Business-Ready Configuration for Microsoft® Hyper-V™ R2 on Dell PowerEdge™ R-Series Servers with EqualLogic™ Storage

A Solutions Guide

August 2010

Dell | Microsoft

Ryan Weldon and Lance Boley

Table of Contents

Table of Figures

Introduction

Business Ready Configurations for Virtualization are a family of reference architectures offered by Dell designed to aid with the ordering, deployment, and maintenance of a virtualization infrastructure. These architectures are designed to meet specific customer needs through the use of various server, storage, and virtualization technologies available from Dell.

The reference architectures defined in this document are targeted at the large enterprise virtualization needs, although others may also benefit from this architecture. These architectures include Dell™ PowerEdge™ servers, Dell/Equallogic storage, and Microsoft® Hyper-V technology and are built on a 10 Gigabit (10Gb) network architecture that utilizes Dell PowerConnect 8000 series switches. Based on extensive design and engineering work, customers can quickly and confidently deploy this proven engineering architecture into production environments, thereby helping to eliminate much of the costly and time consuming trial and error work often encountered during complex deployments.

This guide includes information useful both before and after purchase of a Business Ready Configuration. Prior to purchase, this information can aid with the sizing of the solution, licensing selection, and preparation of the deployment environment for the solution. Post-purchase, this guide can aid with the setup, configuration, and deployment of the solution. The architectures will help customers achieve the full benefits of Microsoft Virtualization, Dell PowerEdge servers, and Dell/EqualLogic storage in a 10Gb network environment.

1 Audience

The intended audience for this white paper is IT administrators, IT managers, and channel partners who are planning to deploy or resell Microsoft® Virtualization themselves or for their customers. This white paper provides an overview of the recommended servers, storage, software, and services. It can be used to plan, scope, and procure the required components to set up a virtualization infrastructure.

It is assumed that the reader has a basic understanding of server virtualization (Hyper-V preferred), iSCSI storage, and networking concepts.

2 Overview

The reference architectures discussed in this white paper are centered on Microsoft's latest generation virtualization platform, Microsoft Server 2008 R2 with Hyper-V (referred to here on as Hyper-V R2), and a unified 10Gb network that supports both iSCSI and traditional Ethernet traffic. Storage for the virtual infrastructure is provided by a single Dell/EqualLogic storage array. Management of the Hyper-V R2 environment is provided by System Center Virtual Machine Manager 2008 R2 (SCVMM 2008 R2) which resides on a PowerEdge R610.

There are three reference architectures discussed in this white paper that vary in the number of virtualization hosts (PowerEdge R710 servers), the storage capacity provided, and the 10Gb network implementation. A simplified view that covers all three reference architectures is shown below in Figure 1.

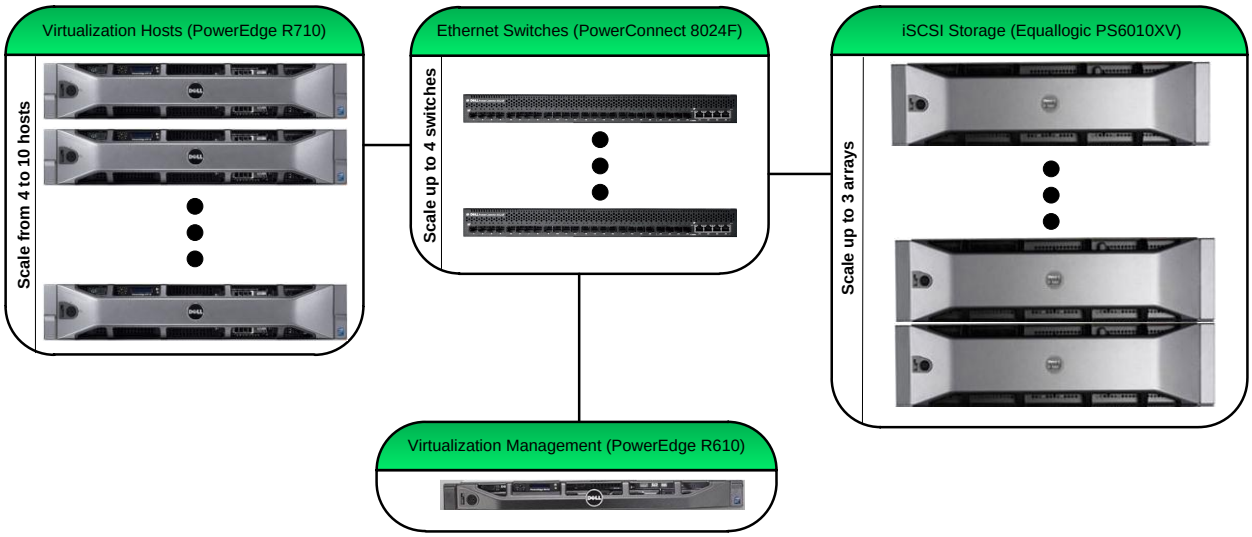

Figure 1: Reference Architectures (Logical View)

2.1 Reference Architectures

A high-level overview of the hardware included in each different configuration is shown in table 1.

	Entry	Medium	Large
Virtualization Hosts (Hyper-V R2)	4 x PowerEdge R710	6 x PowerEdge R710	10 x PowerEdge R710
iSCSI Storage	1 x PS6010XV (16 x 600GB 15k SAS)	1 x PS6010XV (16 x 600GB 15k SAS)	2 x PS6010XV (16 x 600GB 15k SAS)
Network Infrastructure	2 x PowerConnect 8024F	2 x PowerConnect 8024F	4 x PowerConnect 8024F
Virtualization Management (SCVMM 2008 R2)	1 x PowerEdge R610	1 x PowerEdge R610	1 x PowerEdge R610

Table 1: Reference Architecture Hardware Overview

2.2 Design Principles

The following design principles were utilized during the creation of the architectures:

1. **Optimal hardware configuration for virtualized workloads:** The PowerEdge servers are configured with specific hard drives, RAID configuration, memory, processors, and network adapters to support a Hyper-V™ R2 virtualized environment. The storage array is sized with appropriate storage capacity to support the virtual infrastructure of each reference architecture.

2. **Redundancy with no single point of failure:** Availability is always a concern in any implementation and in many ways becomes even more critical in a virtualized environment. As such, redundancy is incorporated in every aspect of the solution, including networking, storage, and power. This is a key element of the architectures and will be discussed in detail throughout the document.

3. **Scalability:** Scaling within the reference architecture is possible by adding additional memory, increasing processor speeds, and/or adding additional storage. In addition, the ability to scale from smaller reference architecture to larger architecture was taken into account during design. General guidance on both of these scenarios is provided within the document.

4. **Ease of Deployment:** A basic overview of the steps required for implementation and sample switch configurations are provided.

5. **Performance:** Load balancing supports simultaneous utilization of multiple adapters and therefore increases the available bandwidth and removes potential bottlenecks. Load balancing for iSCSI traffic is provided by EqualLogic and the Microsoft MPIO framework. Network teaming is implemented to provide load balancing for virtual machine traffic.

6. **Manageability:** Virtualization management is accomplished with SCVMM 2008 R2 and provides a large number of advanced features over the base Hyper-V Manager interface that is provided in Hyper-V R2. The servers are configured with iDRAC 6 Enterprise controller to provide remote out-of-band management. The storage array and switches also support remote out-of-band management and are standard in each product.

7. **Traffic Segregation and Prioritization:** In a Hyper-V R2 environment that utilizes failover clustering with Dell best practices, there are a minimum of three unique types of traffic. With the unified fabric, iSCSI traffic is also on the same set of switches. To keep the traffic separated, VLANs are utilized in the reference architecture. Priority is given to critical traffic types (such as iSCSI) to provide distinct quality of service (QoS) levels on the unified network.

8. **Integration into an existing data center:** The architectures assume that there are existing services provided and either an existing 10Gb or 1Gb network. The minimum services required to support the architectures are DNS and Active Directory. In addition, it is assumed that there is network infrastructure (either 1Gb or 10/100Mb) in place to support the out-of-band hardware management network. Although the reference architectures implements VLANs, it is not a requirement that the existing data center infrastructure support this capability.

2.3 Base Solution Capabilities

With each of the reference architectures, the following capabilities are provided.

- **Virtual Machine High Availability:** With the PowerEdge R710s being in a Microsoft Failover Cluster together, the virtual machines on these systems can be made "Highly Available" virtual machines. In the event that one of the R710 servers fails, the virtual machines that resided on that system can be restarted on another R710 server in the cluster without administrator intervention.

- **Virtual Machine Live Migration:** An administrator can live migrate a virtual machine from one R710 server to another R710 to balance workload or prior to performing proactive maintenance. Live migration can be performed without administrator interaction when SCVMM 2008 R2 is integrated with System Center Operations Manager (see Section 3.4, *Advanced Solution Capabilities*).

- **Support for Cluster Share Volumes (CSV):** A CSV provides the capability to host multiple virtual machines on a single volume and migrate those virtual machines independently amongst the R710 servers in the cluster. In addition, each R710 can simultaneously read and write directly (using its 10Gb iSCSI adapters) to the volume on the storage array.

- **Hot addition/removal of virtual machine storage:** Storage can be dynamically allocated to a virtual machine while the virtual machine is running. If the guest operating system (guest OS) supports hot plug of storage devices, then capacity can be added or removed without restarting the guest OS.

- **Template-based virtual machine provisioning:** Virtual machine templates can be created and stored in the SCVMM 2008 R2 library. These templates allow administrators to rapidly deploy standard virtual machines and support image generalization tools such as sysprep.

- **Workload Migration to Hyper-V R2:** SCVMM 2008 R2 supports migration from physical servers to Hyper-V virtual machines and from ESX virtual machines to Hyper-V virtual machines. The guest operating system within those virtual machines must be a Microsoft operating system and specific versions are supported. For additional information refer to http://technet.microsoft.com/en-us/library/cc764277.aspx.

- **Self-service virtual machine provisioning:** Administrators can delegate authority to other users or groups of users and allow them to create and utilize a predetermined set of virtual machines through a web interface. The web portal is provided by SCVMM 2008 R2 and supports integration with Active Directory.

- **Quick Storage Migration:** This capability provided by SCVMM 2008 R2 allows administrators to move a virtual machine that resides on one storage device to another storage device. In our reference architectures, the primary use case exists if there is an additional Hyper-V R2 implementation in the data center. In this case, then individual virtual machines can be moved between the two instances.
  Note: Unlike virtual machine live migration, there can be application unavailability associated with the quick storage migration and should be planned for during this migration process.

2.4 Advanced Solution Capabilities

There are numerous additions that can be made to enhance the base capabilities provided by the reference architectures. We have highlighted a subset of those that provide easy integration and add significant value.

- **Integration with Microsoft System Center Operations Manager (SCOM):** Microsoft supports SCVMM and SCOM integration is supported through SCOM-based application monitoring of the SCVMM environment and through the Physical Resource Optimization (PRO) framework. The PRO framework allows administrators to load PRO-enabled management packs in SCOM that can create PRO Tips based on alerts received in SCOM. The PRO Tips are designed to remediate the underlying issue that initiated the alert and can be configured for automatic or manual implementation by administrators. To support this integration, the following components are required:

  - SCVMM 2008 R2 Management Pack - This Microsoft management pack provides monitoring for the SCVMM server, library, self-service web portal, Hyper-V hosts, Virtual Server hosts, VMware ESX Server hosts, and their associated virtual machines. In addition, it enables third-party PRO packs (such as the Dell Server PRO Management Pack discussed below) to be loaded in SCOM. It also includes four Microsoft created PRO packs that provide PRO tips to optimize the performance of hosts and virtual machines based on CPU and memory thresholds. Of particular interest, there is a PRO tip that is generated when an individual Hyper-V host exceeds the CPU threshold and will live migrate a virtual machine or subset of virtual machines to another node in the cluster to load balance the virtual workload across the cluster.

The currently supported versions of SCOM at the time this document was published are SCOM 2007 SP1 and 2007 R2. For additional details on this management pack, refer to the SCVMM 2008 R2 Management Pack Guide available at http://technet.microsoft.com/en-us/library/ee423731.aspx

- Dell Server PRO Management Pack v2.0 – This Dell created PRO pack integrates with Dell OpenManage to monitor events such as loss of power supply redundancy, exceed temperature threshold, server storage battery error, and internal disk failures. The PRO Tips generated support actions such as the live migration of all virtual machines off of the alerting host.

2.5 Required Components to Support Reference Architectures

To support any of the reference architectures, several components must either already be in place in the data center or must be deployed simultaneously with the reference architecture. Active Directory (AD) and Domain Name Services (DNS) are required to support the Hyper-V R2 failover cluster and SCVMM 2008 R2. In addition, a 10/100Mb or 1Gb network infrastructure must be in place to support out-of-band hardware management. A management station on the hardware management network must be in place to support remote management. A simplified view of the reference architectures along with the required components is shown in Figure 2.

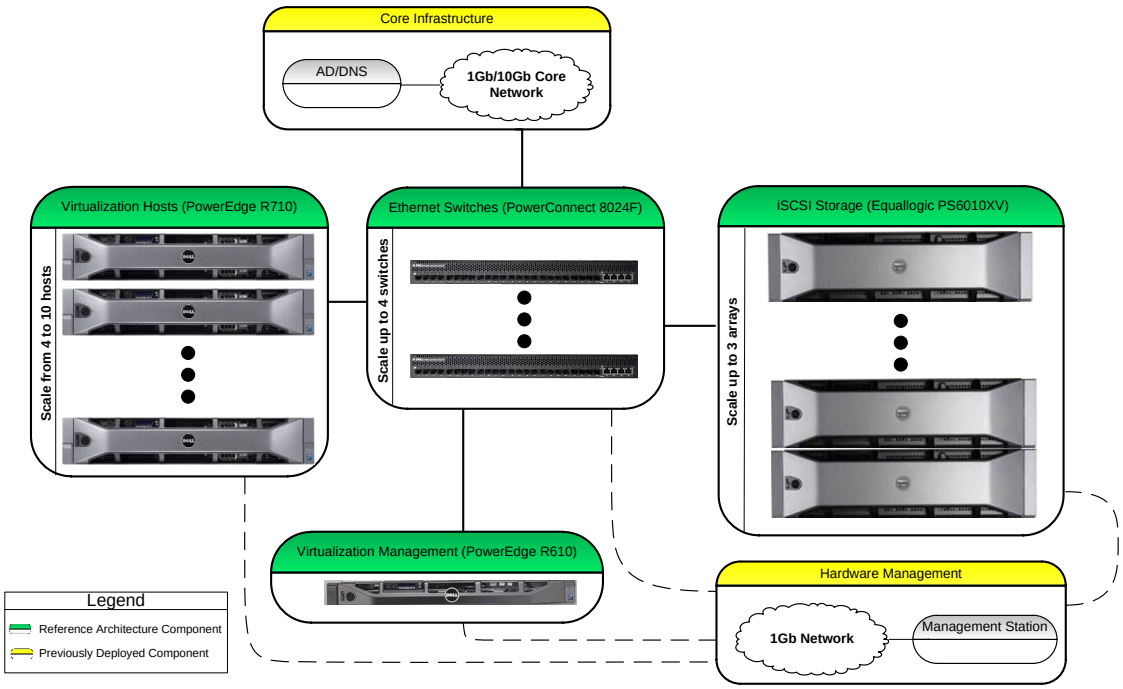

Figure 2: Reference Architectures with Required Components (Logical View)

2.6 Reference Architecture Sizing

The reference architectures are sized based on the following goals:

- Able to tolerate the failure of a single virtualization host in the cluster and continue to support running all virtual machines (virtual machines will restart across other Hyper-V R2 nodes in the cluster)
- Reserve the appropriate amount of memory for the Hyper-V management partition
- Provide adequate storage on the storage array to support the virtual machines
- Provide 500GB of storage on the storage array to support the SCVMM Library files

A standard virtual machine profile was created to appropriately size each reference architecture. This profile defines the number of virtual machines that can be hosted by each reference architecture and the disk capacity on the storage array required to support the virtual machine virtual hard drives, files, and snapshots.

Profile Attribute	Value	Detail
Memory	3 GB	Enterprise applications typically require 2+ GB of memory.
Boot Volume	40 GB	Assumes that the virtual machines will run Windows

		Server 2008 R2 (minimum disk capacity required is 32GB). Additional capacity is provided for applications/software.
Data Volume(s)	50 GB	Application storage
Snapshots and VM Files	12 GB	Assumes ~10% of total disk capacity for Hyper-V snapshots (also referred to as SCVMM Checkpoints) and capacity of the VM files (XML, BIN, VSV).

Table 2: Virtual Machine Profile

With the profile and sizing goals defined, calculations were performed based on Microsoft and Dell best practices to determine the maximum number of virtual machines that can be supported and minimum disk capacity required in each reference architecture.

	Entry	Advanced	Premium
Virtual Machine Count	40	70	125
Disk Space Required	~5 TB	~8 TB	~14 TB

Table 3: Reference Architecture Sizing

If different goals meet the needs of your virtualized environment, then adjustments can be made to the configuration to support those goals. For example, if the virtual machines are allocated 512MB as opposed to 3GB, the *Entry* configuration can support ~250 virtual machines, which results in a virtual machine to core ratio of ~10.5 to 1. This may impact the storage capacity required and place additional burden on the processors, so these factors should be taken into account and may require customization of the target reference architecture.

2.7 Ordering

To order the hardware utilized in the reference architectures discussed in this paper, contact your Dell Sales representative with the *Solution ID* listed below.

	Entry	Advanced	Premium
Solution ID	1127452.1	1127453.1	1127455.1

Table 4: Reference Architecture Solution Identifiers

The servers and switches included in each reference architecture can also be directly ordered online with a few clicks and is available at http://www.dell.com/virtualization/businessready.

2.7.1 What's included?

The solution ID's provided in table 4 contain the servers and switches that are configured as defined in Section 4, *Reference Architecture Hardware*. The 10Gb network cables required to interconnect the reference architecture components (servers, switches, and storage) are also included.

The following list details additional components that may need to be removed from the order if your datacenter already has them:

- Rack
- Power Distribution Units (PDU)
- Uninterruptable Power Supply (UPS)
- 1Gb network cabling (CAT 5) for out-of-band hardware management

The requirements to support these additional components are defined in Section 5, *Planning*.

2.8 Dell Global Services

Dell Global Services helps customers find a suitable virtualization option to reduce total cost of ownership, speed time to ROI, increase agility, and reclaim IT resources. Today's financial environment dictates that IT organizations reduce costs, while still providing ever-increasing infrastructure services. Dell Global Services believes that by heavily leveraging server virtualization and increasing the rate of adoption of this technology, you can accomplish this task.

Dell Global Services virtualization consultants work with customers to design and plan around the most common bottlenecks in virtualization implementations. Our methodology, tools, and processes are designed to speed up the implementation, ease migration scheduling, automate reporting, and provide transparency to the entire process. Dell Global Services also has the ability to offer end-to-end solutions with a single point-of-contact for hardware, software, services, and on-going support. Dell Global Services are focused on IT infrastructure services excellence.

To engage Dell Global Services, see http://www.dell.com/content/topics/global.aspx/services/adi/virtualization_new?c=us&cs=555&l=en&s=biz.

3 Reference Architecture Hardware

3.1 Virtualization Hosts – PowerEdge R710

The PowerEdge R710 servers in all of the reference architectures are configured identically. The table below details the server configuration.

Item	Detail	Summary
Processors	(2) E5530 Intel® Xeon® processor, 2.4GHz 8-M cache, TurboHT	Two quad core processors
Memory	(12) 4GB, 1066MHz dual-ranked RDIMMs for two processors, optimized	48GB total memory
Hard Drive Controller	PERC 6/i SAS RAID Controller 2x4 connectors, internal, PCIe 256-MB cache, x8 chassis	
Raid Level/Hard Drives	Raid 1: (2) 146-GB 10-K RPM serial-attach SCSI 2.5-inch hot-plug hard drive	146GB mirrored internal storage that will host Windows Server 2008 R2
BIOS Setting	Performance Setting	
Remote Management Controller	iDRAC6 Enterprise	Provides remote out-of-band management capability
Operating System	Windows Server 2008 R2 Datacenter x64, including Hyper-V, including 5 CALs	
Riser Card	Riser with 2 PCIe x8 + 2 PCIe x4 Slot	
Onboard Network Adapter	Dual Two-Port Embedded Broadcom NetXtreme II 5709 Gigabit Ethernet NIC	The onboard 1Gb adapters will not be utilized in the reference architecture
Additional Network Cards	2 x Intel X520 DA 10GB, Dual port network adapters (SFP+ form factor)	2 x 10Gb adapters provide 40Gb of available bandwidth and redundancy
Power Supply	High Output Power Supply, Redundant, 870W	Redundant power supplies
Power Cord	**(2)** Power cord, C13 to C14, PDU Style, 12 Amps, 2 meter	
Rails	Sliding ready rails with cable management arm	

Table 5: PowerEdge R710 Configuration

3.1.1 Networking – Hardware

The two Intel X520 DA network adapters should be plugged into the PCIe x8 slots. The two cards provide a total of four 10Gb ports. All of the network traffic (excluding out-of-band management) on the server is through these 10Gb ports. There are two ports dedicated to iSCSI traffic and those ports are split across the two adapters to support fault tolerance. The remaining two ports, referred to as "combined traffic" in this document, support all other traffic required in a clustered Hyper-V R2 environment (e.g. cluster public, cluster private, virtual machine).

From the point of view of an individual server, the connectivity to the PowerConnect switches is identical. The figure below displays the physical connections. Take note that the combined and iSCSI ports are split across the two switches to support the fault tolerance design.

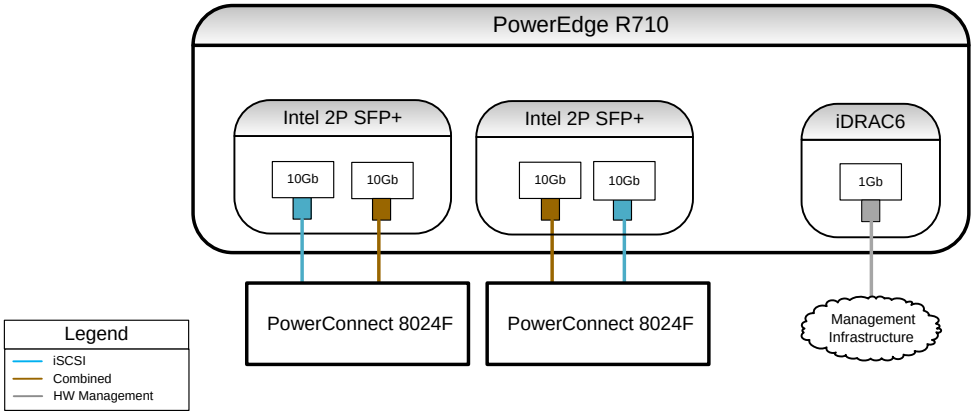

Figure 3: PowerEdge R710 Physical Network Connectivity

There are four onboard 1Gb ports available on each PowerEdge R710, however they are not utilized in the reference architectures. Those ports can be utilized if attaching to an existing 1Gb network, however that implementation is outside the scope of this document.

3.1.2 Networking – iSCSI traffic

The two ports dedicated to iSCSI are configured to allow for faults and provide redundancy for iSCSI communication between Hyper-V R2 hosts and EqualLogic PS storage array.

In addition, the EqualLogic array has specific recommendations for connecting PS Series arrays to the network. We have highlighted some of the important recommendations; however, for more information please see the Dell EqualLogic PS Quick Start Guide at https://www.equallogic.com/support/ (Account registration may be required).

• Spanning-Tree protocol (STP) should not be used on switch ports that connect end nodes (iSCSI initiators or array network interfaces). If you want to use STP or Rapid STP (preferable to STP), you should enable the port settings (FastLink or Port Fast) available on some switches that let the port immediately transition into the STP forwarding state upon link up. This functionality can reduce network interruptions that occur when devices restart and should only be enabled on switch ports that connect end nodes.

Note: The use of Spanning-Tree for a single-cable connection between switches is encouraged, as is the use of trunking for multi-cable connections between switches.

• Enable Flow Control on each switch port and NIC that handles iSCSI traffic. The PS Series arrays will correctly respond to Flow Control.

• Disable unicast storm control on each switch that handles iSCSI traffic if the switch provides this feature. However, the use of broadcast and multicast storm control is encouraged on switches.

• Enable Jumbo Frames on the switches and the NICs used for iSCSI traffic.

• Disable iSCSI optimization on the PowerConnect 5424 switches used for iSCSI traffic.

3.1.3 Networking

The two ports identified for combined traffic support all non-iSCSI Hyper-V R2 related traffic. These two ports are teamed together. The Virtual Machines Load Balancing (VMLB) team type is utilized on this team and provides both load balancing and failover capabilities. On top of the team, multiple virtual adapters can be created, each with its own associated VLAN. These virtual VLAN adapters are not associated with the Hyper-V concept of virtual switches and virtual adapters. The figure below illustrates the teaming and virtual VLAN adapter concept.

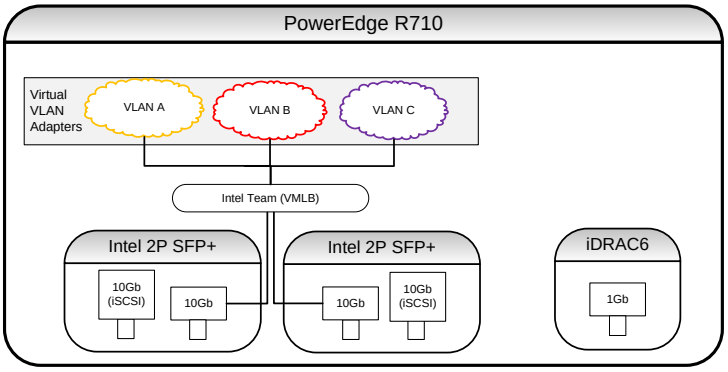

Figure 4: Virtual VLAN Adapter Concept

The virtual VLAN adapters will be utilized to support the multiple unique networks required in a Hyper-V R2 clustered environment. The table below details the types of traffic in Hyper-V R2:

Type	Details
Cluster public/ management	Provides a management interface to the cluster. External management applications (SCVMM, SCOM, Backup/Restore, etc) communicate with the cluster through this network.
Cluster private	Provides the primary interface for inter-node communication in the cluster.
Cluster Shared Volumes (CSV)	CSV traffic will flow over the same network identified for use by cluster private. Although CSV is not a requirement for supporting live migration, implementing CSV provides additional redundancy and provides an easier management experience for administrators.
Virtual machine	Allows virtual machines to communicate with clients. A Hyper-V virtual switch is required to support virtual machine traffic.
Live migration	Live migration traffic can flow over any network made available to the cluster. By default, live migration traffic will prefer private networks over public networks. In a configuration with more than one private network (the reference architectures utilize two), live migration traffic will flow on the private network that is not being used by cluster private/CSV. The priority of the networks can be set in the failover cluster manager interface or through WMI/PowerShell.

Table 6: Hyper-V R2 traffic types

To support these traffic types, four virtual VLAN adapters will be utilized as shown in the figure below.

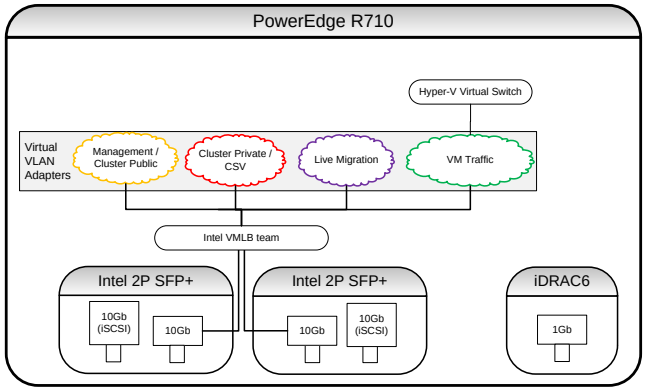

Figure 5: Virtual VLAN Configuration

Unlike iSCSI traffic that is tagged at the switch, the VLAN tagging for combined traffic is handled by BACS on each virtual VLAN adapter or by the Hyper-V virtual switch. As an example, the following VLAN configuration and subnet configuration could be implemented:

Type	Sample VLAN	Sample Subnet	Tagging Method
Cluster public/management	10	172.10.X.X	Tagged virtual VLAN adapter with VLAN 10
Cluster private/CSV	20	172.20.X.X	Tagged virtual VLAN adapter with VLAN 20
Virtual machine	10,11	172.10.X.X, 172.11.X.X	Untagged virtual VLAN adapter. Tagged by the Hyper-V virtual switch; VLAN is set on each Hyper-V virtual adapter.
Live migration	30	172.30.X.X	Tagged virtual VLAN adapter with VLAN 30

Table 7: Sample VLAN subnet configuration

Two VLANs are shown for virtual machine traffic, however only one is required. Up to 12 unique VLANs can be created per virtual machine.

3.1.4 VLAN and Subnet Summary

The following table provides a summary of the VLANs and a sample implementation.

Type	Sample VLAN	Sample Subnet
Cluster public/management	10	172.10.X.X
Cluster private/CSV	20	172.20.X.X
Virtual machine	10,11	172.10.X.X, 172.11.X.X
Live migration	30	172.30.X.X
iSCSI	100	172.100.X.X

Table 8: Sample VLAN/subnet summary

3.1.5 Power

Each power supply should be connected to a unique power distribution unit (PDU) to provide fault tolerance.

3.1.6 Storage

The internal disks on the PowerEdge R710 host the Windows Server 2008 R2 operating system. Storage for the virtual machines and their associated files is provided by the EqualLogic storage array.

3.1.7 Scalability

Each PowerEdge R710 can be scaled by adding additional memory, replacing the existing memory with larger DIMMs, or replacing the processors with higher frequency models. Additional PowerEdge R710 servers can be added to the failover cluster (up to sixteen servers are supported in a single Hyper-V R2 failover cluster).

NOTE: An overview of the server configuration process, including the installation and configuration of the applications above, is provided in Section 6, *Deployment*.

3.1.8 Customization

When ordering a configuration, customization of certain items is supported and will remain within the confines of the reference architecture.

- **Memory:** Memory can be added or removed from each server and the frequency of the memory can be changed, as well. The amount of memory configured has a direct impact on the memory available to allocate for virtual machines. When running additional virtual machines, the requirements for shared storage capacity may change and should be taken into account.
- **Processor:** A different processor model can be selected without impacting the reference architecture.
- **Internal Storage:** Although internal disk storage is not recommended for anything other than the operating system and associated applications, if a business need dictates usage of additional internal storage, additional disks may be added to the servers.
- **Operating System:** The Windows Server edition may be changed from Datacenter to Enterprise. Be aware that there are licensing differences between the two editions for the OS instances on the virtual machines. Windows Server 2008 R2 Standard Edition is not supported based on the lack of support for failover clustering. The operating system may be removed if it has been purchased/licensed separately and it will be installed during deployment.

3.2 Virtualization Management – PowerEdge R610

The PowerEdge R610 hosts SCVMM 2008 R2. With SCVMM there are multiple components including the VMM server, administrator console, database, self-service portal, and library. The PowerEdge R610 configuration in the reference architectures can support hosting all of the SCVMM components. The table below details the server configuration.

Item	Detail	Summary
Processors	(1) E5530 Intel® Xeon® processor, 2.4GHz 8-M cache, TurboHT	Single quad core processor
Memory	(4) 2GB, 1333MHz dual-ranked RDIMMs for one processors, optimized	8GB total memory
Hard Drive Controller	PERC 6/i SAS RAID Controller 2x4 connectors, internal, PCIe 256-MB cache, x8 chassis	
Raid Level/Hard Drives	Raid 1: (2) 146-GB 10-K RPM serial-attach SCSI 2.5-inch hot-plug hard drive	146GB mirrored internal storage that will host Windows Server 2008 R2
BIOS Setting	Performance Setting	
Remote Management Controller	iDRAC6 Enterprise	Provides remote out-of-band management capability
Operating System	Windows Server 2008 R2 Standard x64, including Hyper-V	
Riser Card	Riser with 2 PCIe x8 + 2 PCIe x4 Slot	
Onboard Network Adapter	(2) Dual-Port Embedded Broadcom NetXtreme II 5709 Gigabit Ethernet NIC	The onboard 1Gb adapters will not be utilized in the reference architecture
Additional Network Cards	(1) Intel X520 10GB dual port, network adapters (SFP+ form factor)	1 x 10Gb adapters provide iSCSI and Management connectivity
Power Supply	(2) High Output Power Supply, Redundant, 870W	Redundant power supplies
Power Cord	(2) Power cord, C13 to C14, PDU Style, 12 Amps, 2 meter	
Rails	Sliding ready rails with cable management arm	

Table 9: PowerEdge R610 Configuration

This configuration is sized to support a virtual infrastructure of up to 20 virtual hosts. These hosts can be any of the SCVMM 2008 R2 supported virtualization platforms (Hyper-V, Virtual Server, or VMware ESX). As the number of virtual hosts scales, the requirements for SCVMM 2008 R2 scale as well. For additional details, refer to Section 4.2.5, *Scalability*.

To support SCVMM 2008 R2, a SQL Server database is required. If an existing Microsoft SQL Server 2005 or 2008 deployment exists in the data center, then it is recommended to utilize that database. If a database is not available, then SQL Server Express Edition 2005 SP3 can be installed during the SCVMM 2008 R2 installation process. If the optional SCVMM and SCOM integration is desired, then the Express Edition of SQL server cannot be utilized and a full version of SQL Server must be implemented. For more information on the database requirements, refer to the Microsoft TechNet article on the system requirements for the VMM database at http://technet.microsoft.com/en-us/library/cc764220.aspx.

3.2.1 Networking

The PowerEdge R610 network configuration is very similar to that of the PowerEdge R710 servers. The iSCSI configuration is similar; however all of the Hyper-V R2 traffic types are not applicable. The only requirement for SCVMM 2008 R2 is to have access to the management network. A combined view that shows hardware connectivity is illustrated in the Figure 6 below.

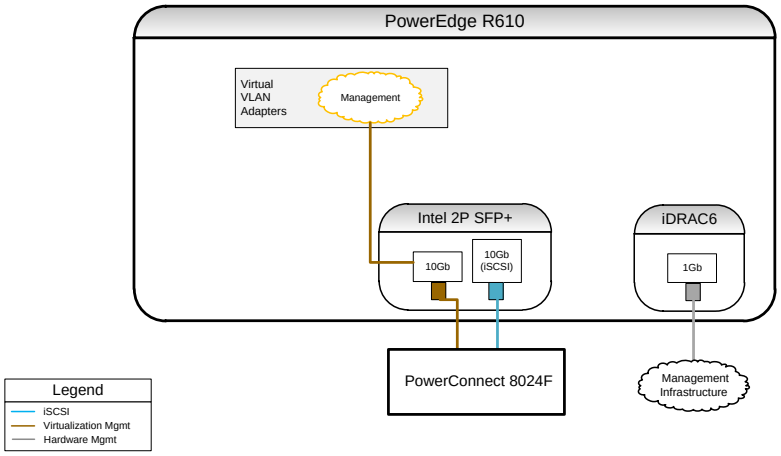

Figure 6: PowerEdge R610 Networking

3.2.2 VLAN and Subnet Summary

The table below depicts the sample VLANs to implement that align with those provided for the virtualization hosts. The iSCSI traffic is tagged by the switch and management traffic should be tagged.

Type	Sample VLAN	Sample Subnet
Management	10	172.10.X.X
iSCSI	100	172.100.X.X

Table 10: Sample VLAN/subnet summary

3.2.3 Power

Each power supply should be connected to a unique power distribution unit (PDU) to provide fault tolerance.

3.2.4 Storage

The internal disks on the PowerEdge R610 host the Windows Server 2008 R2 operating system and SCVMM 2008 R2. The reference architecture provides support for storing the SCVMM 2008 R2 library files (templates, scripts, ISO images) on the storage array.

3.2.5 Scalability

The PowerEdge R610 can be scaled by adding additional memory, replacing the existing memory with larger DIMMs, adding an additional processor, or replacing the existing processor with a higher frequency model. Scaling the PowerEdge R610 should be done in coordination with the scaling of the overall virtualization environment that is going to be managed.

When scaling beyond 20 virtual hosts, the R610 in the default configuration defined above can be utilized to support multiple SCVMM components, however it is recommended that the database be moved to a separate system. For details on the system requirements for larger virtual infrastructures, refer to the Microsoft TechNet article on VMM system requirements at http://technet.microsoft.com/en-us/library/cc764328.aspx.

3.2.6 Customization

Customization of the PowerEdge R610 should be done in accordance with the planned size of the virtual infrastructure that will be supported. See Section 4.2.5, *Scalability* for more information. If the datacenter has already deployed SCVMM 2008 R2, then the PowerEdge R610 can be removed from the configuration.

3.3 PowerConnect 8024F

The PowerConnect 8024F switches provide connectivity between the virtualization hosts, virtualization management server, and the storage array. Each reference architecture utilizes the minimum number of switches required to provide connectivity for the components, uplink to the existing switch infrastructure, and redundancy in the event of a switch failure.

The PowerConnect 8024F provides (24) SFP+ based 10Gb ports. Four ports on the switch are combo ports that support either SFP+ or 100MB/1GB/10GBASE-T connectivity. In each of the reference architectures there are dedicated links for uplinking into existing datacenter network infrastructure. The ports defined for uplinking are in the range of ports that are the combo ports on the switch. This allows for uplinking into a switch infrastructure that supports the SFP+ or 100MB/1GB/10GBASE-T connectivity.

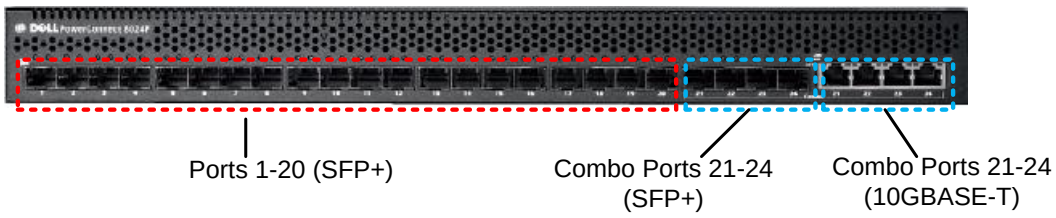

Figure 7: PowerConnect 8024F Port Overview

In addition, a serial console port and out-of-band management port are included on the switch. The serial console port is required for initial configuration of the switch. The figure below depicts the two ports.

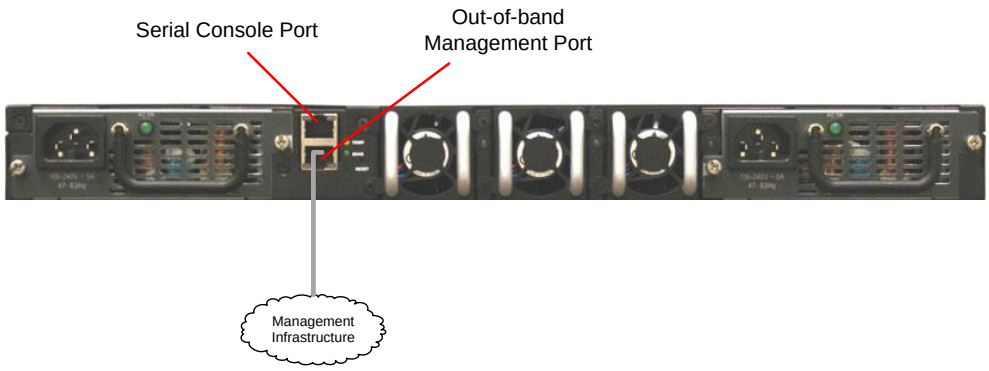

Figure 8: PowerConnect 8024F Management Ports

There are two network configurations that are utilized across the three reference architectures. The first network configuration includes two PowerConnect 8024F switches and is utilized by the *Entry* and *Advanced* reference architectures. The second network configuration includes four PowerConnect 8024F switches and is utilized by the *Premium* reference architecture.

3.3.1 Customizing Recommended Switch Configurations

The recommended switch configurations provided here may need to be customized for your environment. Typical adjustments include the following:

- **ISL:** ISLs may be moved up in the data center infrastructure to the core switches. Additional ports can be dedicated to ISLs if a large amount of cross-switch traffic is expected.
- **Uplinks:** Ports may be added or removed from the set of uplink ports based on bandwidth requirements. In addition, the VLAN tag may be removed on switch egress and added on ingress if VLANs are not implemented in the existing switch infrastructure.
- **Hosts:** The configurations assume that only the virtualization hosts and management server will be attached. Other data center roles, such as a SQL server or System Center Operational Manager host may be added directly into the switch configuration.

3.3.2 Jumbo Frames

As discussed previously, the reference architectures utilize jumbo frames. To support jumbo frames, each device in the path must support the larger MTU size. As such, the switches must be configured to support this. The sample switch configuration provided in appendix A include the appropriate jumbo frame settings.

3.3.3 ISL Configuration

The ISLs configured in both the two switch and four switch configurations utilize a link aggregation group (LAG) to combine the multiple ISL links into a single logical link. Without the LAG configuration, a loop would be created, spanning tree protocol would break the loop, and only a single ISL link would be utilized.

3.3.4 Two switch configuration

The *Entry* and *Advanced* reference architectures utilize two PowerConnect 8024F switches. The 48 ports across the two switches are allocated as follows:

Use	Port Count	Detail
Combined traffic for servers	16	Supports up to (7) virtualization hosts and the virtualization management server
iSCSI traffic for servers	16	Supports up to (7) virtualization hosts and the virtualization management server
iSCSI traffic for storage array	4	Supports the (4) 10Gb ports on the storage array
Inter-switch Links (ISL)	4	Provides 20Gb of bandwidth between switches.
Uplink to existing infrastructure	4	Provides 40Gb of bandwidth for uplinking to the existing switch infrastructure in the data center
Unused ports	4	Ports are not allocated for a function and are left unused to support an easy transition to the four switch configuration.

Table 11: PowerConnect 8024F port allocation (Two switch configuration)

The ports described in table 12 are mapped to the ports on each switch as shown below in Figure 9. A sample switch configuration that supports this configuration is provided in Appendix A.

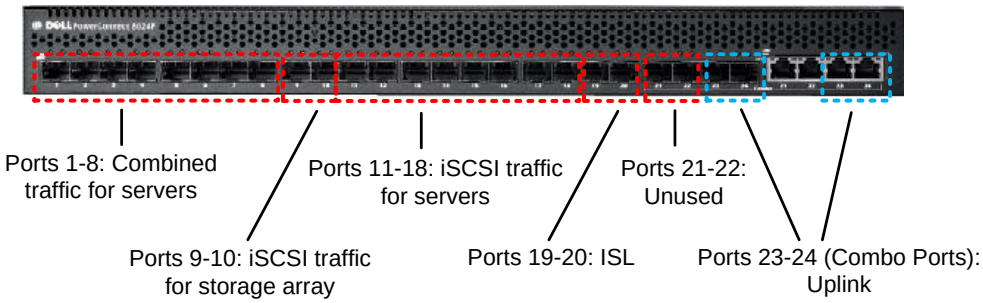

Figure 9: PowerConnect 8024F Port Mapping (Four switch configuration)

Figure 10 pulls together the sample VLAN implementation and displays connectivity of a single virtualization host and the storage array. Up to seven additional servers can connect to the switches and mirror the connectivity of the single server shown.

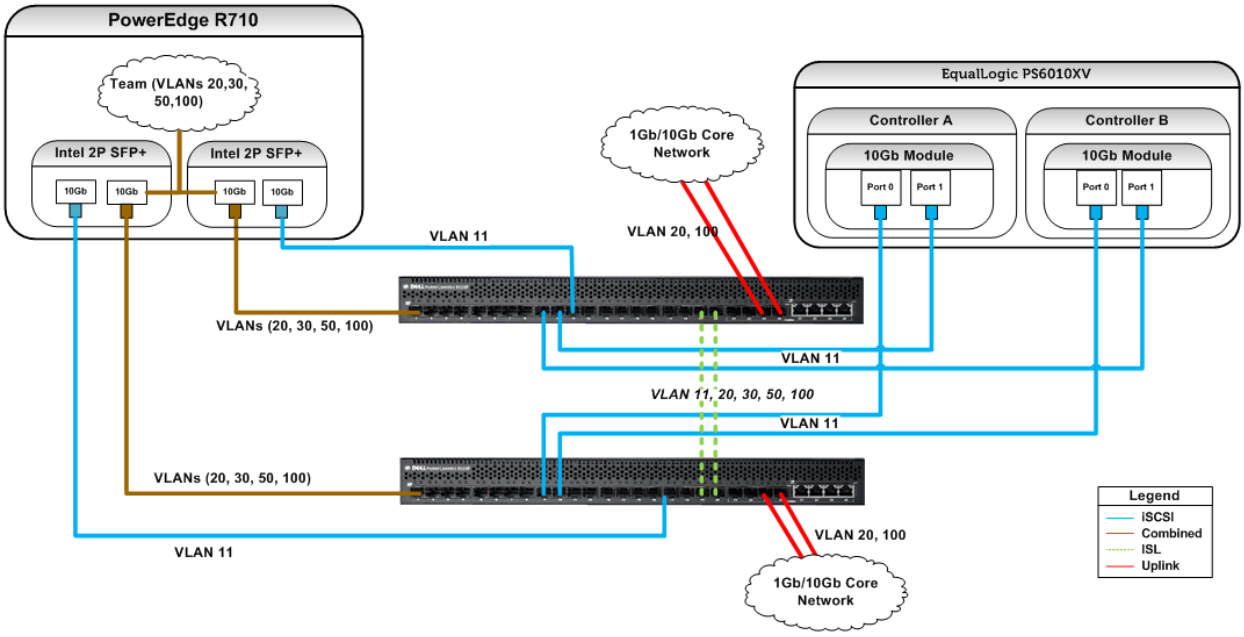

Figure 10: Two Switch Configuration VLAN Overview

There are two items on Figure 10 worth discussing that may not be obvious at first glance:

- iSCSI traffic and the two private networks (Cluster Private/CSV and Live Migration) are not allowed over the uplinks.
    - There is no reason to route the private network traffic outside of the switches unless you are integrating a server into the Hyper-V R2 cluster that resides on the core network. This implementation is outside the scope of the reference architectures.

    - iSCSI traffic can be supported over the uplinks. When doing so, be aware of the performance and capacity implications of providing iSCSI storage on the array to additional servers. In addition, keeping the unified fabric on the core network should only be done on switches that are designed to support that implementation. If the data center currently has physically separate switch infrastructure for iSCSI traffic, then the configuration could be modified to support this. Supporting iSCSI traffic over the uplinks is outside the scope of the reference architectures.

3.3.5 Four switch configuration

The four switch configuration utilized by the *Premium* reference architecture is a differentiation of the two switch configuration. The differentiation between the two switch and the four switch configuration is that all iSCSI traffic will now be on a pair of dedicated switches and the remainder of the traffic will reside on the other two switches.

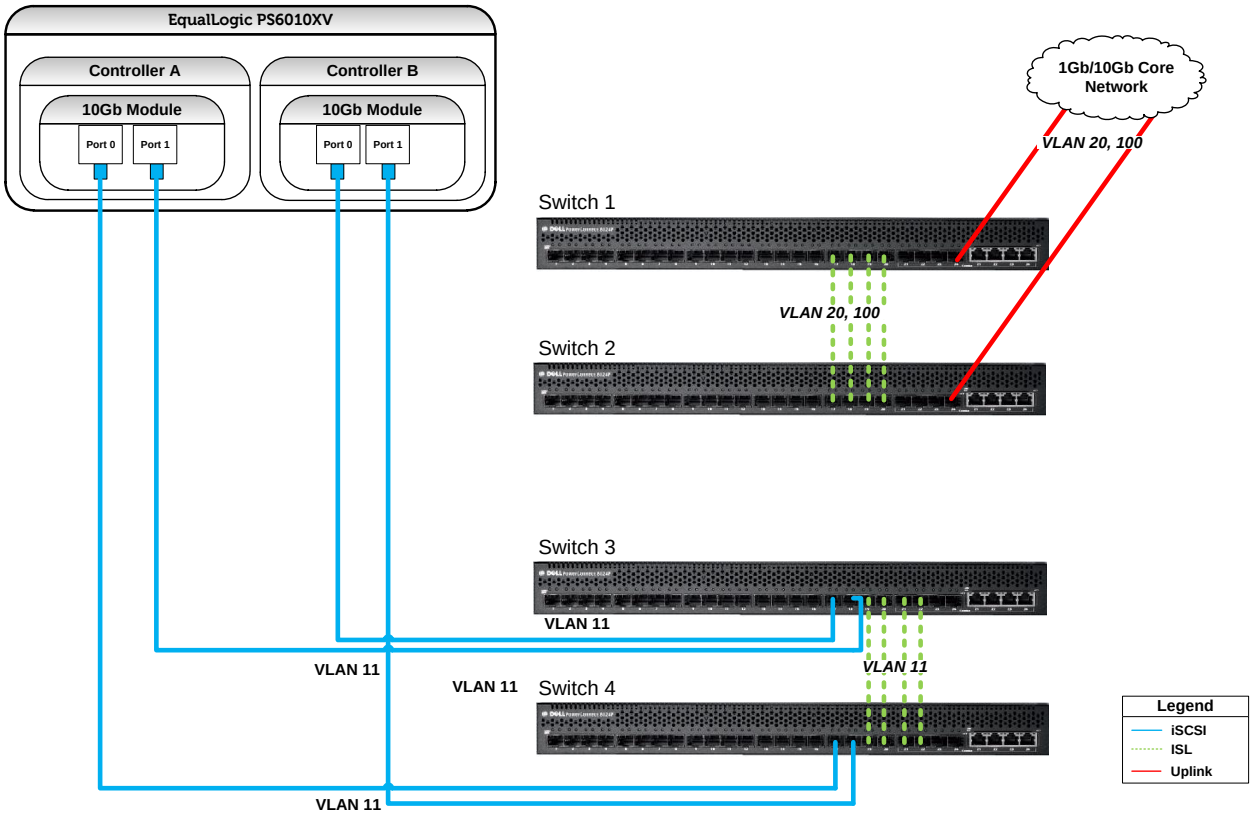

Figure 11: Four Switch Configuration VLAN Overview

Figure 12 displays how 16 of the servers attach to the switches. On a per server basis, this is identical to the two switch configuration. Eight servers mirror the connectivity of the R710 on the left of figure and eight servers mirror the connectivity of the server on the right.

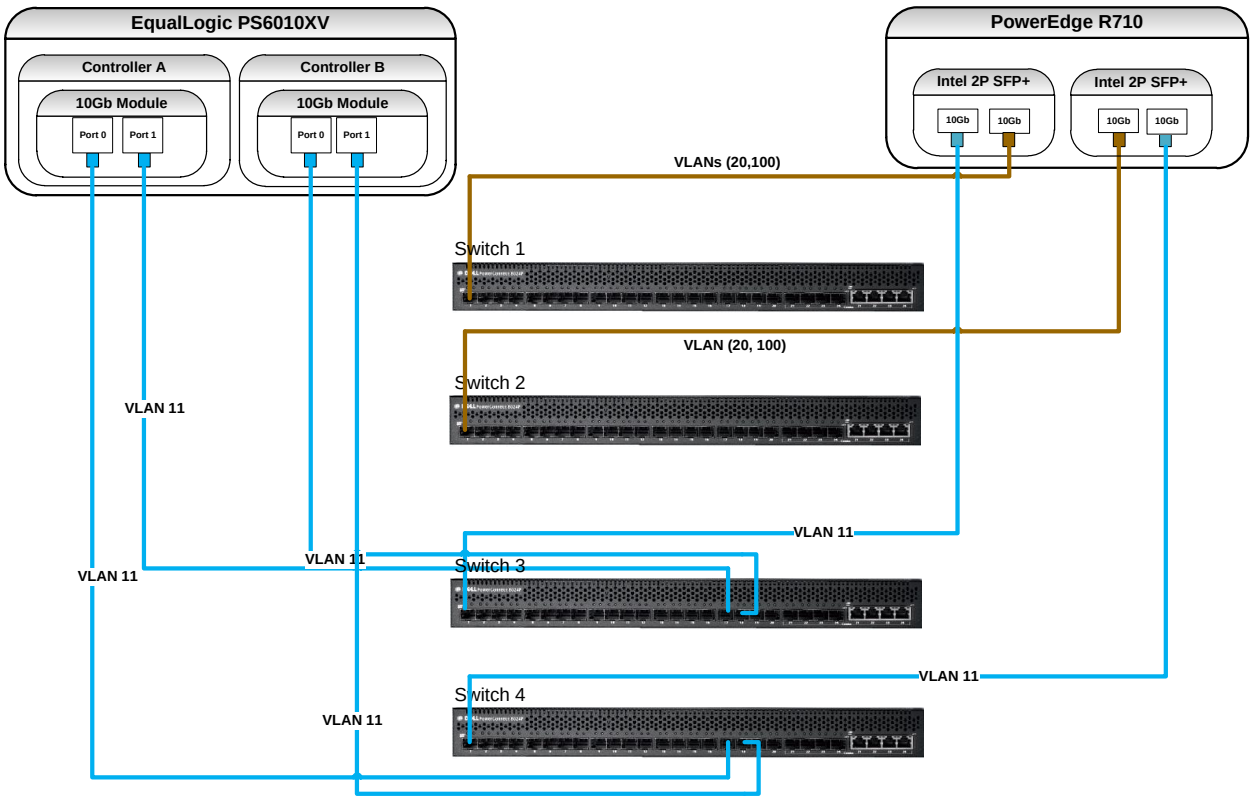

Figure 12: Four Switch Configuration Server Connectivity

With the ability to connect 17 servers, the virtualization management server and 16 virtualization hosts can be supported. This corresponds with the maximum number of nodes that are supported within a single Windows Server 2008 R2 Failover Cluster (16). Scaling beyond this requires implementation of an additional failover cluster.

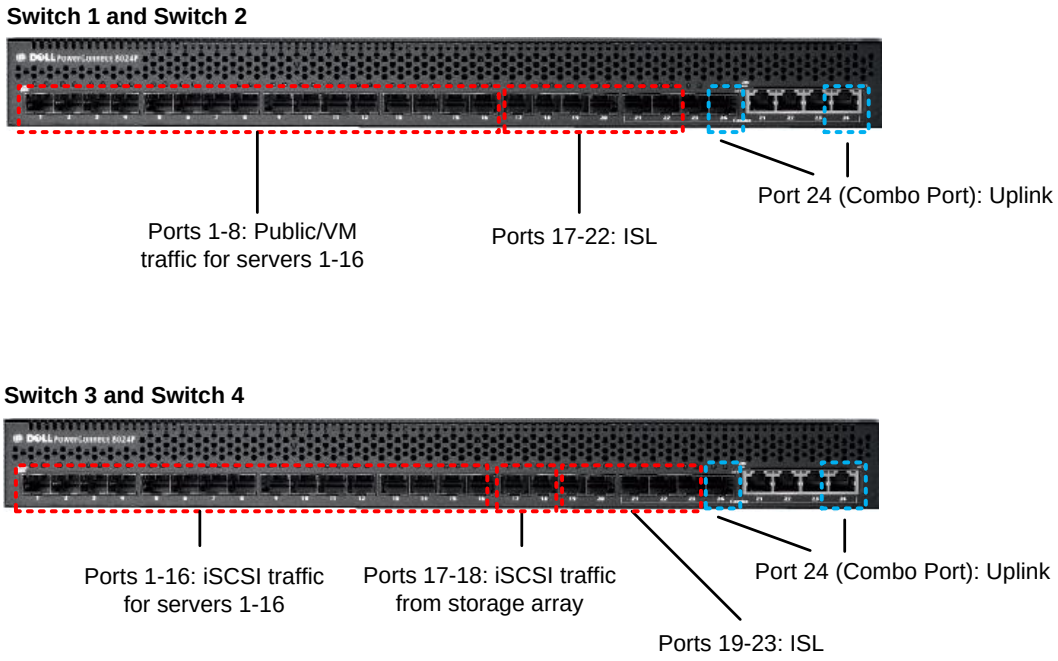

Figure 13: PowerConnect 8024F Port Mapping (Four switch configuration)

3.3.6 Power

The switch includes redundant power supplies. Each power supply should be connected to a unique power distribution unit (PDU) to provide fault tolerance.

3.3.7 Scalability

As mentioned previously, the two switch configuration was designed to support a simple upgrade path to the four switch configuration. Only four cables will need to be moved from the existing two switch configuration, eight cables added for ISL links, and the switch configurations will need to be updated. Downtime should be planned for during the reconfiguration. Scaling below two or beyond four switches is outside the scope of the reference architectures. Figure 13 depicts the four ports that need to be moved (Port 9 and 23 on both switches) and the additional ISL links to cable.

3.3.8 Customization

The PowerConnect 8024F does not have any configurable options outside of the 10Gb cabling. Each of the Business Ready Configurations includes the appropriate cables for connecting to the servers, storage, and uplinking to an existing 10Gb network that utilizes the SFP+ form factor. The Business Ready Configurations do not include Cat 5e or Cat 6 cables that are required if uplinking to the existing network in the datacenter utilizing the 10GBASE-T ports.

3.4 iSCSI Storage Array

The EqualLogic storage array provides 10Gb iSCSI shared storage to support the Hyper-V R2 cluster, virtual machines, and SCVMM 2008 R2 library files. The storage array consists of the following components:

- Main Chassis
- Controllers
- Power Supplies

3.4.1 RAID Configuration

The reference architectures assume that RAID 6 is implemented on each array. RAID 6 provides high performance in various I/O patterns and data protection in the event of a disk failure. The reference architecture also provides two global hot spares per physical array to support automatic rebuilding of the RAID group in event of a disk failure.

Other RAID levels, such as RAID 5, RAID 50 and RAID10, can be implemented and may decrease or increase the overall storage capacity based on the RAID level chosen.

3.4.2 LUN Configuration

There is no single recommendation that can be provided that meets every application and/or datacenter's requirements. The rule is that the virtual machine's I/O requirements are no different than a physical machine. To determine what configuration is appropriate for your environment, you must understand what the I/O requirements are going to be for each virtual machine or class of virtual machines. There may be cases where multiple virtual machines and the application related data may reside on a single LUN and other cases where the application data requires its own LUN.

3.4.3 Networking

The network connectivity implemented in the two switch configuration is shown in figure 19 and in the four switch configuration in figure 20. For more details on the VLAN implementation refer to Section 4.3, *PowerConnect 8024F*.

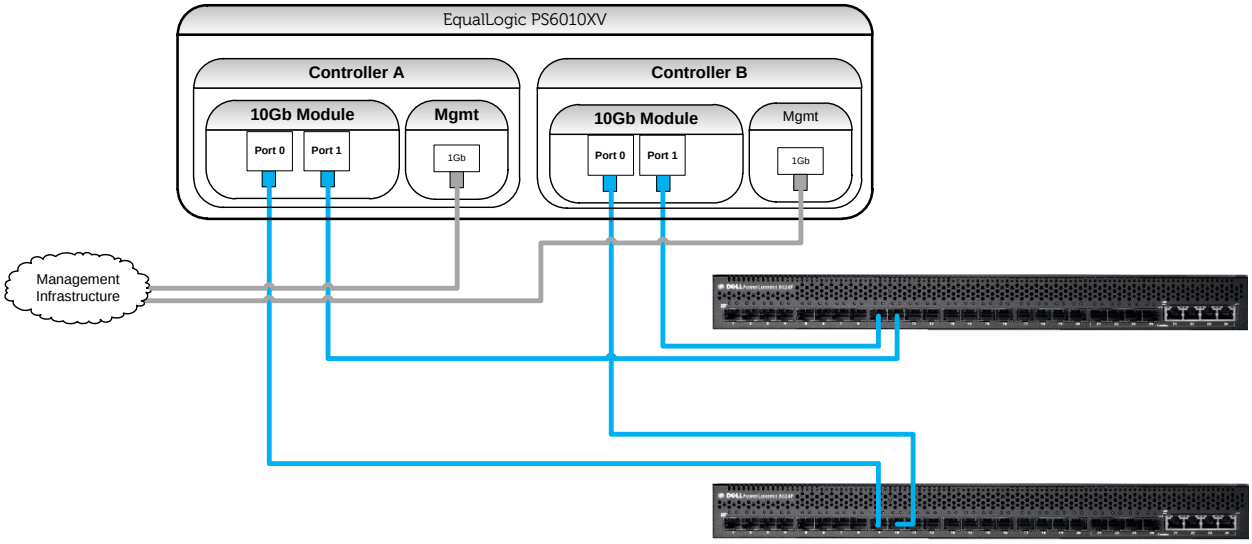

Figure 14: iSCSI Connectivity (Two Switch Configuration)

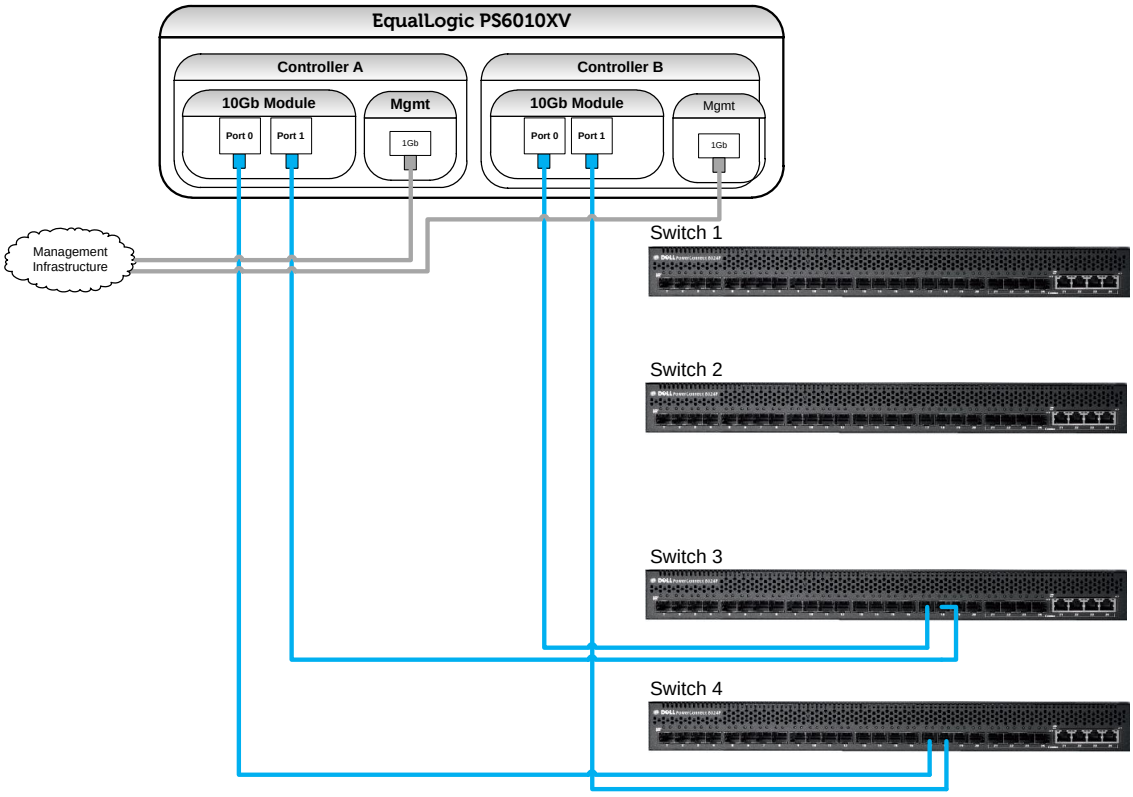

Figure 15: iSCSI Connectivity (Four Switch Configuration)

As mentioned previously, jumbo frames requires end-to-end configuration of the MTU size. As such, the MTU of each 10Gb iSCSI port should be set to 9000 (maximum value supported by array).

4 Planning

4.1 Data center support requirements

As we already discussed, there are certain components that must already be in place to support any of the three reference architectures. The required and optional components are provided:

- **Active Directory:** All Hyper-V R2 servers must be in the same AD domain
- **DNS:** All Hyper-V R2 servers must use DNS for name resolution
- **1Gb Network Infrastructure:** This network provides support for out-of-band management. In addition, a link between this network and the 10Gb network should be provided to support server/storage array communication required by EqualLogic. The 1Gb switch infrastructure must be able to support the following:

	Entry	Medium	Large
Hyper-V R2 Servers	4	6	10
SCVMM Server	1	1	1
PowerConnect Switches	2	2	4
Storage arrays	2	2	2
Total 1Gb Ports Required	**9**	**11**	**17**

Table 12: 1Gb Port Requirements

- **Integrating PowerConnect 8024F switches:** It is impossible to provide a single recommendation that meets all data center needs. For some, the 10Gb PowerConnect switches included in the reference architecture may act as the core switches. For others, uplinks to an existing 10Gb network may be implemented. The network administrator will have to analyze the impact that the addition of the switches will have. Dell Global Services can be engaged to support the integration if need be.

- **Workstation:** This system will be utilized to perform out-of-band management and configure the hardware devices. This system should run a Microsoft client (Windows XP or later) or server (Windows Server 2003 or later) operating system.

- **SQL Server (Optional):** If integration between SCVMM and SCOM is desired, then either SQL Server 2005 or 2008 (Standard or Enterprise Editions) must be in place. For more information on the supported versions and required service packs, refer to the Microsoft TechNet article on VMM System Requirements available at http://technet.microsoft.com/en-us/library/cc764220.aspx.

The maximum power and weight requirements for the data center are the following:

	Entry		Advanced		Premium	
Hyper-V R2 Servers	6960 watts	230 lbs	10,440 watts	345 lbs	17,400 watts	575 lbs
SCVMM Server	1,000 watts	35 lbs	1,000 watts	35 lbs	1,000 watts	35 lbs
PowerConnect Switches	322 watts	~20 lbs	322 watts	~20 lbs	644 watts	~40 lbs
EqualLogic PS Storage Arrays	500 watts	86 lbs	500 watts	86 lbs	1,000 watts	172 lbs
Total Requirement	**8,782 watts**	**~371 lbs**	**12,262 watts**	**~371 lbs**	**20,044 watts**	**~822 lbs**

Table 13: Maximum Power and Weight Requirements

The rack space requirements for the data center are the following:

	Entry	Advanced	Premium
Hyper-V R2 Servers	8U	12U	20U
SCVMM Server	1U	1U	1U
PowerConnect Switches	2U	2U	4U
EqualLogic PS Storage Arrays	3U	3U	6U
Total Requirement	**14U**	**18U**	**31U**

Table 14: Rack Space Requirements

4.2 Determining virtualization candidates

There are several methods available to determine potential virtualization candidates in the data center:

- **Dell Global Services:** http://content.dell.com/us/en/enterprise/d/services/it-consulting-virtualization-optimization-server-virtualization-assessment.aspx

- **Assessment Software:** Software exists to analyze your data center and provide recommendations.

    - **Microsoft Assessment and Planning (MAP) Toolkit:** MAP is a free kit that provides a hardware inventory, compatibility analysis, and a readiness report. For more information on MAP, refer to http://technet.microsoft.com/en-us/library/bb977556.aspx.

- **SCOM/SCVMM Reporting:** When SCVMM and SCOM are integrated using the System Center VMM 2008 Management Pack, virtualization reports can be created. One of the reports, Virtualization Candidates, helps identify physical computers that may be good candidates for virtualization.

5 Deployment

This section will aid in the deployment of the reference configuration. This an outline of the procedures that need to be performed. For those familiar with the components in the reference architecture, the outline may be sufficient to perform a successful deployment. However if this is not the case, please refer to the product documentation for each component (links are provided in Section 8, *Additional Reading*).

1. **Perform physical Configuration**
   - Rack and cable the components of the reference architecture.

2. **Configure PowerConnect 8024F switches**
   - Perform initial configuration of switches (set the out-of-band management IP address).

     Note: *Management station to switch connection with a RJ-45 to DB-9 crossover cable (included with switch) is required for initial configuration.*

   - Connect to the Dell OpenManage Switch Administrator by browsing to the out-of-band management IP address and configure the switches.

3. **Perform initial configuration of the storage array**
   - Enable storage groups and pools on the array.
   - Configure the 10Gb network ports (Set IP address, enable jumbo frames).
   - Enable any optional array-based advanced features that were purchased (such as virtual provisioning).

4. **Perform initial configuration of the Hyper-V R2 servers**
   It is recommended to review the Microsoft® Windows Server® 2008 R2 With Hyper-V™ for Dell™ PowerEdge™ Systems Important Information Guide available at http://support.dell.com/support/edocs/software/win2008/WS08_R2/en/IIG_HyperV/IIG_HypV.pdf. Among other things, this guide provides updates on the latest known issues and resolutions.

   On each Hyper-V R2 server perform the following:

   - Ensure Hardware-assisted virtualization (Intel-VT) is enabled in the BIOS.
   - Configure the iDRAC adapter (utility available during the boot process).
   - Install the latest supported version of the Dell Open Manage Server Administrator.
   - Enable the Hyper-V Role.
   - Configure the iSCSI adapters.
   - Configure network adapters.

  - Set the static IP addresses adapters for cluster public, private, and live migration traffic.
  - Configure a Hyper-V virtual switch on the untagged virtual VLAN adapter.

    Note: *The virtual switch must have the same name across all Hyper-V R2 servers in the cluster*.

- Enable the MPIO feature.
- Start the iSCSI service.
- Install the EqualLogic Host Integration Toolkit (HIT) software.
- Configure the iSCSI initiator.
  - Connect to each 10Gb iSCSI port on the array (configure CHAP settings when establishing each connection).

5. **Perform initial configuration of the SCVMM 2008 R2 server**

- Ensure Hardware-assisted virtualization (Intel-VT) is enabled in the BIOS.
- Configure the iDRAC adapter (utility available during the boot process).
- Install the latest supported version of the Dell Open Manage Server Administrator.
- Enable the Hyper-V Role (required to create virtual machines/templates and store them in the library).
- Configure the iSCSI adapters.
  - Set the static IP addresses adapters.
- Configure network adapters.
  - Set the static IP addresses adapters for cluster public, private, and live migration traffic.
  - Configure a Hyper-V virtual switch on the untagged virtual VLAN adapter.

    Note: *The virtual switch must have the same name across all Hyper-V R2 servers in the cluster*.

- Enable MPIO feature.
- Start the iSCSI service.
- Install the EqualLogic Host Integration Toolkit (HIT) software.
  - Connect to each 10Gb iSCSI port on the array.

6. **Provide Hyper-V R2 servers with storage (Quorum and VM storage).**

- Using Group Manager, perform the following:
  - Create a Storage Group.

- Create LUNs.
- Add LUNs & Hyper-V R2 servers to storage group.

7. **Provide SCVMM server with storage (VMM Library)**

   - Using Group Manager, perform the following:
     - Create a Storage Group.
     - Create LUNs.
     - Add LUNs & Hyper-V R2 servers to storage group.
   - On the SCVMM server, perform the following:
     - Force a rescan via Disk Mgmt.
     - Format/Assign a drive letter.

8. **Install SCVMM 2008 R2**

   - On the SCVMM server, install SCVMM 2008 R2.
   - During installation either attach to an existing SQL server in the data center or allow the install procedure to install SQL Server Express Edition 2005 SP3.

   ***Note**: Do not add the Hyper-V R2 servers to the configuration yet.*

9. **Create the Hyper-V cluster**
   On only one of the Hyper-V R2 servers, perform the following:

   - Initialize/format disks
     - Assign a drive letter to the quorum disk.
   - Create the cluster
     - Run through the "Validate a Configuration Wizard" and ensure that no unexpected errors are present.

***Note**: The wizard may alert that multiple interfaces utilize the same MAC address (due the teaming configuration). Consult Microsoft KB article 974264 at* http://support.microsoft.com/kb/974264 *for more details.*

- Select all the other Hyper-V R2 servers during the creation process.

- Enable CSVs.
  - Make VM storage disks CSVs.
- Configure the cluster networks.
  - Ensure Virtual Machine network not available for use by cluster.

- Using the Failover Cluster Manager, set the priority of the networks for use by Live Migration (Live Migration (highest), Cluster Private/CSV, Cluster Public/Management).
- Configure the cluster network metrics on the private networks (Live Migration and Cluster Private/CSV).

10. Add Hyper-V R2 cluster to SCVMM configuration.

- On the SCVMM server, add the Hyper-V R2 cluster to the SCVMM configuration.

11. Configure SCOM (Optional).

- Add Hyper-V R2 servers and SCVMM server as managed systems.

- Integrate SCVMM & SCOM.
  - On the SCOM server, Install/Configure SCVMM 2008 R2 Management Pack.
  - On the SCOM server, Install/Configure Dell Server PRO Management Pack v2.0.

12. Deploy virtual machines.

At this point, virtual machines are ready to be deployed. Either new guest OS instances can be created or existing instances can be migrated to Hyper-V.

6 Additional Reading

Dell PowerEdge Server Documentation and Hardware/Software Updates

Visit support.dell.com, select "Drivers & Downloads", enter a server service tag or select the server model and operating system version (Adobe Flash is required).

Dell PowerConnect Switch Documentation and Firmware Updates

Visit support.dell.com, select "Drivers & Downloads", enter a server service tag or select the switch model and operating system version (Adobe Flash is required).

Dell Virtualization Documentation

Dell TechCenter Hyper-V R2 Blogs/Wiki Site

http://www.delltechcenter.com/page/Microsoft+Virtualization+-+Windows+2008+Hyper-V+R2

Microsoft® Windows Server® 2008 R2 With Hyper-V™ for Dell™ PowerEdge™ Systems Important Information Guide

http://support.dell.com/support/edocs/software/win2008/WS08_R2/en/index.htm

Business Ready Configurations

http://www.dell.com/virtualization/businessready

Dell™ Server PRO Management Pack 2.0 For Microsoft® System Center Virtual Machine Manager User's Guide

Visit support.dell.com, search for "Dell Server PRO Management Pack". The documentation is included in the zip file that contains the management pack.

Microsoft® Hyper-V Documentation

Hyper-V Getting Started Guide

http://technet.microsoft.com/en-us/library/cc732470(WS.10).aspx

Microsoft® Management Software

Microsoft Server Management Suite Enterprise (SMSE)

http://www.microsoft.com/systemcenter/en/us/management-suites.aspx

Microsoft System Center Virtual Machine Manager

http://www.microsoft.com/systemcenter/virtualmachinemanager

Virtualization Solution Accelerators (MAP toolkit, IPD Guide)

http://www.microsoft.com/vsa

SCVMM 2008 R2 P2V and V2V Migration

http://technet.microsoft.com/en-us/library/cc764277.aspx

SCVMM 2008 R2 Management Pack Guide

http://technet.microsoft.com/en-us/library/ee423731.aspx

VMM Hardware Requirements

http://technet.microsoft.com/en-us/library/cc764328.aspx.

EqualLogic Storage and Software

User Programmable Documentation (Planning, Installation, Maintenance)

7 Appendix A: Two Switch Sample Configuration

This appendix contains a sample network configuration for the Dell PowerConnect 8024F switches used in the two switch configuration. This file includes the setup and configuration options used in the qualification of the *Basic* and *Advanced* reference architectures. Customers are encouraged to use this file as a starting point and the example provided here should be modified to fit the data center's needs.

```
!Current Configuration:
!System Description "Powerconnect 8024F, 3.1.1.9, VxWorks 6.5"
!System Software Version 3.1.1.9
!
configure
vlan database
vlan  5,20,53,80
exit
ip address none
ip routing
interface vlan 5
routing
ip address 172.5.1.1 255.255.0.0
exit
!
interface vlan 20
name "iSCSI"
exit
interface vlan 5
name "LAN"
exit
!
username "admin" password password level 15
!
interface ethernet 1/xg1
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg2
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg3
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg4
spanning-tree disable
```

```
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg5
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg6
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg7
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg8
spanning-tree disable
switchport mode general
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5,53,80 tagged
exit
!
interface ethernet 1/xg9
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg10
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg11
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg12
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg13
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg14
spanning-tree disable
switchport access vlan 20
exit
!
```

```
interface ethernet 1/xg15
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg16
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg17
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg18
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg19
spanning-tree disable
switchport access vlan 20
exit
!
interface ethernet 1/xg20
spanning-tree disable
switchport access vlan 20
exit
!
interface port-channel 1
description lag_1
switchport mode general
switchport general allowed vlan add 5,20,53,80 tagged
exit
!
interface port-channel 2
description lag_2
exit
!
interface ethernet 1/xg21
channel-group 1 mode auto
switchport general allowed vlan add 5,20,53,80 tagged
exit
!
interface ethernet 1/xg22
channel-group 1 mode auto
switchport general allowed vlan add 5,20,53,80 tagged
exit
!
interface ethernet 1/xg23
spanning-tree disable
switchport mode general
switchport general pvid 5
switchport general acceptable-frame-type tagged-only
switchport general allowed vlan add 5 tagged
exit
!
interface ethernet 1/xg24
spanning-tree disable
switchport mode general
switchport general pvid 5
switchport general acceptable-frame-type tagged-only
```

```
switchport general allowed vlan add 5 tagged
exit
!
interface out-of-band
ip address dhcp
exit
snmp-server community public ro
exit
```