<td>Storwize V3700 Disk Control Enclosure</td>
<td>1</td>
</tr>
<tr>
<td>ACLL</td>
<td>900 GB 10,000 rpm 6 Gb SAS 2.5 Inch HDD</td>
<td>24</td>
</tr>
<tr>
<td>ACHB</td>
<td>Cache 8 GB</td>
<td>2</td>
</tr>
<tr>
<td>ACHK</td>
<td>8Gb FC 4 Port Host Interface Card</td>
<td>2</td>
</tr>
<tr>
<td>ACHS</td>
<td>8Gb FC SW SPF Transceivers (Pair)</td>
<td>2</td>
</tr>
<tr>
<td>88Y6854</td>
<td>5m LC-LC fiber cable (networking)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 8: Storwize V3700 expansion enclosure

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>609924E</td>
<td>Storwize V3700 Disk Expansion Enclosure</td>
<td>1</td>
</tr>
<tr>
<td>ACLL</td>
<td>900 GB 10,000 rpm 6 Gb SAS 2.5 Inch HDD</td>
<td>24</td>
</tr>
<tr>
<td>88Y6854</td>
<td>5m LC-LC fiber cable (networking)</td>
<td>2</td>
</tr>
</tbody>
</table>
For more information about the topics in this paper, see the following resources:

Reference architecture: Microsoft SharePoint Server 2013