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# Reference Architecture for Active System 200 with Microsoft Hyper-V

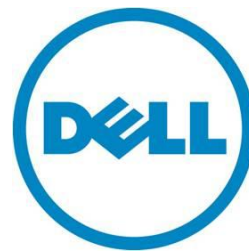
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*Release 1.1 for Dell 12<sup>th</sup> Generation PowerEdge Rack Servers, Dell Networking Switches, Dell EqualLogic iSCSI SAN, Microsoft Windows Server 2012 with Hyper-V role, and Dell Active System Manager*

Dell Global Solutions Engineering

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## Revision History

Revision	Description	Date
A00	Initial Version with Active Infrastructure 1.1 and Active System Manager 7.1	July 2013

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## 1 Introduction

Dell™ Active Infrastructure is a family of converged infrastructure solutions that combine servers, storage, networking, and infrastructure management into an integrated and optimized system that provides general purpose virtualized resource pools. Active Infrastructure leverages Dell innovations including unified management with Active System Manager, converged LAN/SAN fabrics, and rack server architecture for the ultimate converged infrastructure solution. Active Infrastructure helps IT rapidly respond to dynamic business demands, maximize datacenter efficiency, and strengthen IT service quality.

The Active System 200, a member of Dell Active Infrastructure family, is a converged infrastructure solution that has been designed and validated by Dell Engineering. It is available racked, cabled, and delivered to your site to speed deployment. Dell Services deploys and configures the system tailored for business needs and ready for integration into the datacenter. Active System 200 is Dell's first Active Infrastructure System to include Dell PowerEdge™ R720 Rack Servers, iSCSI / 10GbE unified fabric switching, Dell EqualLogic™ PS6110 Series 10GbE iSCSI storage, and Dell Active System Manager to build private cloud solutions that address key needs of the mid to large datacenter.

Active System 200 offers converged LAN and SAN fabric design to enable a converged infrastructure solution. The end-to-end converged network architecture in Active System 200 is based upon Data Center Bridging (DCB) technologies that enable convergence of all LAN and iSCSI SAN traffic into a single fabric. The converged fabric design of Active System 200 reduces complexity and cost while bringing greater flexibility to the infrastructure solution.

The solution is offered in configurations with either VMware® vSphere™ or Microsoft® Windows Server® 2012 with Hyper-V® role enabled Hypervisors. The VMware vSphere solution is the Active System 200v and the Microsoft Hyper-V solution is the Active System 200m. This document defines the reference architecture for Active System 200m.

The Active System configurations vary in the number of Dell PowerEdge Rack servers and Dell EqualLogic PS6110 Series storage arrays to meet virtualization resource needs.

## 2 Audience

This document provides an overview of the Active System 200m solution. Readers, including CTOs and IT managers, can use this document to understand the overview and scope of the solution.

IT administrators and managers can use this document to understand the solution architecture.

### 3 Overview

The system discussed in this document implements Dell and Microsoft best practices and is powered by Dell PowerEdge rack servers, Dell Networking network switches, Dell EqualLogic storage, and Microsoft Windows Server 2012. Figure 1 illustrates key features and major components in the solution. Dell Active System Manager, Dell OpenManage™ Essentials (OME) and Dell EqualLogic SAN-HQ are included for the monitoring and management of individual components. The solution also includes the rack, power distribution units (PDU) and KMM (Keyboard, Monitor, Mouse).

Figure 1: Overview of Dell Servers, Dell Networking Converged Network Switches, Dell EqualLogic Storage, and Software



- Microsoft Windows Server 2012**
  - Failover Clustering (High Availability and Live Migration)
  - Hyper-V Role Enabled
  - Hyper-V and Cluster Management tools
- Management Components**
  - Dell Active System Manager – Hardware provisioning and management
  - Dell EqualLogic SAN-HQ – SAN monitoring
  - Dell OpenManage Essentials – Hardware monitoring
  - System Center Virtual Machine Manager – Hypervisor and VM management
- Host Cluster - Dell PowerEdge R720 Rack Server**
  - 2 to 7 Hosts
  - CPU: 2x Intel® Xeon 2.2GHz 8C
  - Memory: 128 GB (16x8GB) 1333 MHz RDIMMs
  - NDC: BCM5720 rNDC (4x 1GbE)
  - NIC: 1x BCM57810 PCI-e (2x 10GbE SFP+)
  - iDRAC: iDRAC7 Enterprise
- Management Cluster – Dell PowerEdge R620 Rack Server**
  - CPU: 2x Intel® Xeon 2.2GHz 95W 8C
  - Memory: 128 GB (16x8GB) 1333 MHz RDIMMs
  - NDC: BCM 5720 (4x 1GbE RJ-45)
  - NIC: BCM 57810 PCI-e (2x 10GbE SFP+)
  - iDRAC: iDRAC7 Enterprise
- Dell Networking S55 44x 1GbE + 4x SFP Ports**
  - 10/100/1000MbE Out of Band (OOB) Mgmt Traffic
- Dell Networking S4810 48x 10GbE + 4x 40GbE Ports**
  - 2x S4810 High-density 48 port 10GbE switches for converged traffic
  - 80 GbE Inter-Switch Link (ISL) between the switches
- Dell EqualLogic PS6110 Series iSCSI Storage**
  - 10GbE Controllers with up to 4 Arrays
  - Default disk configuration
    - PS6110XV (24) 2.5" 600GB 10k

Table 1 below describes key solution components and the roles served in Active System 200m.

**Table 1: Solution Components**

Component	Description	Role
Compute Cluster	(2) to (7) Dell PowerEdge R720 servers running Windows Server 2012 Datacenter Edition and Hyper-V role enabled	Host virtual machines (VMs)
Storage	Up to (4) Dell EqualLogic PS6110 Series controllers with 24 bay 2.5" SAS enclosures or 24 Bay 3.5" SAS enclosures	Provide iSCSI based shared storage for the Hyper-V cluster to host the VMs
Management	(2) Dell PowerEdge R620 rack servers hosting management VMs.	Host Dell Active System Manager, Dell EqualLogic SAN HQ, Dell OpenManage Essentials, System Center 2012 SP1 Virtual Machine Manager and other optional System Center 2012 components
Converged Fabric Switches	Two Dell Networking S4810 switches	Support LAN and SAN traffic consisting of VM, Live Migration, Management, iSCSI and Cluster traffic types
Out-of-Band (OOB) management Switch	One Dell Networking S55 switch	Provide OOB management connectivity

**Microsoft Windows Server 2012:** Microsoft® Windows Server® 2012 is Microsoft’s flagship server operating system which provides the Hyper-V® virtualization platform. Hyper-V provides a virtualization platform that can consolidate Windows® and Linux® workloads enabling IT managers the ability to more fully utilize their available hardware resources.

**Dell Active System Manager:** Active System Manager sits at the center of Active System, and simplifies infrastructure configuration, collapses management tools, and drives automation and consistency. Through capabilities such as template-based provisioning, automated configuration, and infrastructure lifecycle management, Active System Manager enables IT to respond rapidly to business needs, maximize datacenter efficiency, and strengthen quality of IT service delivery.

The software enables a cloud like environment, and supports pre-built provisioning templates and custom orchestrated workflows for a wide range of physical or virtual environments. Use and features of the Dell Active System Manager is described in more detail in subsequent sections of this document. Additional detail can also be found on the Dell website at: [Dell Active System Manager](#).

**Dell OpenManage Essentials:** The Dell OpenManage™ Essentials Console provides a single, easy-to-use, one-to-many interface through which to manage resources in multivendor operating system and hypervisor environments. It automates basic repetitive hardware management tasks – like discovery, monitoring, and updates – for Dell servers, storage, and network systems. OME employs the embedded management of Dell PowerEdge™ servers – Integrated Dell Remote Access Controller 7 (iDRAC7) with Lifecycle Controller – to enable agent-free remote management and monitoring of server hardware



components like storage, networking, processors, and memory. For more information on Dell Enterprise Management and OpenManage Essentials, see <http://content.dell.com/us/en/enterprise/data-center-system-management>.

**Dell EqualLogic SAN Headquarters (SAN HQ):** SAN HQ provides in-depth reporting and analysis tools. With the information you get from SAN HQ, you can better customize, protect, and optimize your storage. Dell EqualLogic SAN HQ provides consolidated performance and robust event monitoring across multiple Dell EqualLogic groups. If action is required, the Dell EqualLogic Group Manager can be launched directly from SAN HQ giving you the ability to quickly adjust storage systems to meet business needs. For more information about Dell EqualLogic storage and SAN HQ, see <http://www.dell.com/us/enterprise/p/equallogic-products>.

**Optional Microsoft System Center 2012 Service Pack 1:** System Center 2012 is Microsoft's systems management platform which helps to monitor, manage, deploy, backup, and more. System Center 2012 Service Pack 1 (SP1) introduces support for Windows Server 2012, enabling you to take advantage of Windows Server 2012's new features in a managed environment. This solution utilizes either a customer provided or a trial version of System Center 2012 SP1 and focuses on Virtual Machine Manager 2012. Further information on all Microsoft System Center components can be found at [www.microsoft.com/systemcenter](http://www.microsoft.com/systemcenter).

**System Center 2012 SP1 Virtual Machine Manager (VMM):** VMM is Microsoft's centralized virtualization manager. It provides the fundamental services for creating and managing virtual machines, optimizing resources, and rapid deployment of virtualized infrastructure.

VMM 2012 SP1 supports the features included in Windows Server 2012: network virtualization, Virtual Hard Disk VHDX support, SMB 3.0 file share, and the enhancements on storage management, host provisioning, and Live Migration.

**Dell PowerEdge R720 Rack Servers:** The Dell PowerEdge R720 server uses Intel® Xeon® E5-2600 series processors and Intel chipset architecture in a 2U rack mount form factor. The PowerEdge R720 is a powerful general purpose platform with highly expandable memory and I/O capabilities to match. Its extensive scalability and balanced design allows it to handle very demanding workloads. The server features two CPU sockets and 24 memory slots supporting 2, 4, 8, 16, or 32GB DIMMs to meet the memory demands of a virtualized infrastructure.

Energy-efficient design features include power-supply units sized appropriately for system requirements, innovative system-level design efficiency, policy-driven power and thermal management, and highly efficient standards-based Energy Smart components. For more information, see the Dell PowerEdge R720 specifications at [Dell.com/PowerEdge](http://Dell.com/PowerEdge).

**Dell PowerEdge R620 Management Server:** The management server uses Intel® Xeon® E5-2600 series processors in a 1U rack mount form factor. The server features two CPU sockets and 24 memory DIMM slots supporting 2, 4, 8, 16 or 32GB DIMMs. For more information, see the Dell PowerEdge R620 specifications at [Dell.com/PowerEdge](http://Dell.com/PowerEdge).

**Embedded Management with Dell's Lifecycle Controller:** The Lifecycle Controller is the engine for advanced embedded management and is delivered as part of iDRAC7 Enterprise in Dell PowerEdge 12<sup>th</sup> generation servers. For more information on Dell Lifecycle Controllers, see <http://content.dell.com/us/en/enterprise/dcsm-embedded-management>.

**Dell Networking S4810 Switches:** The S-Series S4810 is an ultra-low-latency 10/40 GbE top-of-rack (ToR) switch. Leveraging a non-blocking, cut-through switching architecture, the S4810 switch delivers line-rate L2 and L3 forwarding capacity with ultra-low latency to maximize network performance. The compact S4810 switch design provides 48 dual-speed 1/10 GbE (SFP+) ports, as well as four 40 GbE QSFP+ uplinks to conserve valuable rack space and simplify the migration to 40 Gbps in the datacenter network. The S4810 switch incorporates multiple architectural features that optimize datacenter network flexibility, efficiency, and availability, including Dell Networking's stacking technology, reversible front-to-back or back-to-front airflow for hot/cold aisle environments, and redundant, hot-swappable power supplies and fans. For more information on Dell Networking switches, see <http://www.dell.com/networking>.

**Dell Networking S55 Switches:** The S-Series S55 1/10 GbE Top-of-Rack switch leverages a non-blocking architecture that delivers line-rate, low-latency L2 and L3 switching to eliminate network bottlenecks. The S55 switch design provides 48 GbE access ports with up to four modular 10GbE uplinks in 1-RU to conserve valuable rack space. The S55 switch incorporates multiple architectural features including reversible front-to-back or back-to-front airflow for hot/cold aisle environments and redundant, hot-swappable power supplies and fans. For more information on Dell Networking switches, see <http://www.dell.com/networking>.

**Dell EqualLogic PS6110 Series Storage:** EqualLogic PS6110X 10GbE arrays include Dual 10GbE controllers, high-performance 2.5" SAS HDDs Cache-to-flash memory de-staging and up to 21.6TB of capacity in a 2U chassis. Management features include:

- Group Manager, which integrates all management into one console for both file and block-storage protocols
- Dell EqualLogic Host Software that extends the functionality of the array-based software to enable cooperation with the host
- Host Integration Tools for Microsoft®, VMware® and Linux® products, as well as Dell EqualLogic SAN Headquarters (SAN HQ) management software

Contact your Dell sales representative for more information on Dell EqualLogic PS6110 Series storage configurations and sizing guidelines. For additional information, see <http://www.dell.com/us/enterprise/p/equallogic-ps6110-series?-ck=anav>.

**Dell 2700W Line Interactive Rack UPS:** Monitor your power consumption, power events, available battery runtime, alarm conditions, and more with free software and a range of control options.

- **The Dell Multi-UPS Management Console (MUMC):** Designed for multi-host server environments.
- **The Dell UPS Local Node Manager (ULNM):** Created for single-host environments, Dell's node manager provides graceful automatic shutdown of any UPS, load segment, or connected device during prolonged power disruptions.
- **Free multi-platform software:** Manage your UPS systems with software that works intuitively across most popular virtualization platforms.
- **Large on-unit display:** Change control settings easily with a large, backlit LCD control panel offering the same color-coded system as Dell servers.
- **Virtual Environments:** Integrates with VMware, Microsoft, and Citrix. Manage virtual machine start/stop profiles through plug-ins like VMware vCenter. Use advanced virtualization functions like vMotion™ and LiveMigration to move VMs.

For more UPS and PDU information, see the web page for [Dell UPS & PDU Information](#).

The Active System 200m is available in three default configurations, allowing users to better tailor the solution to their environment. Table 2 below describes these default configurations.

**Table 2: Default Configurations**

Component	3 Host Configuration	5 Host Configuration	7 Host Configuration
<b>Computer Host Server</b>	(3) Dell PowerEdge R720	(5) Dell PowerEdge R720	(7) Dell PowerEdge R720
<b>Storage Device</b>	(1) Dell EqualLogic Series 6110X Storage Arrays	(2) Dell EqualLogic Series 6110X Storage Arrays	(3) Dell EqualLogic Series 6110X Storage Arrays
<b>Drives</b>	PS6110X, 14.4TB capacity, (24) 10K SAS, 600GB	PS6110X, 14.4TB capacity, (24) 10K SAS, 600GB	PS6110X, 14.4TB capacity, (24) 10K SAS, 600GB
<b>Racks</b>	(1) Dell PowerEdge Rack 4220	(1) Dell PowerEdge Rack 4220	(1) Dell PowerEdge Rack 4220

## 4 Design Principles

1. **Converged Network:** The infrastructure is designed to achieve end-to-end LAN and SAN convergence.
2. **Redundancy to minimize single point of failure:** The system is designed to mitigate failure points. NIC teaming and Multipath I/O (MPIO) are used to provide failover across the redundant network interfaces. iSCSI storage redundancy is achieved with multiple ports and storage controllers. For network traffic, NIC ports are teamed in such a way to distribute traffic across separate ports. The solution also includes redundant power supplies connected to separate Power Distribution Units (PDUs). The solution is further optimized to reduce components such as NICs, cables, and IO Modules, then utilizes hypervisor-based high-availability to provide virtual machine failover. Out-of-Band (OOB) Management is not architected with this level of redundancy since mission critical workloads will continue to operate in the event of an OOB management failure.
3. **Management:** Integrated management using Active System Manager, Dell OpenManage Essentials, EqualLogic SAN HQ, and Microsoft System Center VMM 2012 SP1.
4. **Flexible configurations:** Dell Active System 200m is pre-configured to suit most customer needs for a virtualized infrastructure. Each server is configured with sufficient CPU, memory, and network adapters. Where desired, the solution also supports processor, memory, and storage options. Additional options, such as wide or deep racks are also available.
5. **Racked, Cabled, and Ready to be deployed:** This Dell Active System is available to be racked, cabled, and delivered to the customer site ready for deployment. Components are configured

and racked to optimize airflow and thermals. Based on customer needs, different rack sizes and configurations are available to support various datacenter requirements.

## 5 Prerequisites and Datacenter Planning

**Power, Cooling, and Weight Considerations:** Dell Active System 200m solution is configured with Power Distribution Units (PDUs) to meet the power requirements of the components, as well as regional constraints. Power consumed, cooling required, and information regarding rack weight are provided to enable customers to plan appropriate power and cooling for the solution.

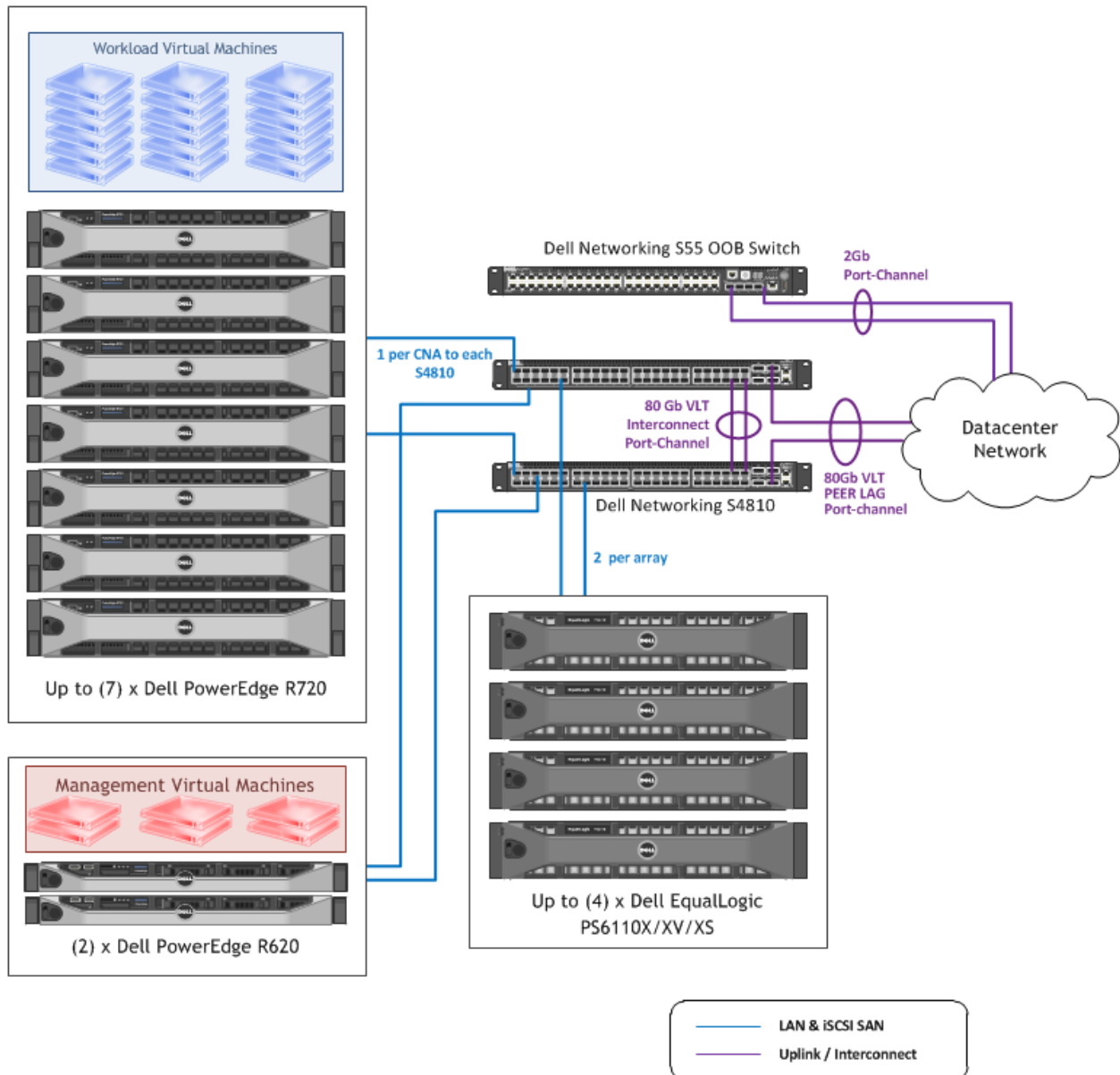
To support the architecture, the following components are required to be present in the customer environment:

- An existing Ethernet infrastructure with which to integrate is required. 10Gb or 40Gb Ethernet infrastructure is recommended.
- Additional components, such as Dell Networking network cables and transceivers, are needed to uplink the solution to the customer network. The necessary components depend upon customer networking and uplink requirements.
- Active Directory® Domain Services (AD DS) must be available on the network. The Hyper-V hosts are joined to an existing or new domain. Cluster Services also require AD DS. Consult with your Dell Sales and Services representatives for more details.
- Domain Name System (DNS) must be available on the management network.
- Database to support System Center 2012 SP1 VMM - For a list of supported databases refer to: [Requirements for System Center 2012 - Virtual Machine Manager](#).
  - If IT Administrators wish to install VMM on the Dell PowerEdge R620 Management Server or as a VM, then a route must exist between the management server (physical or as a VM) and the database used.
- The database is presumed to have maintenance and backup configured as per the business needs of the customer.
- Sufficient power and cooling to support the solution must be present. Detailed power, weight, and cooling requirements for the datacenter are defined in the *Specification Guide for Active System 200 with Hyper-V*.

## 6 Architecture

This solution utilizes Dell PowerEdge R720 and PowerEdge R620 servers running Windows Server 2012 Datacenter Edition. Figure 2 below depicts the high-level reference architecture for the solution including solution components and redundant connectivity for each I/O fabric.

Figure 2: Network Topology (Logical View) shown with 7 Dell PowerEdge R720 Servers



## 6.1 Server / Network Connectivity

One of the key attributes of the Dell Active System 200m is the convergence of SAN and LAN over the same network infrastructure. LAN and iSCSI SAN traffic share the same physical connections from servers to storage. The converged network is designed using Data Center Bridging, Priority Flow Control (IEEE 802.1Qbb), Enhanced Transmission Selection, and Data Center Bridging Exchange (IEEE 802.1Qaz) technologies and features. The converged network design drastically reduces cost and complexity by reducing the components and physical connections and the associated efforts in deploying, configuring, and managing the infrastructure.

Data Center Bridging is a set of related standards to achieve enhanced Ethernet capabilities, especially in datacenter environments, through converged network connectivity. The functionalities provided by DCB and DCBX are:

- **Priority Flow Control (PFC):** This capability provides separate flow control for LAN and SAN by providing a link level flow control mechanism that can be controlled independently for each priority.
- **Enhanced Transmission Selection (ETS):** This capability provides a framework and mechanism for bandwidth management for different traffic types by assigning bandwidth to different frame priorities.
- **Data Center Bridging Exchange (DCBX):** This functionality is used for conveying the capabilities and configuration of the above features between neighbors to ensure consistent configuration across the network.

Dell Networking S4810 switches, Broadcom 57810 Converged Network Adapters (CNA), and Dell EqualLogic PS6110 iSCSI SAN arrays enable the solution to utilize these technologies, features, and capabilities to support converged network architecture.

The network traffic on each Server includes iSCSI, as well as traffic for the parent partition (hypervisor), Live Migration, cluster heartbeat and cluster shared volume, and child partitions (virtual machines).

A fault-tolerant network team is created using the two 10 GbE ports for each server, a virtual switch is provisioned in Hyper-V, A virtual network adapter is created, shared with the parent partition, segmented with VLANs, and bandwidth weighting applied.

Each Dell PowerEdge R720 and R620 rack server is configured with a Broadcom BCM57810 Add-in CNA providing two 10Gb SFP+ ports. These are connected into the two S4810 switches. The two S4810 switches are configured with a Virtual Link Trunk interconnect (VLTi) using two 40 Gbps QSFP+ ports in each switch providing an 80Gbps path for communication across the switches. This design eliminates the need for Spanning Tree-based networks and also provides redundancy as well as active-active full bandwidth utilization on all switch uplinks.

Virtual Link Trunking technology allows a server or bridge to uplink a single trunk into more than one S4810 switch, and to remain unaware of the fact that the single trunk is connected to two different switches. The switches, a VLT-pair, make themselves appear as a single switch for a connecting bridge or server. Both links from the bridge network can actively forward and receive traffic. VLT provides a replacement for Spanning Tree-based networks by providing both redundancy and active-active full bandwidth utilization.

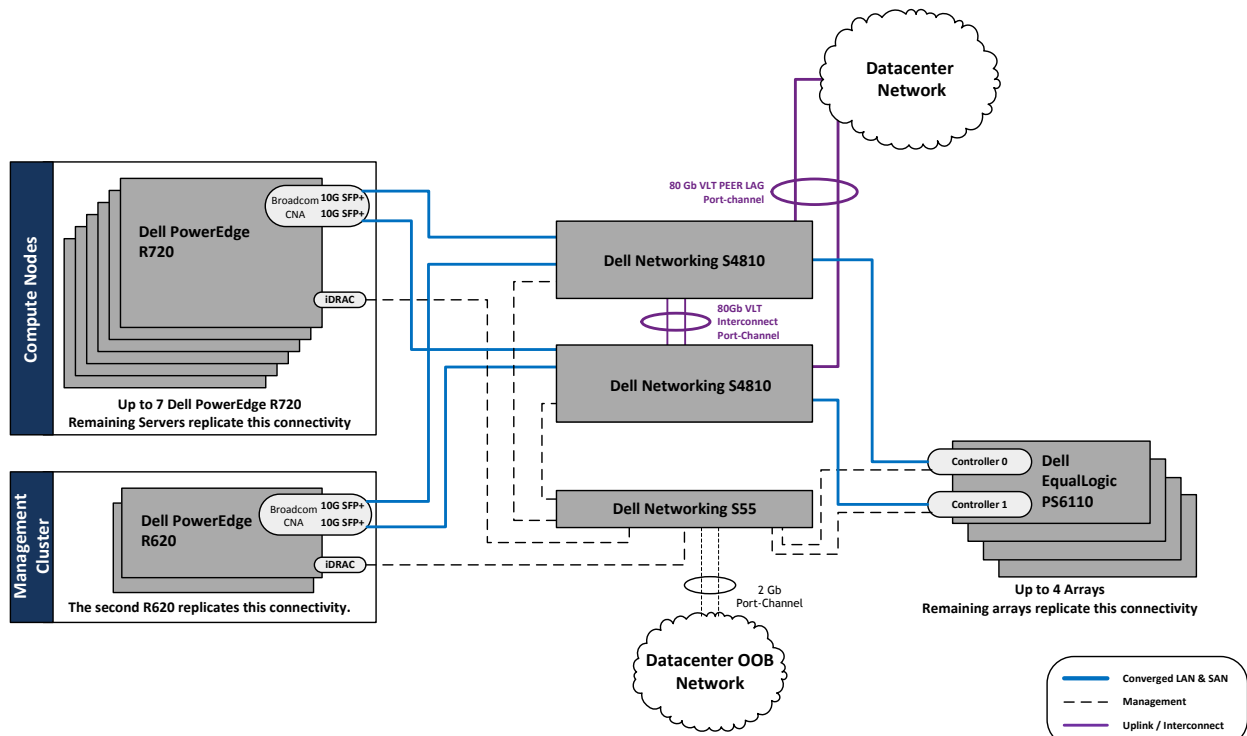
Major benefits of VLT technology are:

1. Dual control plane on the access side that lends resiliency.
2. Full utilization of the active LAG interfaces.
3. Rack-level maintenance is hitless and one switch can be kept active at all times.

Note that the two switches can also be stacked together. However, this is not recommended, as this configuration incurs downtime during firmware updates of the switch or failure of stack links.

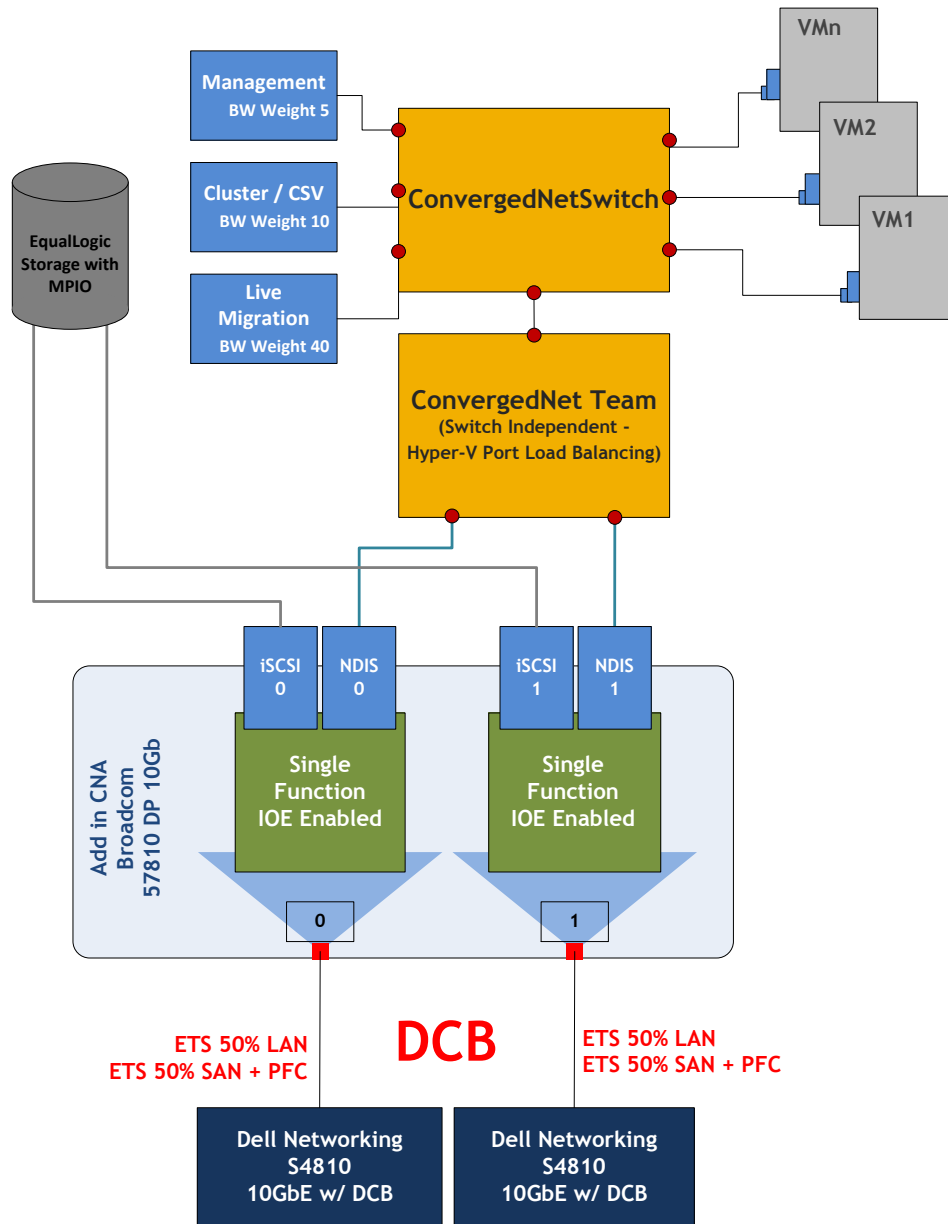
The network architecture is illustrated in Figure 3 below.

Figure 3: Dell Active System Converged Network Connectivity Overview



On the Dell PowerEdge rack servers, each of the 10GbE ports are configured in single function mode with an iSCSI Offload Engine enabled. Then one team is created and configured as a switch independent team using the Windows Server 2012 Load Balancing/Failover (LBFO) tools. Figure 4 below illustrates the converged network configuration and DCB settings for the Dell PowerEdge servers.

Figure 4: Converged Network Configuration for PowerEdge Rack Servers



The VLAN IDs are assigned to the virtual network adapters assigned to the parent partition to segregate the traffic on the host between the cluster, Live Migration, parent management, and other types of traffic are described in Table 3 below. The VLAN configuration used in the Dell Active System configuration is listed in Table 4 below.



Table 3: Traffic Description

Traffic Type	Use
Hypervisor Management	Supports virtualization management traffic and communication between the host servers in the cluster.
Live Migration	Supports migration of VMs between the host servers in the cluster.
Tenant VM	Supports communication between the VMs hosted on the cluster and external systems.
Cluster	Supports internal cluster network communication between the servers in the cluster.
Out-of-Band Management	Supports configuration and monitoring of the servers through the iDRAC management interface, storage arrays, and network switches.
iSCSI Data	Supports iSCSI traffic between the servers and storage array(s). In addition, traffic between the arrays is supported.

Table 4: Sample VLAN and subnet configuration

Traffic Type	Sample VLAN	Sample Subnet
Compute Node Management	20	10.110.0.0/24
Compute Live Migration	21	10.110.1.0/24
Compute Cluster Private	22	10.110.2.0/24
Management Tenant VM	23	10.110.3.0/24
Out-of-Band Management	24	10.110.4.0/24
iSCSI	25	10.110.5.0/24
Management Hypervisor	26	10.110.6.0/24
Management Cluster LM	27	10.110.7.0/24
Management Cluster Private	28	10.110.8.0/24
Guest Clustering (Microsoft FastTrack)	30	10.110.10.0/24
Tenant VM	32	10.110.12.0/22

## 6.2 Server / Storage Connectivity

In the Active System 200m configuration, each Dell PowerEdge server uses a Dell PERC H710 internal RAID controller connected to two SAS HDDs configured in a RAID 1. This RAID volume hosts Windows Server 2012 for the hypervisor OS.

Each server also includes Broadcom BCM57810 CNA for attaching to SAN volumes.

## 6.3 Server / HA and Redundancy

The design of Dell PowerEdge rack servers include high availability and redundant features such as redundant fans and power supplies that are distributed to independent power sources. The servers also use PERC H710 controllers with two hard disks configured with RAID 1 to prevent server crashes in the event of single disk failures.

## 6.4 Storage Architecture

EqualLogic PS6110 storage provides capabilities essential to the Active System 200 design, like 10GbE connectivity, flexibility in configuring RAID arrays and creating volumes, thin provisioning, and storage tiering, while providing tight integration with Microsoft Windows Server 2012 for better performance and manageability through the use of the EqualLogic Host Integration Tools (HIT) Kit and SAN HQ.

### 6.4.1 EqualLogic Group and Pool Configuration

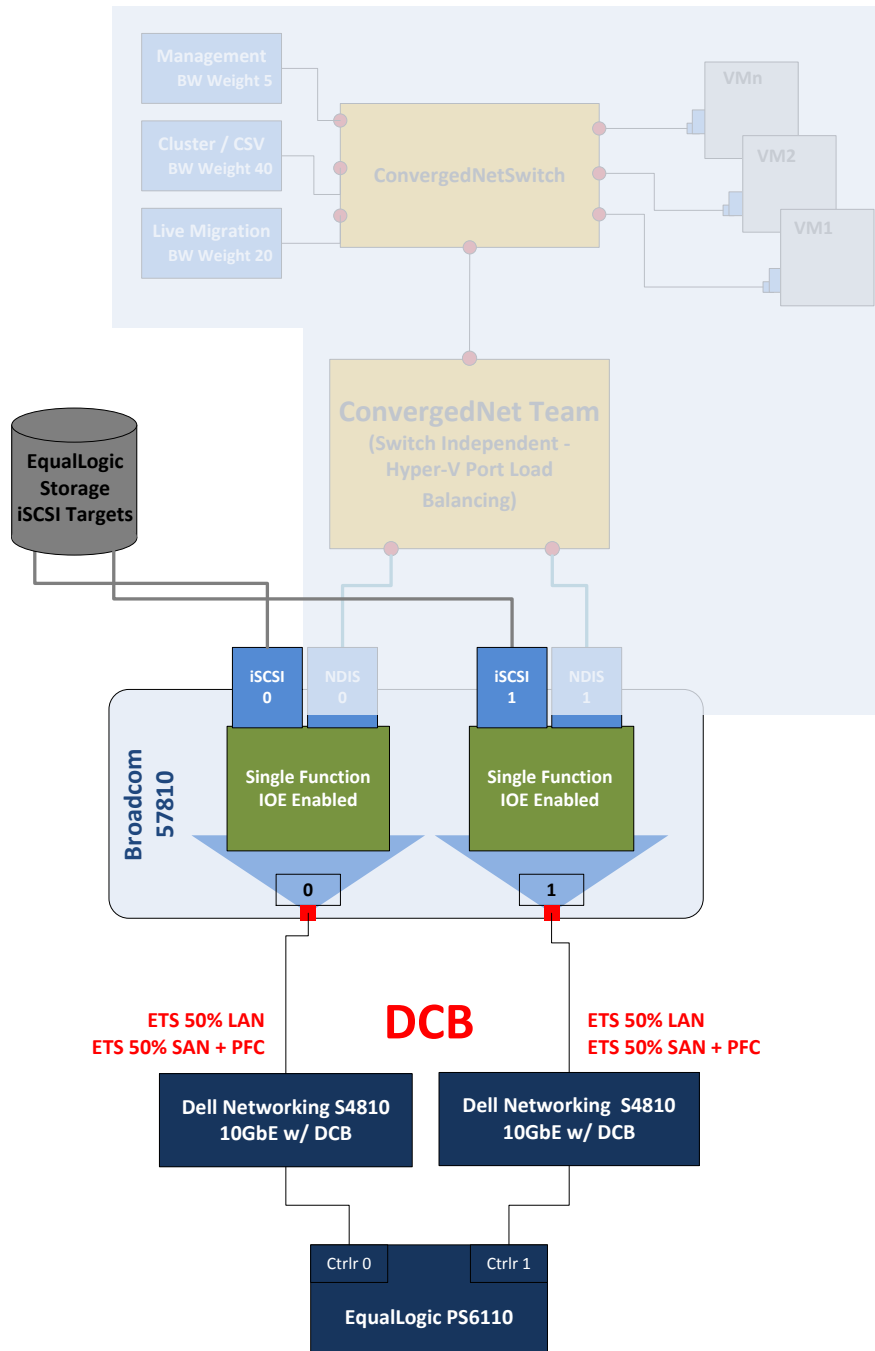
Each EqualLogic array (or member) is assigned to a particular group. Groups help in simplifying management by enabling management of all members in a group from a single interface. Each group contains one or more storage pools. Each pool must contain one or more members and each member is associated with only one storage pool.

The iSCSI volumes are created at the pool level. In the case where multiple members are placed in a single pool, the data is distributed amongst the members of the pool. With data being distributed over a larger number of disks, the potential performance of iSCSI volumes within the pool is increased with each member added.

### 6.4.2 Storage Network

Each Dell PowerEdge server is configured with a Broadcom BCM57810 Add-in PCI-E Card and connected to the Dell Networking S4810 switches. These servers utilize DCB to guarantee traffic flows from each node to the SAN. The DCB configuration utilizes DCB Exchange (DCBx), Priority Flow Control (PFC), and Enhanced Transmission Selection (ETS). The DCB settings default to allow 50% bandwidth for LAN traffic and 50% for SAN traffic. These ETS settings are configurable based upon customer requirements. The PFC settings are configured to be lossless for the iSCSI queue. Figure 5 below illustrates the connectivity and default settings.

Figure 5: Storage Connectivity



### 6.4.3 Performance

Dell EqualLogic PS6110 Series uses redundant controller architecture with a single active 10GbE front-end port per controller. To allow the network port to dedicate the 10GbE bandwidth to SAN traffic, the 1GbE out-of-band port is used for configuration and performance monitoring.

#### 6.4.4 Drive Types

The Dell EqualLogic PS6110 Series arrays use a high performance 10K RPM SAS drive in the default configuration. This provides a balance of size and performance. The Dell EqualLogic PS6110 is available with drives in multiple speeds and sizes, including 10K RPM and 15K RPM SAS drives, 7.2K RPM NL-SAS drives, and solid-state disks.

#### 6.4.5 RAID Array Design

The storage array RAID configuration is highly dependent on the workload in your virtual environment. The EqualLogic PS series storage arrays support RAID types RAID 6, RAID 10, and RAID 50. The RAID configuration depends on workloads and customer requirements. In general, RAID 10 provides the best performance at the expense of storage capacity, especially in random I/O situations. RAID 50 generally provides more usable storage, but has less performance than RAID 10. RAID 6 provides better data protection than RAID 50.

For more information on configuring RAID in EqualLogic, refer to the [Dell TechCenter blog](#) and white paper, [How to Select the Correct RAID for an EqualLogic SAN](#).

#### 6.4.6 Storage Tiering

Tiering storage is the practice of physically partitioning data into multiple distinct classes based on price, performance, or other attributes. Data may be dynamically moved among classes in a tiered storage implementation based on access activity or other considerations.

This is normally achieved through a combination of varying types of disks which are used for different data types. (i.e. Production, non-production, backups, etc.) Dell EqualLogic PS6110 Series dynamically moves data to the optimal storage tier based on actual use. The most active blocks reside on high-performance SSD and SAS drives, while infrequently accessed data migrates to lower-cost, high-capacity SAS drives. The result is network storage that remains in tune with application needs.

#### 6.4.7 High Availability

In order to maintain continuous connectivity to stored data from the server, the controllers of the Dell EqualLogic PS6110 have port failover from active to standby controller. This port failover mechanism allows a port to fail over without having to fail over the controller. This results in a lower time that a controller is unavailable.

#### 6.4.8 Multipath Configuration

For Windows Server 2012, the native MPIO provides functionality for Dell EqualLogic. The EqualLogic HIT kit provides additional load balance and tools. The multi-pathing solution uses the Least Queue Depth load balancing algorithm to utilize all available paths. Dell recommends the EqualLogic HIT kit for its enhanced functionality and performance, but either can be used.

#### 6.4.9 iSCSI Encryption and Authentication

Challenge Handshake Authentication Protocol (CHAP) is available for use on the Dell EqualLogic PS6110 Series Storage Center. This feature allows hosts to authenticate to the EqualLogic PS6110 iSCSI target prior to the target being available for use on the system.

#### 6.4.10 Jumbo Frames

In this Dell Active System configuration, Jumbo Frames are enabled for all devices of the iSCSI SAN fabric. This includes the server network interface ports, the network switch interfaces, and the Dell EqualLogic PS6110 Series interfaces.

#### 6.4.11 Thin Provisioning

Particularly in virtualization environments, thin provisioning is a common practice. This allows for efficient use of the available storage capacity. The volume and corresponding CSV may grow as needed, typically in an automated fashion to ensure availability of the volume. However, as storage becomes over-provisioned in this scenario, careful management and capacity planning is critical.

Dell EqualLogic PS6110 Series offers thin provisioning and eliminates pre-allocated but unused capacity.

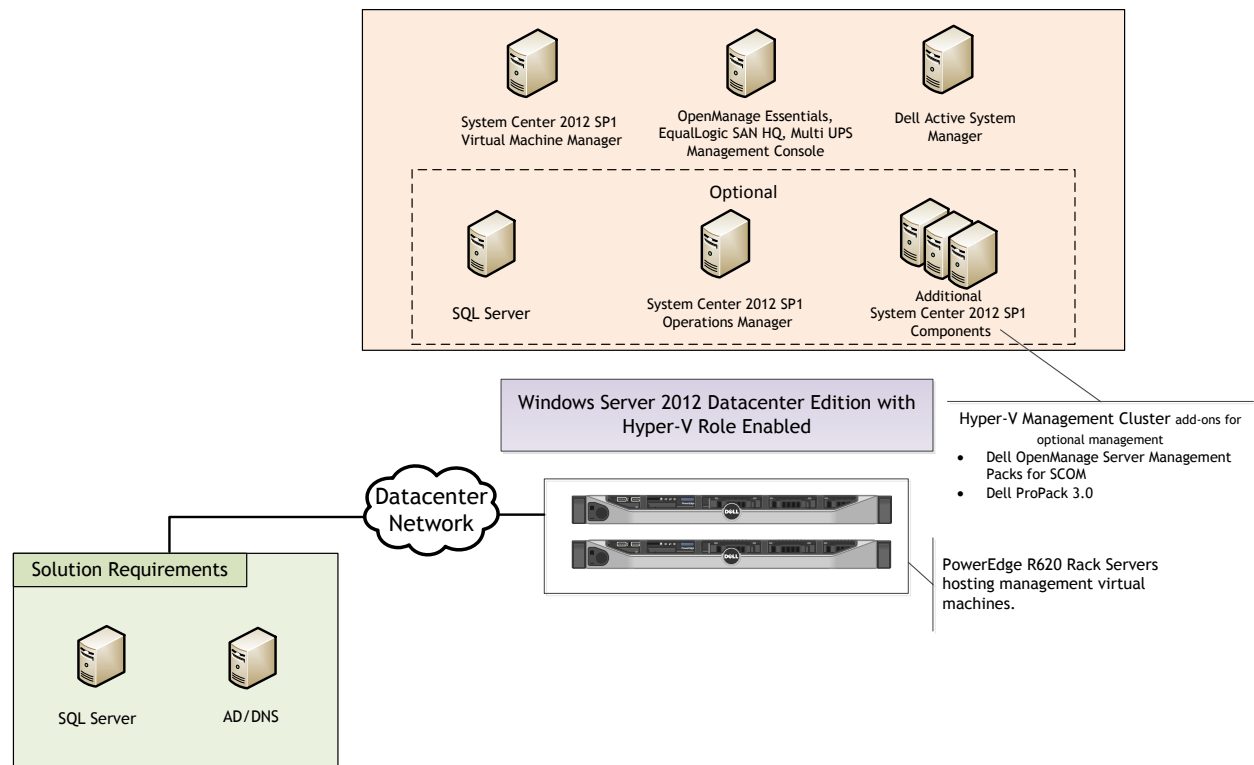
## 7 Management Architecture

The default management architecture consists of two PowerEdge R620 servers running Hyper-V in a failover cluster. The cluster provides a highly available infrastructure to run virtual machines for managing the solution. Virtual Machines used in the infrastructure along with optional components in the management cluster are shown in Figure 6 below. The default management cluster is sized to provide a highly-available infrastructure for running the Microsoft System Center 2012 suite of management components. At least two virtual machines need to be deployed on the management cluster. One VM hosts the Dell Active System Manager, and another VM hosts Dell management tools such as OpenManage Essentials and EqualLogic SAN HQ.

A Dell Networking S55 switch is used for out-of-band management connectivity for Dell iDRAC and the management ports on Dell EqualLogic arrays. The management cluster infrastructure duplicates the compute cluster in using converged network infrastructure and configuration. The PowerEdge R620 servers are connected to the S4810 switches using Broadcom 57810 Dual Port 10Gb network adapters. The management servers are connected to the EqualLogic storage through the two S4810 switches.

Note that the EqualLogic storage is shared between the management cluster and the compute cluster. The EqualLogic storage must be sized so that sufficient capacity and bandwidth are allocated for both the management VMs and compute VMs.

Figure 6: Management Architecture



## 7.1 Active System Manager

Active System Manager is an intelligent and intuitive converged infrastructure and workload manager. Active System Manager leverages templates to automate infrastructure provisioning, on-boarding, and re-configuration, which greatly simplifies and speeds up the process, and also significantly reduces errors associated with manual configuration. The result is better infrastructure and workload quality with fewer configuration errors that can be costly. Key features provided with Active System Manager:

- **Template-Based Provisioning** – Streamline and standardize workload deployments through centralized capture and application of best practices and operational steps
- **Infrastructure Lifecycle Management** – Discovery, inventory, configuration, provisioning, and ongoing management of physical and virtual infrastructure
- **Resource Pooling and Dynamic Allocation** – Create and manage physical and virtual resource pools; efficiently schedule or allocate resources on-demand
- **End-To-End Automation** – Multi-tier automation across physical (server, storage, and network) and virtual layers
- **Workflow Orchestration** – Intelligent workflow orchestration engine for rapid physical and virtual workload provisioning
- **Centralized Management** – Intuitive centralized, role-based management and access through self-service web portal

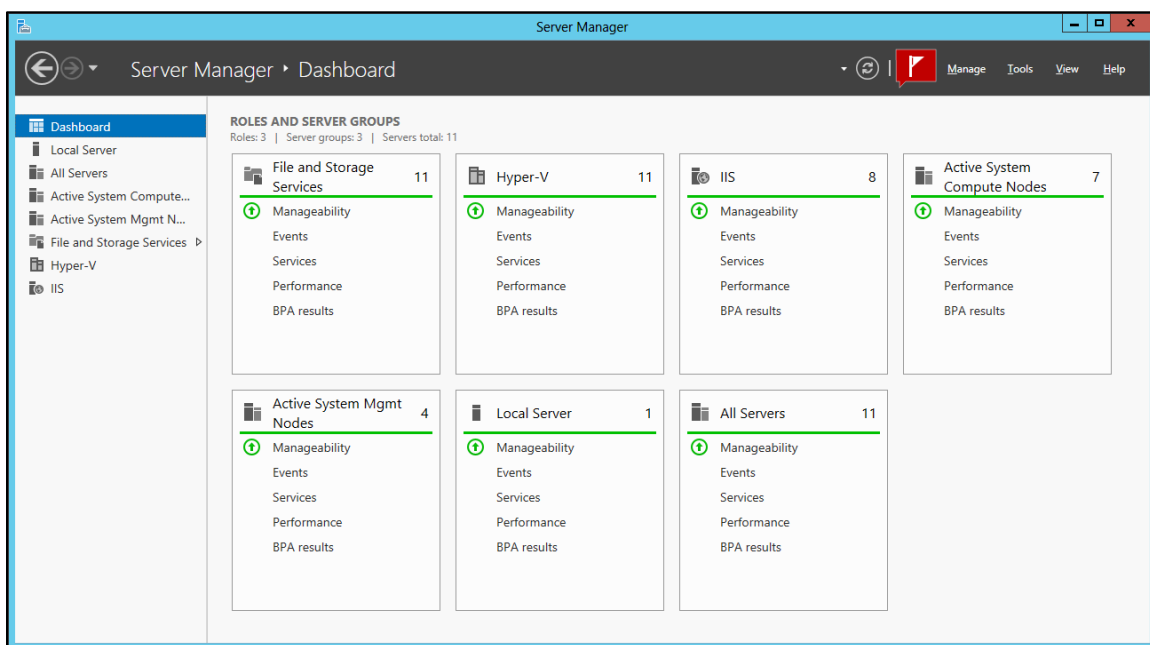
## 7.2 Windows Server 2012 Built-In tools

Windows Server 2012 provides the following built-in new or updated management features and tools for the virtualization solution:

**Server Manager:** Server Manager in Windows Server 2012 is re-designed as the primary management console for all the systems including the remote servers in your environment. The Server Manager can also manage the virtual machines and installed Windows roles on all the managed systems. It includes a role-based dashboard which can aggregate the data from managed servers. It reports system health state and surfaces issues which require your attention. The Server Manager also allows you to create customized groups for the managed systems.

Figure 7 below illustrates an example of managing with Server Manager.

Figure 7: Manage Active System 200m with Server Manager



**Hyper-V Manager:** In Windows Server 2012, more than 160 PowerShell cmdlets are added for Hyper-V. On the host management, Hyper-V Manager allows configuring physical GPU, Live Migrations, storage migration, and Hyper-V replication. On the virtual machine management, Hyper-V Manager allows more VM configuration options, such as NIC HW acceleration ( VM Queue (VMQ), Internet Protocol security (IPSec), Single Root I/O Virtualization (SR-IOV)), and advanced features on MAC spoofing, DHCP guard, Router guard, port mirroring, and NIC teaming. Also, VM management includes the support of Hyper-V Replica.

**Failover Cluster Manager:** With Failover Cluster Manager, the host configuration is validated for a Failover Cluster. Multiple failover clusters and high-availability virtual machines are created, configured and managed with the Failover Cluster Manager. In Windows Server 2012, the Failover Cluster Manager adds support for storage space, Hyper-V Replica, and new types of Live Migration. It also reports VM health states with more details, including Replication State, and allows monitoring of the services running inside VMs.

**PowerShell 3.0:** Several significant features are included in PowerShell 3.0 which eases and extends the management in the Windows-based environment. PowerShell 3.0 adds modules for Hyper-V, storage, and network, etc. Hyper-V cmdlets help automate the Hyper-V management tasks. With PowerShell 3.0, the resource utilization of VMs can be measured. This helps dynamic chargeback (vs. flat upfront cost) and capacity planning. Figure 8 below shows an example of how to measure a VM with PowerShell 3.0.

Figure 8: Resources Measuring in PowerShell 3.0

```

PS C:\Users\administrator.HER3> Enable-VMResourceMetering -VMName SQLSCVMMDB
PS C:\Users\administrator.HER3> Add-VMNetworkAdapterACL -VMName SQLSCVMMDB -Action Meter -Direction Inbound -RemoteIPAd
ress 10.10.0.0/16
PS C:\Users\administrator.HER3> Add-VMNetworkAdapterACL -VMName SQLSCVMMDB -Action Meter -Direction Outbound -RemoteIPAd
dress 10.100.0.0/16
PS C:\Users\administrator.HER3> $report=Measure-VM -VMName SQLSCVMMDB
PS C:\Users\administrator.HER3> $report | Format-List

```

ComputerName	: R610-2
VMId	: 280cdd17-e5aa-4a28-8706-caa1fa7ce05f
VMName	: SQLSCVMMDB
MeteringDuration	: 00:03:44.6070000
AverageProcessorUsage	: 664
AverageMemoryUsage	: 4062
MaximumMemoryUsage	: 4096
MinimumMemoryUsage	: 4096
TotalDiskAllocation	: 61440
NetworkMeteredTrafficReport	: {Microsoft.HyperV.PowerShell.VMNetworkAdapterPortACLMeteringReport, Microsoft.HyperV.PowerShell.VMNetworkAdapterPortACLMeteringReport, Microsoft.HyperV.PowerShell.VMNetworkAdapterPortACLMeteringReport, Microsoft.HyperV.PowerShell.VMNetworkAdapterPortACLMeteringReport...}
AvgCPU	: 664
AvgRAM	: 4062
MinRAM	: 4096
MaxRAM	: 4096
TotalDisk	: 61440

```

PS C:\Users\administrator.HER3> $report.NetworkMeteredTrafficReport

```

LocalAddress	RemoteAddress	Direction	TotalTraffic(M)
::/0	Outbound	0	
10.10.0.0/16	Inbound	1529	
0.0.0.0/0	Inbound	1	
::/0	Inbound	1	
0.0.0.0/0	Outbound	7	
10.100.0.0/16	Outbound	0	
0.0.0.0/0	Inbound	126	
::/0	Outbound	0	
0.0.0.0/0	Outbound	1	
10.100.0.0/16	Outbound	8487	
10.10.0.0/16	Inbound	0	
::/0	Inbound	1	

**CPU (MHz):** Across hosts if LM.  
**Memory (MB):** Average, Minimum and Maximum.  
**Disk (MB):** VHD and the snapshots.

**Network (MB):** Use ACLs to separate traffics. Each ACL includes:  
 - **Direction:** Inbound vs. Outbound  
 - **Remote IP:** the source or destination of the network packet, depending on direction.

### 7.3 Dell OpenManage Essentials

Dell OpenManage Essentials (OME) is a system management console that provides simple, basic Dell hardware management. Dell OME manages the host running Windows Server 2012. It supports agent-free hardware inventory and system update (e.g., BIOS, firmware) for the 11<sup>th</sup> and 12<sup>th</sup> generations of Dell PowerEdge servers. It also adds Dell SupportAssist extension for proactive “phone home” hardware issue resolution. Figure 9 below shows the dashboard of Dell OME. Other features in Dell OME 1.1 are:

- Discover, inventory, monitor health, and view logs of Dell clients (i.e., desktops, portables)
- Discover, inventory, and monitor health of Dell Networking Switches, Dell PDU and UPS devices
- Discover and collect limited inventory Linux servers via Secure Shell (SSH)
- Enhanced hardware inventory for ESXi servers with Dell OpenManage Server Administrator (OMSA)
- Alerts for hardware health status changes (not just when a hardware trap is sent)
- Ability to forward alerts in original format to support tiered event management
- A new command line interface (CLI) for automation of server discovery and grouping
- Calendar style task schedule view

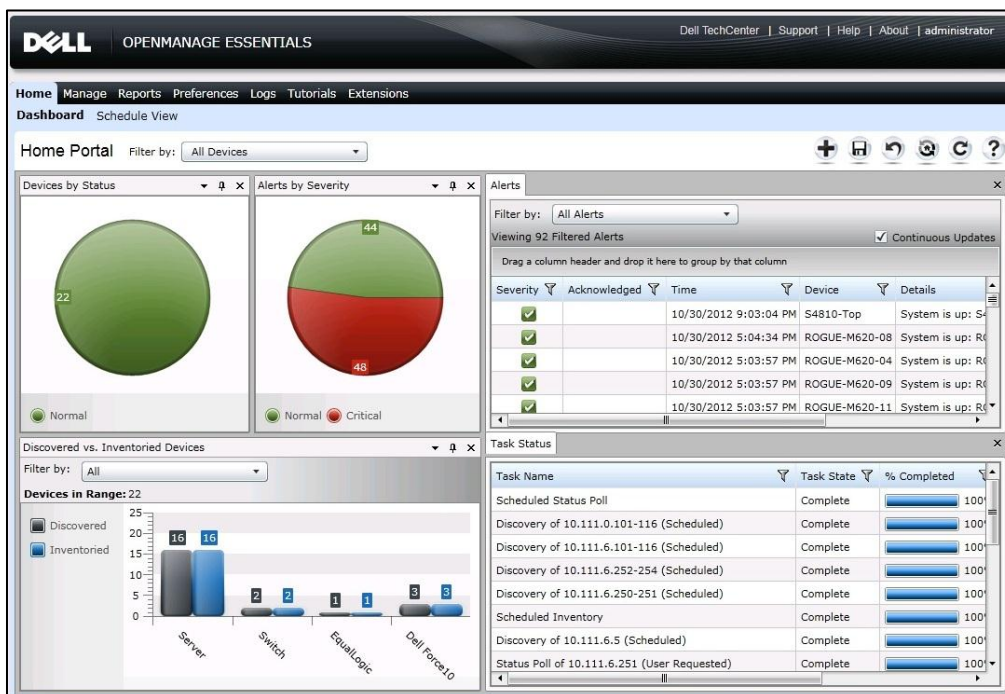


- Group filtering on portal pages
- More configurable portal pages
- Grouped discovery ranges for common protocol settings
- Custom URL launch points to allow user-defined right-click actions on devices

OME 1.1 can manage the Windows Server 2012 systems. However, the OME 1.1 cannot be hosted on a Windows Server 2012 system. Instead, it is recommended to create a Windows Server 2008 R2 virtual machine and deploy the OME 1.1 on it. OME 1.2 can be hosted on Windows Server 2012.

For more information on OpenManage Essentials, see [www.delltechcenter.com/ome](http://www.delltechcenter.com/ome).

Figure 9: OME Dashboard



**Dell Lifecycle Controller:** Helps to reduce operating costs by simplifying server deployment and management. Key features include diagnostics, self-update (UEFI, Driver Pack update), firmware updates (BIOS, NIC FW, RAID Controllers), and hardware configuration. Also, the integrated iDRAC provides the mechanism for OME agentless management.

**Dell OpenManage Server Administrator (OMSA):** Dell OMSA provides a comprehensive, one-to-one systems management solution. OMSA provides the mechanism for the agent-based management for Dell OME. With agent-based management, OME can update the device drivers on the host in addition to other management capabilities provided by the agentless management. For more information, see <http://en.community.dell.com/techcenter/systems-management/w/wiki/1760.openmanage-server-administrator-omsa.aspx>.

## 7.4 Out-of-band Management: iDRAC

The iDRAC on each server provides the flexibility to remotely manage the server through Console redirection and Virtual CD-ROM/DVD/Floppy/Flash capabilities.

## 7.5 Dell EqualLogic SAN HQ

Dell EqualLogic SAN HQ provides comprehensive monitoring of performance and health statistics for one or more Dell EqualLogic PS Series groups. The tool is a client/server application that runs on a Microsoft Windows server and uses SNMP to query the groups. Acting like a “flight data recorder” on an aircraft, SAN HQ collects data over time and stores it on the server for later retrieval and analysis. Client systems connect to the server and format and display the data in the SAN HQ GUI. SAN HQ enables the following as examples:

- Monitor one or more PS Series groups and store operational data for up to a year
- Obtain a centralized view of the health and status of multiple groups
- View IO rates, throughput, and latency for each volume, member, pool, or group
- Allow the same performance data to be viewed by multiple clients simultaneously
- Monitor and analyze capacity usage for groups

If action is required, the EqualLogic Group Manager can be launched directly from SAN HQ giving quick access to adjust storage systems to meet business needs.

## 7.6 System Center 2012 SP1

System Center 2012 SP1 Virtual Machine Manager. VMM 2012 is Microsoft’s Virtualization management platform. VMM 2012 provides in-depth management of both hypervisor and VMs. It provides a system administrator the capability to create and deploy VM templates, manage library stores of VMs, hardware profiles, and image files, and even manage VMware environments. VMM 2012 also provides P2V (physical to virtual) functionality, thereby allowing a system administrator to convert physical servers to virtual machines. VMM 2012 integrates with the hypervisor, VMs, and System Center Operations Manager to provide a deep view of the system utilization.

VMM 2012 SP1 introduces the following new features:

- **Network Virtualization:** Provides the ability to run multiple virtual network infrastructures, even with overlapping IP addresses, on the same physical network. There are two mechanisms to virtualize the IP address of a virtual machine: IP Rewrite or IP encapsulation.
- **VHDX Support:** Supports converting from .vhd to vhdx. When creating a new virtual machine with a blank virtual hard disk, VMM determines the VHD format based on the operating system of the destination host.
- **Storage Management Enhancements:** Support the new Windows Standard-based Storage Management service, which enables discovering storage by using multiple provider types. It also supports thin provisioning of logical units, and the discovery of SAS storage.
- **Host Provisioning Enhancement:** Support for performing Deep Discovery to retrieve more detailed information about the physical computer hardware before deploying the OS.
- **SMB 3.0 File Shares:** Support for designating network file shares on Windows Server 2012 computers as the storage location for virtual machine files, such as configuration, virtual hard disk files, and checkpoints.

- **Live Migration Enhancements:** Supports performing simultaneous live migrations with the options like Live, Live VSM, and Live Storage.

## 7.7 System Center 2012 SP1 Integration

Dell provides management packs for the optional System Center components to monitor servers, storage, and networking components. These management packs allow System Center 2012 Operations Manager (SCOM) to monitor, report on, and take actions based upon alerts generated by the individual components. Dell Server PRO Management Packs can be integrated with VMM to monitor Dell servers and take remedial action when an inefficient system is identified.

Dell also provides integration tools for System Center Configuration Manager for the Lifecycle Controller, providing a framework for bare-metal deployment of servers and operating systems. Dell EqualLogic PS6110 Series also includes management tools for automating the deployment of virtual machines with VMM 2012 SP1. These optional components are beyond the scope of this document. Additional information can be obtained from a Dell Sales or Services representative.

## 7.8 Dell Multi-UPS Management Console

The Dell Multi-UPS Management Console (MUMC) is designed for multi-host server environments, allowing easy and versatile monitoring and management across the network from a single interface. MUMC also provides agentless integration into multi-host managers. Other features include:

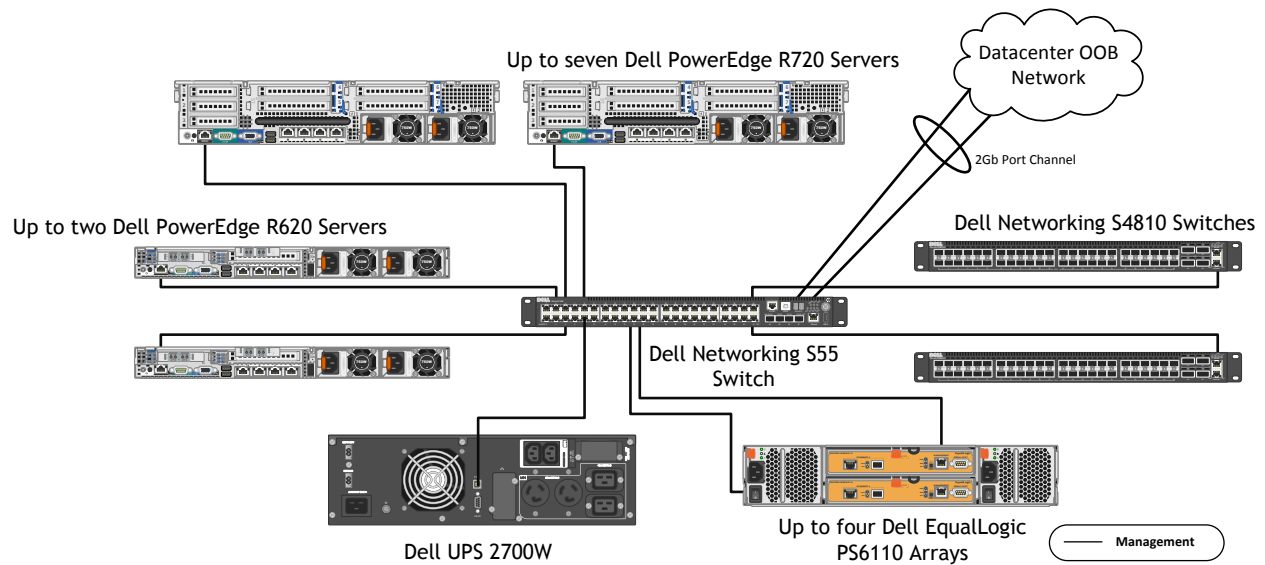
- Ability to monitor and manage multiple power and environmental devices from a Web browser
- Creates virtual composite groups of UPSs to manage redundant installations as one device
- User-definable tree structure enables grouping, access and management of multiple devices across multiple locations
- Auto discovery of Dell UPS and Dell intelligent PDU systems on the network
- Power device asset management tracks moves, adds, and changes of equipment
- Support for up to 32 UPS and PDU systems is included at no charge

For more information, see the web page for [Dell UPS Management Software](#).

## 7.9 Out-Of-Band Management Connectivity

The Dell Networking S55 switch is used as 1GbE out-of-band management switch. Each of the components is connected to the S55 switch, as shown in Figure 10. The S55 switch is uplinked to either the Datacenter OOB network or through the Dell Networking S4810 switches for Datacenter network connectivity. Section 8.1 below describes the default and alternative OOB uplink configurations.

Figure 10: Connectivity of OOB management components.



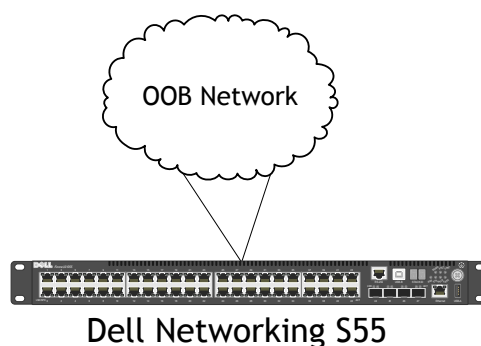
## 8 Connecting Active System 200m to Datacenter Network

It's likely that an Active System 200m is connected into a datacenter infrastructure that consists of Dell Networking switches, Cisco switches, or those of some other vendor. Active System uses S4810 as the ToR switch and S55 for the OOB switch. In this section, we provide examples to show how Active System is connected to the Datacenter network.

### 8.1 Connecting the Dell Networking S55 OOB switch to Datacenter Network

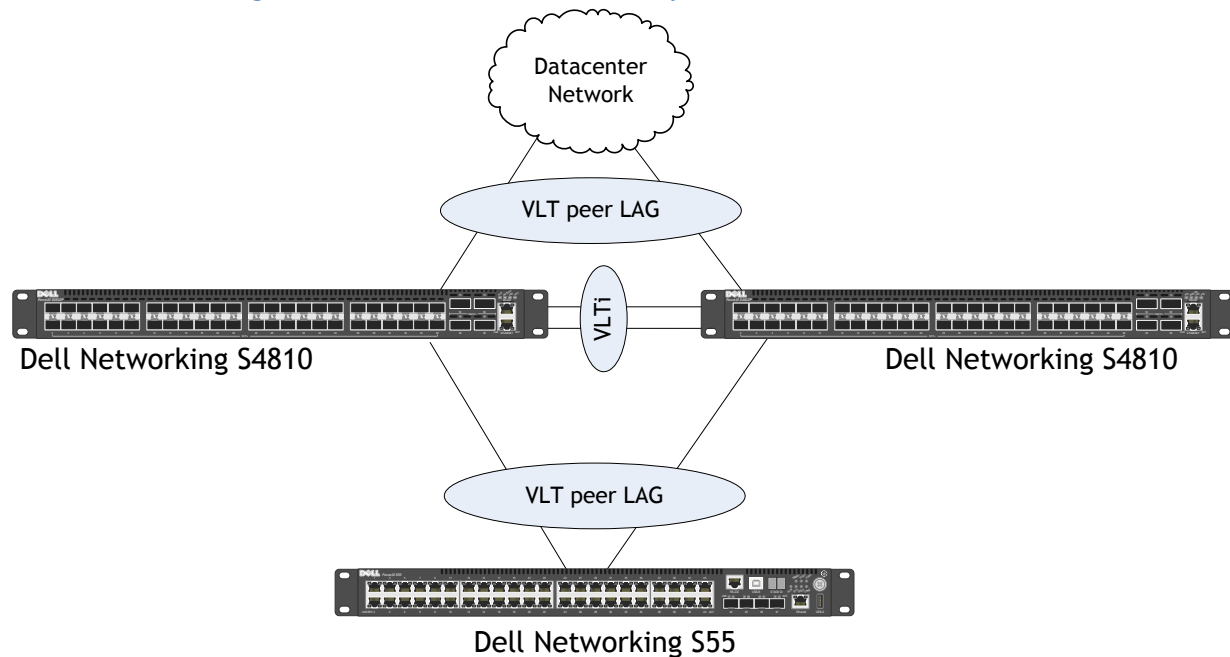
The S55 switch needs to be connected to the datacenter out of band network, if available, using two 1Gb uplinks from the S55 switch. This is shown in Figure 11.

Figure 11: S55 Connectivity to Datacenter OOB Network (Default Option)



If a datacenter OOB network is not available or to eliminate additional cabling, the S55 switch can alternatively be connected to the S4810 switches for OOB connectivity to the datacenter, as shown in Figure 12. The management connections of the S4810 then become only a VLT Heartbeat connection.

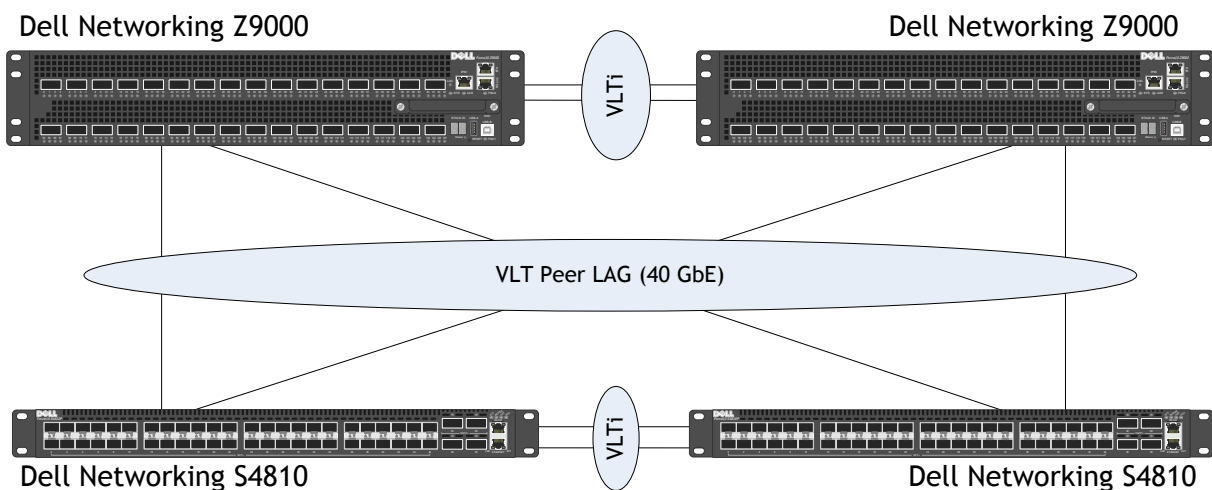
Figure 12: Alternative OOB Connectivity - S55 Switch to S4810 Switches



## 8.2 Connecting to a Dell Networking Datacenter Network

Figure 13 below illustrates an example with Dell Networking Z9000 switches. The two Z9000 switches are connected together using VLTi. The S4810 switches in the Active System use a 4-port VLT Peer LAG connecting to two Z9000 switches. The number of VLT Peer LAG links is flexible and can be changed according to use cases. The VLT Peer LAG will be used for VLAN traffic from the VLT uplinks, so they should be planned in an appropriate manner to avoid oversubscription.

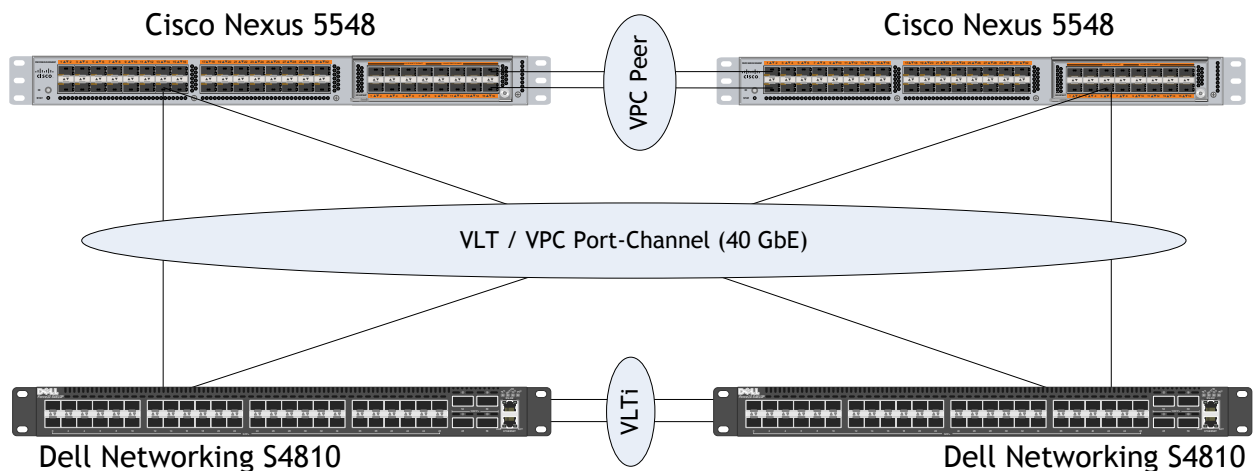
Figure 13: Active System 200 connectivity to Dell Networking Z9000



### 8.3 Connecting to a Cisco Nexus Datacenter Network

Figure 14 below illustrates an example with Cisco Nexus 5548 switches. The S4810 switches in the Active System 800 have a 4-port LAG/Port Channel linking into two Cisco Nexus switches. The two Cisco Nexus 5000 Series switches implement a virtual PortChannel (vPC) allowing the S4810 VLT Peer LAG to connect into both Nexus 5548 switches as a single port channel. The number of links is flexible and can be changed according bandwidth uplink requirements. Also in this example, four ports were used for the vPC Peer Link where the vPC Peer Link may be passing any of the uplinked traffic. As a result, careful planning must be undertaken to plan for appropriate oversubscription.

Figure 14: Connectivity to Cisco Nexus 5548



## 9 Scalability

As workloads increase, the solution can be scaled to provide additional compute and storage resources independently.

**Scaling Compute and Network Resources:** Active System 200m is configured with two Dell Networking S4810 network switches. Up to seven PowerEdge R720 rack servers can be added to the two S4810 switches. In order to scale the compute nodes beyond this, additional S4810 switches would need to be added. Additional switches could either be stacked together and/or connected to this distribution switch based on customer needs. The additional equipment may also require a larger PDU and UPS infrastructure.

**Scaling Storage Resources:** EqualLogic storage can be scaled seamlessly and independent of the server and network architectures. Additional EqualLogic PS6110 arrays of the same or different configuration can be added to the existing PS 6110 arrays. New volumes can be created or existing volumes can be expanded to utilize the capacity in the added enclosures. Active System 200m solution can scale up to a maximum of four arrays. To scale beyond this, additional racks can be added which may require additional switches and power.

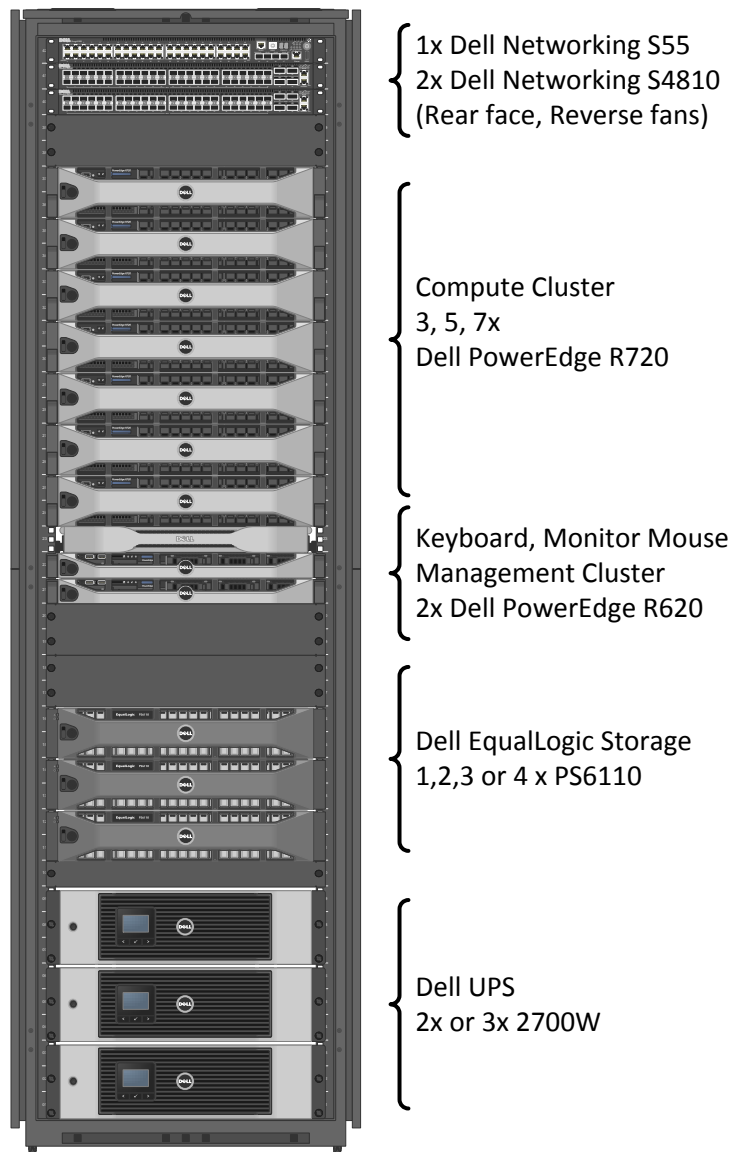
## 10 Delivery Model

This Dell reference architecture can be purchased as a complete solution. The solution is available to be racked, cabled, and delivered to the customer site, to speed deployment. Dell Services deploys and configures the solution tailored to the business needs of the customer and the architecture is developed and validated by Dell Engineering. For more details or questions about the delivery model, please consult with your Dell Sales representative.

Figure 15 below shows the Dell Active System 200m solution in the seven compute host default configuration. The EqualLogic arrays shown are PS6110X. If a different PS6110 array type is ordered, the actual rack configuration may be different from the one shown below.

Note that switches are shown mounted forward for representation. In actual use, ports face the back of the rack. Additional PDUs are utilized within the rack.

Figure 15: Active System 200m Rack and Component Overview





The Active System design accommodates up to seven Dell PowerEdge R720 compute hosts, two Dell PowerEdge R620 management hosts and up to four Dell EqualLogic Series PS6110 Arrays.

## 11 References

### 11.1 Dell PowerEdge Server Documentation and Hardware/Software Updates

For Drivers and other downloads: Visit <http://support.dell.com>, then choose Server, Storage & Networking product category.

### 11.2 Dell Networking Switch Documentation and Firmware Updates

Visit <http://support.dell.com> for documentation.

### 11.3 Dell EqualLogic

Dell EqualLogic PS Series Architecture Whitepaper

[http://www.dell.com/downloads/global/products/pyaul/en/dell\\_equallogic\\_architecture.pdf](http://www.dell.com/downloads/global/products/pyaul/en/dell_equallogic_architecture.pdf)

Host Integration Tools for Windows

<http://www.dell.com/downloads/global/products/pyaul/en/equallogic-host-software.pdf>

PS Series Storage Arrays: Choosing a Member RAID Policy

<http://en.community.dell.com/techcenter/b/techcenter/archive/2012/08/14/new-equallogic-raid-tech-report-considerations-and-best-practices-released.aspx>

[http://en.community.dell.com/cfs-file.ashx/\\_key/communityserver-components-postattachments/00-19-86-14-80/TR1020\\_5F00\\_v44\\_5F00\\_RAID\\_5F00\\_Final.pdf](http://en.community.dell.com/cfs-file.ashx/_key/communityserver-components-postattachments/00-19-86-14-80/TR1020_5F00_v44_5F00_RAID_5F00_Final.pdf)

Using Tiered Storage in a PS Series SAN

[http://en.community.dell.com/cfs-file.ashx/\\_key/communityserver-components-postattachments/00-19-86-14-79/TR1027\\_2D00\\_Tiered\\_2D00\\_Storage\\_2D00\\_v2.1\\_2D00\\_Final.pdf](http://en.community.dell.com/cfs-file.ashx/_key/communityserver-components-postattachments/00-19-86-14-79/TR1027_2D00_Tiered_2D00_Storage_2D00_v2.1_2D00_Final.pdf)

Monitoring your PS Series SAN with SAN HQ

[http://en.community.dell.com/cfs-file.ashx/\\_key/communityserver-components-postattachments/00-19-86-14-50/TR1050\\_2D00\\_Monitoring-Your-PS-Series-SAN-with-SAN-HeadQuarters.pdf](http://en.community.dell.com/cfs-file.ashx/_key/communityserver-components-postattachments/00-19-86-14-50/TR1050_2D00_Monitoring-Your-PS-Series-SAN-with-SAN-HeadQuarters.pdf)

### 11.4 Dell Windows Server 2012 and Virtualization Documentation

[http://support.dell.com/support/topics/global.aspx/support/windows\\_server\\_support/windows-server?c=us&cs=555&l=en&s=biz](http://support.dell.com/support/topics/global.aspx/support/windows_server_support/windows-server?c=us&cs=555&l=en&s=biz)

### 11.5 Microsoft® Hyper-V Documentation

Windows Server 2012

<http://technet.microsoft.com/en-us/library/hh801901>

Windows Server 2012 Hyper-V Whitepaper

[http://download.microsoft.com/download/5/D/B/5DB1C7BF-6286-4431-A244-438D4605DB1D/WS%202012%20White%20Paper\\_Hyper-V.pdf](http://download.microsoft.com/download/5/D/B/5DB1C7BF-6286-4431-A244-438D4605DB1D/WS%202012%20White%20Paper_Hyper-V.pdf)



Failover Clusters in Windows Server 2012

<http://technet.microsoft.com/en-us/library/hh831579>

## 11.6 Microsoft® Management Software

Microsoft System Center 2012 SP1

<http://www.microsoft.com/en-us/server-cloud/system-center/datacenter-management.aspx%20>

System Center 2012 Virtual Machine Manager Deployment

<http://technet.microsoft.com/en-us/library/gg610669>