Reference Architecture for Active System 1000 with Microsoft Hyper-V

Release 1.1 for Dell PowerEdge Blade Servers, Dell Networking Switches, Dell Compellent Storage Center, and Dell Active System Manager

Dell Global Solutions Engineering

Revision: A00

July 2013

July 2013| Rev A00

Revision History

Revision	Description	Date
A00	Initial Version	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 (Active System Manager), LAN & SAN fabrics, and modular server architecture for the ultimate infrastructure solution. Active Infrastructure helps IT rapidly respond to dynamic business demands, maximize data center efficiency, and strengthen IT service quality.

The Active System 1000 solution, a member of Dell Active Infrastructure family, is an enterprise 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 will deploy and configure the solution tailored for business needs and ready to be integrated into your datacenter. Active System 1000 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 1000v and the Microsoft Hyper-V solution is the Active System 1000m. This document will define the Reference Architecture for Active System 1000m.

The architecture defined in this document includes Dell™ PowerEdge™ M620 blade servers, Dell Compellent™ Storage, Dell Networking switches & Cisco™ network switches, Brocade Fibre Channel switches, Microsoft Windows Server 2012 Datacenter Edition with Hyper-V Role enabled and two Dell PowerEdge R620 servers that manage the solution by hosting Dell management tools, Microsoft System Center 2012 SP1 System Center Virtual Machine Manager and optionally other System Center 2012 SP1 components. Dell management tools include Dell Active System Manager, Compellent Enterprise Manager, and Dell OpenManage™ Essentials.

2 Audience

This document provides an overview of the Active System 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 Solution Overview

This section provides a high-level product overview of Microsoft Hyper-V, Dell PowerEdge blade servers, Dell Networking Switches, Brocade 6510 Fibre Channel Switches, and Dell Compellent Storage, as illustrated in Figure 1 and Figure 2 below. Readers can skip the sections of products with which they are familiar.

Figure 1: Overview of Dell Blade Servers, Dell Networking Switches, Brocade Fibre Channel Switches, Dell Compellent Storage, and Microsoft Hyper-V

Microsoft Windows Server 2012 Datacenter
With Hyper-V role Enabled
Failover Clustering (High Availability and Live Migration)
Native MPIO
Native NIC teaming
Dynamic Memory

Dell PowerEdge Blade Servers
Energy efficient PowerEdge M1000e enclosure
12th generation M620 blade server
Intel Xeon E5 series processors
Flex Address
CMC and iKVM for enclosure management

Dell Networking S4810 Switches
High-density 48-port 10 GbE switch with four 40 GbE uplinks
Ultra-low-latency, non-blocking, cut-through switch ensures line-rate L2 and L3 performance
Integrated network automation and virtualization tools via the Open Automation Framework

Brocade 6510 Fibre Channel Switches
1U 48 port high density switch
2, 4, 8, 10, or 16 Gbps Fibre Channel

Dell Compellent Storage array
Fluid Data Architecture with Thin Provisioning and Automated Tiered Storage
Centralized management using Enterprise Manager
Fast Track

Management Components
Dell Active System Manager – Hardware provisioning and management
Compellent Enterprise Manager
Dell OpenManage Essentials – Hardware Monitoring
System Center SP1 Virtual Machine Manager – Hypervisor and VM management

Figure 2: Dell Blade Servers, Dell Networking Switches, Brocade Fibre Channel Switches, Dell Compellent Storage

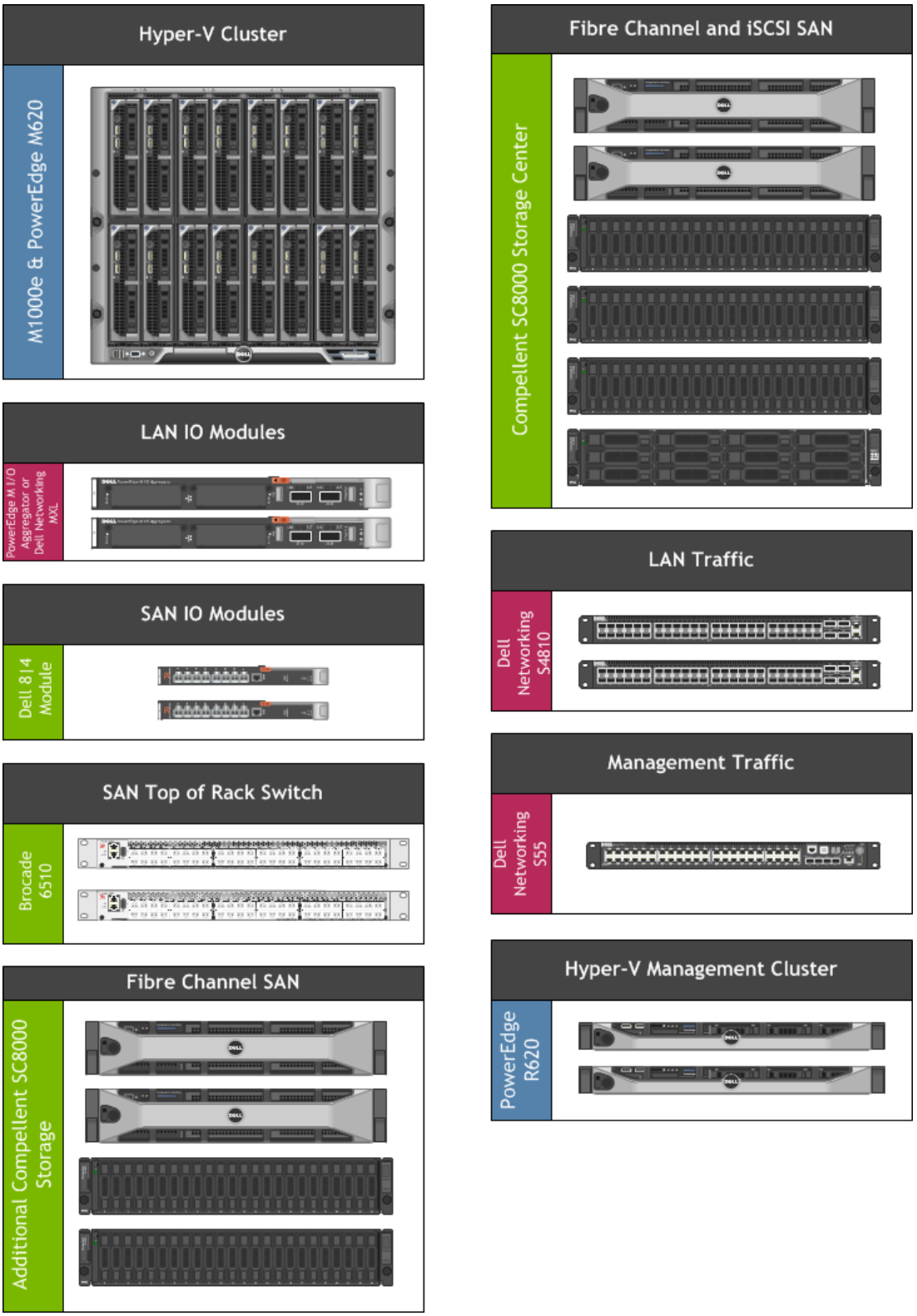


Table 1 below describes the key solution components and the roles served.

Table 1: Component Logical Groups

Component	Description	Role
Hyper-V Cluster	PowerEdge M620 blade servers running Windows Server 2012 Datacenter Edition and Hyper-V role enabled	Host highly available virtual machines (VMs)
Management Cluster	PowerEdge R620 servers running Microsoft® Windows Server® 2012 Datacenter Edition	Host management VMs: Dell Active System Manager, System Center VMM 2012 SP1, and Compellent Enterprise Manager, and Dell OpenManage Essentials
Storage	Dell Compellent SC8000 controllers with 24 bay 2.5" SAS enclosures or 12 Bay 3.5" SAS enclosures	Provide shared storage for the Hyper-V cluster to host the VMs
LAN Traffic Switches	Two Dell Networking S4810 and two Dell I/O modules for the blade chassis (PowerEdge M I/O aggregator or Dell Networking MXL)	Support VM, Live Migration, Management, iSCSI and Cluster traffic
OOB management Switch	One Dell Networking S55	Provide Management OOB management connectivity
SAN Traffic Switches	Two Brocade 6510	Support Fibre Channel data

3.1 Microsoft Windows Server 2012

Microsoft® Windows Server® 2012 is Microsoft's flagship server operating system which provides the Hyper-V® virtualization platform. Hyper-V can consolidate Windows® and Linux workloads enabling IT managers the ability to more fully utilize their available hardware resources. Live Migration provides customers with the ability to move VMs from one host to another with near zero down time.

3.2 Microsoft System Center 2012 SP1

System Center 2012 is Microsoft's systems management platform. System Center 2012 includes products to monitor, manage, deploy, backup, and more. This solution utilizes customer provided or a trial version of System Center 2012 and focuses on Virtual Machine Manager 2012. Further information on all Microsoft System Center components can be found at www.microsoft.com/systemcenter.

System Center Virtual Machine Manager (VMM) 2012: VMM 2012 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.

3.3 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 data center 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 will be 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.

3.4 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 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.

OpenManage Essentials helps you maximize IT performance and uptime with capabilities like:

- **Automated discovery, inventory, and monitoring** of Dell PowerEdge™ servers, EqualLogic™ and PowerVault™ storage, and PowerConnect™ switches
- **Agent-free server monitoring** as well as BIOS, firmware and driver updates for Dell PowerEdge servers, blade systems, and internal storage
- **Control of PowerEdge servers** within Windows®, Linux®, VMware®, and Hyper-V® environments
- Interface with additional optional Dell systems management solutions including:
    - Repository Manager to facilitate and secure precise control of system updates
    - KACE® K1000 Appliance service desk to provide actionable email alerts describing the status of Dell servers, storage, and switches
    - Dell ProSupport™ phone home services for your data center resources

For more information on OpenManage Essentials, see Dell.com/openmanageessentials.

3.5 Dell PowerEdge Blade Servers

Blade Modular Enclosure: The Dell PowerEdge M1000e is a high-density, energy-efficient blade chassis that supports up to sixteen half-height blade servers, or eight full-height blade servers, and six I/O modules. A high-speed passive mid-plane connects the server modules to the I/O modules, management, and power in the rear of the chassis. The enclosure includes a flip-out LCD screen (for local configuration), six hot-pluggable/redundant power supplies, and nine hot-pluggable N+1 redundant fan modules.

Blade Servers: The Dell PowerEdge M1000e Blade Server Chassis supports the Dell PowerEdge M620 blade servers based on Intel® Xeon® E5 series processors. Dell's embedded management houses the tools and enablement pieces for management directly on the server, allowing administrators to perform a complete set of provisioning functions from a single, intuitive interface. Zero-media low-touch deployment capabilities enable IT administrators to provision workloads in an efficient, secure, and user-friendly manner. The enclosure supports all Dell PowerEdge 12th generation blade servers, but the PowerEdge M620 was selected as the optimum blade server for this solution.

I/O Modules: The enclosure provides three redundant fabrics using six I/O modules. The modules can be populated with Ethernet switches, Fibre Channel (FC), and IO Aggregator modules.

Chassis Management: The Dell PowerEdge M1000e has integrated management through a redundant Chassis Management Controller (CMC) module for enclosure management and integrated keyboard, video, and mouse (iKVM) modules. Through the CMC, the enclosure supports FlexAddress Plus technology which enables the blade enclosure to lock the World Wide Names (WWN) of the FC controllers and Media Access Control (MAC) addresses of the Ethernet controllers to specific blade slots. This enables seamless swapping or upgrading of blade servers with Ethernet and FC controllers without affecting the LAN or SAN configuration.

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 12th generation blade servers. Embedded management includes:

- Unified Server Configurator (USC) aims at local 1-to-1 deployment via a graphical user interface (GUI) for operating system install, updates, configuration, and for performing diagnostics on single, local servers. This eliminates the need for multiple option ROMs for hardware configuration.
- Remote Services are standards-based interfaces that enable consoles to integrate, for example, bare-metal provisioning and one-to-many OS deployments, for servers located remotely. Dell's Lifecycle Controller takes advantage of the capabilities of both USC and Remote Services to deliver significant advancement and simplification of server deployment.
- Lifecycle Controller Serviceability aims at simplifying server re-provisioning and/or replacing failed parts and thus reduces maintenance downtime.

For more information on Dell Lifecycle Controllers and blade servers, see http://content.dell.com/us/en/enterprise/dcsm-embedded-management and Dell.com/blades.

3.6 Dell Networking S4810 Switches

The Dell Networking S-Series S4810 is an ultra-low-latency 10/40 GbE Top-of-Rack (ToR) switch purpose-built for applications in high-performance data center and computing environments. 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 industry leading density of 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 data center core. Each 40 GbE QSFP+ uplink can support four 10 GbE ports with a breakout cable. Powerful Quality of Service (QoS) features are coupled with Data Center Bridging (DCB) support, making the S4810 switch ideally suited for converged storage environments. In addition, the S4810 switch incorporates multiple architectural features that optimize data center network flexibility,

efficiency, and availability, including Dell Networking's Virtual Line Trunking, 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.

3.7 Dell PowerEdge M I/O Aggregator

The Dell PowerEdge M I/O Aggregator (IOA) is a flexible 1/10GbE aggregation device that is automated and pre-configured for easy deployment into converged iSCSI and FCoE networks. The key feature of the PowerEdge M I/O Aggregator is that all VLANs are allowed as a default setting. This allows the top-of-rack (ToR) managed switch to perform all VLAN management related tasks. The external ports of the PowerEdge M I/O Aggregator are automatically all part of a single link aggregation group (LAG), and thus there is no need for Spanning-tree. The PowerEdge M I/O Aggregator can use Data Center Bridging (DCB) and Data Center Bridging Exchange (DCBX) to support converged network architecture.

The PowerEdge M I/O Aggregator provides connectivity to the Converged Network Adapters (CNA) internally and externally to upstream network devices. Internally the PowerEdge M I/O Aggregator provides thirty-two (32) connections. The connections are 10 Gigabit Ethernet connections for basic Ethernet traffic, iSCSI storage traffic, or FCoE storage traffic. In a typical PowerEdge M1000e configuration with 16 half-height blade server ports, 1-16 are used and 17-32 are disabled. If quad port CNA/Network adapters or quarter-height blade servers are used, then ports 17-32 will be enabled.

The PowerEdge M I/O Aggregator includes two integrated 40Gb Ethernet ports on the base module. These ports can be used in a default configuration with a 4 X 10Gb breakout cable to provide four 10Gb links for network traffic. Alternatively these ports can be used as 40Gb links for stacking. The Dell PowerEdge M I/O Aggregator also supports three different types of add-in expansion modules, which are called FlexIO Expansion modules. The modules available are: 4-port 10Gbase-T FlexIO module, 4-port 10G SFP+ FlexIO module, and the 2-port 40G QSFP+ FlexIO module.

The PowerEdge M I/O Aggregator modules can be managed through the PowerEdge M1000e Chassis Management Controller (CMC) GUI. Also, the out-of-band management port on the PowerEdge M I/O Aggregator is reached by connection through the CMC's management port. This one management port on the CMC allows for management connections to all I/O modules within the PowerEdge M1000e chassis.

For more information on Dell PowerEdge M I/O Aggregator, see http://www.dell.com/us/business/p/poweredge-m-io-aggregator/pd.

3.8 Dell Networking MXL 10/40GbE Switch

The MXL switch provides 1/10/40GbE. The switch supports 32 internal 1/10GbE ports, as well as two fixed 40GbE QSFP+ ports and offers two bays for optional FlexIO modules. To ensure room to grow, uplinks via the FlexIO modules can be added or swapped as needed in the future. Choose from 2-port QSFP+, 4-port SFP+ or 4-port 10GBASE-T FlexIO modules to expand and aggregate (bi-directional) bandwidth up to 160 Gigabit per second. The MXL switch provides the flexibility to mix and match the FlexIO module types.

Like the M I/OA above, the MXL switch includes two integrated 40Gb Ethernet ports on the base module. These ports are used in a default configuration with a 4 X 10Gb breakout cable to provide four 10Gb links for network traffic. Alternatively these ports can be used as 40Gb links for stacking. The MXL Switch provides stacking capability for up to 6 interconnected blade switches allowing both

stacking across chassis and local switching of traffic within the chassis. For more information, see http://www.dell.com/us/business/p/force10-mxl-blade/pd.

3.9 Dell Networking S55 Switch

The Dell Networking S-Series S55 1/10 GbE ToR switch is designed for high-performance data center applications. The S55 switch leverages a non-blocking architecture that delivers line-rate, low-latency L2 and L3 switching to eliminate network bottlenecks. The high-density 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 that optimize data center network efficiency and reliability, 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.

3.10 Brocade 6510

The Brocade 6510 switch is a high density FC switch providing 48 ports in a 1U form factor. The 6510 switch includes redundant power supplies and fans making it well suited to the high availability needs of virtualization infrastructures.

For more information on Brocade 6510 Fibre Channel Switches, see Dell.com/brocade.

3.11 Dell 8/4 Gbps FC SAN Module

The Dell 8/4 Gbps FC SAN Module is a 24-port FC module with eight external ports and 16 internal ports that installs in a Dell PowerEdge M1000e Blade Enclosure. Built on industry-standard N_Port ID Virtualization (NPIV) technology, the module eliminates the traditional challenges of heterogeneous switch-to-switch interoperability and can non-disruptively connect Dell blades to NPIV-enabled FC SANs, including Brocade, Cisco, McData, and others. The Dell 8/4 Gbps FC SAN Module eliminates incremental switch management and configuration by presenting FC connections as a logical device (rather than switch domains) to the SAN fabric. The module enables the benefits of port aggregation, failover, and redundancy without the complexities of additional SAN switches or additional switch domains.

For more information on Dell 8/4 Gbps FC SAN Module, see http://www.dell.com/us/enterprise/p/fc-san/pd.

3.12 Dell Compellent SC8000 Storage Center

The SC8000 is a 2U Storage Center controller built on the Dell 12th generation PowerEdge™ server platform with a custom configuration to support the needs of the enterprise storage controller. The SC8000 offers increased density, exceptional processing power, greater memory, faster PCIe Gen3 IO bus, improved diagnostics capability with the Integrated Dell Remote Access Controller (iDRAC), and exceptional power efficiency with Energy Star Platinum rated dual hot-swappable power supplies using Fresh Air™ technology. The SC8000 IO expansion consists of 7 PCIe Gen 3 (double the bandwidth of Gen 2) capable slots: four full-height and three low-profile slots. One full-height slot contains the controller cache card. The remaining three full-height and three low-profile slots are reserved for back-end and front-end IO expansion. The SC8000 controllers are connected to SC200/220 SAS enclosures in daisy chain loop. The SC200/220 are 2U 6Gb SAS enclosures. The SC200 supports up to twelve (12) 3.5” disk

drives and SC220 supports up to twenty four (24) 2.5” disk drives. Supported drives can include a mix of drive speed and capacity in any slot within the enclosure.

For more information on Dell Compellent, see Dell.com/Compellent.

Features of the Dell Compellent SC8000 Storage Array include:

- **Fluid Data Architecture** – Storage is managed at the most granular level with built-in system intelligence to enable the dynamic flow of enterprise data.
- **Storage Virtualization** – Storage is virtualized at the disk level to create a flexible pool of storage resources shared by all servers all the time.
- **Thin Provisioning** – Allocation is completely separated from utilization so any size volume can be created at any time, yet capacity is only consumed when data is written.
- **Automated Tiered Storage** – Data dynamically cascades from tier to tier according to actual usage, freeing up high-performance drives for mission-critical applications.
- **Space-efficient Replays** – Continuous snapshots only capture changes in data for real-time protection with instant recovery to any point in time.
- **Thin Replication** – Data is replicated between local and remote sites using space-efficient snapshots and native IP or FC connectivity, eliminating the need for high-speed data links or identical system configurations.
- **Unified Storage Resource Management** – All storage resources are managed through a single point-and-click interface, providing a complete view of the entire storage environment.
- **Open, Agile Hardware Platform** – Storage is designed for persistence, not obsolescence, leveraging a single modular hardware platform coupled with technology independence.

For more information on Dell Compellent see, Dell.com/Compellent. Contact your Dell sales representative for more information on Compellent storage configurations and sizing guidelines.

3.13 Dell PowerEdge R620 Management Server

The Dell PowerEdge R620 management server uses Intel® Xeon® E5-2600 series processors in a 1U rack mount form factor. These servers support up to ten 2.5” drives and provide the option for an LCD located in the front of the server for system health monitoring, alerting, and basic management configuration. An AC power meter and ambient temperature thermometer are built into the server, which can be monitored on this display without any software tools. The server features two CPU sockets and 24 memory DIMM slots supporting 2, 4, 8, 16 or 32GB DIMMs.

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 PowerEdge R620 guides at Dell.com/PowerEdge.

4 Design Principles

This section covers the design principles, requirements, and solution capabilities incorporated in the Active System solution architecture.

- **Optimal Hardware Configuration for Virtualization -** The solution is designed with an optimal hardware configuration to support virtualization. Each blade server is configured with sufficient memory and network adapters required for virtualization.

- **Redundancy with No Single Point of Failure -** The system is designed to mitigate failure points. Network redundancy for the mission critical components is achieved with redundant network interface controllers (NICs) and redundant switches. NIC teaming for LAN and MPIO for SAN are used to provide failover across the redundant network interfaces. For FC storage, redundancy is achieved with multiple HBA ports, FC switches, and storage controllers. For network traffic, NIC ports are teamed in such a way that they avoid any single point of failure. Hyper-V High Availability (HA) is provided by Windows Server 2012 Failover Clustering. The solution also includes redundant power supplies connected to separate PDUs. 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.
- **Flexible Configurations -** Active System 1000m is pre-configured to suit most customer needs for a virtualized infrastructure. The solution also supports additional options, such as configuring racks, server processors, server memory, and storage, based on customer needs.
- **Racked, Cabled and Ready to be Deployed -** Active System is available racked, cabled, and delivered to the customer site ready for deployment. Where components are unable to ship in the rack, they will be shipped separately and racked on site. 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

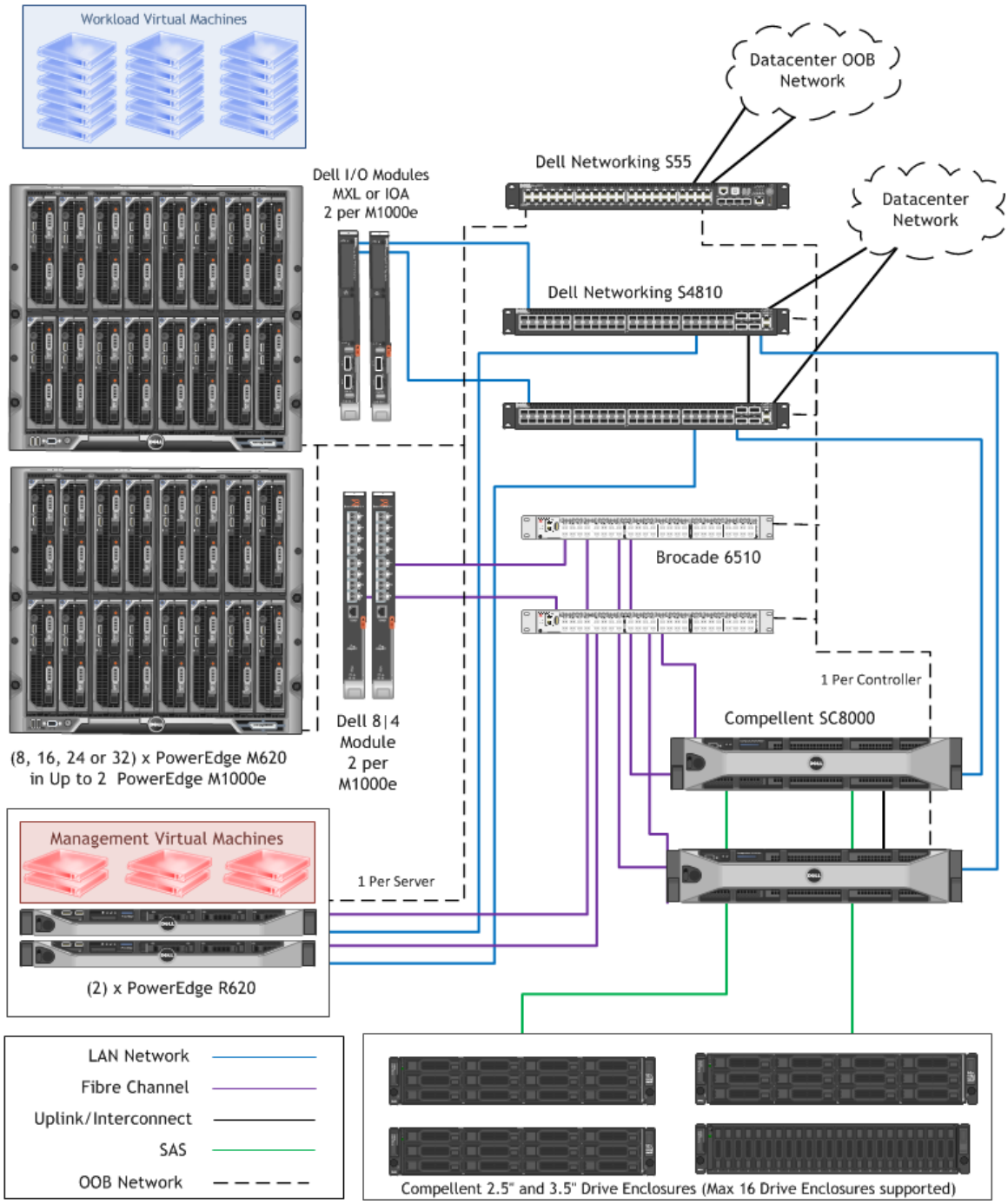
To support the architecture, the following components are required to be present in the customer environment:

- An existing 10 Gb Ethernet infrastructure with which to integrate is required.
- Additional components, such as Dell Networking cables and transceivers, are needed to uplink the solution to the customer network. The components to be added will depend on customer networking and uplink requirements.
- Active Directory® (AD) Domain Services (AD DS) – An AD DS domain must be available on the network. The Hyper-V hosts will be 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 Server (DNS) – DNS must be available on the management network.
- Database to support SC 2012 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 assumed 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 *Solution Specification Guide for Active System 1000 with Microsoft Hyper-V*.

6 Architecture

This solution consists of a Dell PowerEdge M1000e chassis populated with PowerEdge M620 blade servers running Windows Server 2012 Datacenter Edition. Figure 3 below depicts the high-level reference architecture for the solution including solution components and redundant connectivity for each I/O fabric.

Figure 3: Network Topology (Logical View) with optional 2nd Chassis



Note- Compellent Storage configuration is customizable depending upon customer requirements.

6.1 Dell Blade Network Architecture

The Dell blade chassis has three separate fabrics referred to as A, B, and C. Each fabric has two I/O modules, making a total of six I/O modules slots in the chassis. The I/O modules are A1, A2, B1, B2, C1, and C2. Each I/O module can be an Ethernet physical switch, an Ethernet I/O aggregator module, FC switch, or FC pass-through module. Each half-height blade server has a Blade Network Daughter Card (bNDC) that replaces the conventional LAN on Motherboard (LOM) with the NDC that can be selected between several options depending on solution requirements.

The Chassis Fabric A contains 10 GbE PowerEdge M I/O A modules and is used for LAN traffic. Fabric B contains Dell 8|4 Gbps SAN modules and is used for SAN. The Fabric C is unused.

PowerEdge M620 blade servers use a Broadcom 57810-k Dual port 10Gb KR bNDC to connect to the Fabric A. PowerEdge M I/O A modules uplink to Dell Networking S4810 network switches providing LAN connectivity. The QLogic QME2572 8 Gbps Fibre Channel I/O mezzanine cards connected to Fabric B connect to Dell 8|4 Gbps SAN modules. The uplinks of Dell 8|4 Gbps SAN modules connect to Brocade 6510 switches providing SAN connectivity.

The network traffic on each blade includes iSCSI (for in-guest iSCSI) as well as traffic for the parent partition (hypervisor), Live Migration, cluster heartbeat and cluster shared volume, and child partitions (virtual machines). On both the PowerEdge M620 and PowerEdge R620 servers, each of their 10GbE ports is partitioned into four ports using NPAR and a total of eight NICs are created on each server. Two NICs are used to create a switch independent teams using Windows Native NIC team and further two NICs are used for VM ISCSI traffic. The additional four NICs remain unused. Different VLAN IDs are assigned to these teamed NICs to segregate the traffic on the host and provide the segmentation necessary for Cluster Management, Live Migration, Cluster Private, Virtual Machine, and other types of traffic. A Virtual Network Switch is then created and bound to the Virtual Machine VLAN adapter.

6.2 Server / Blade Network Connectivity

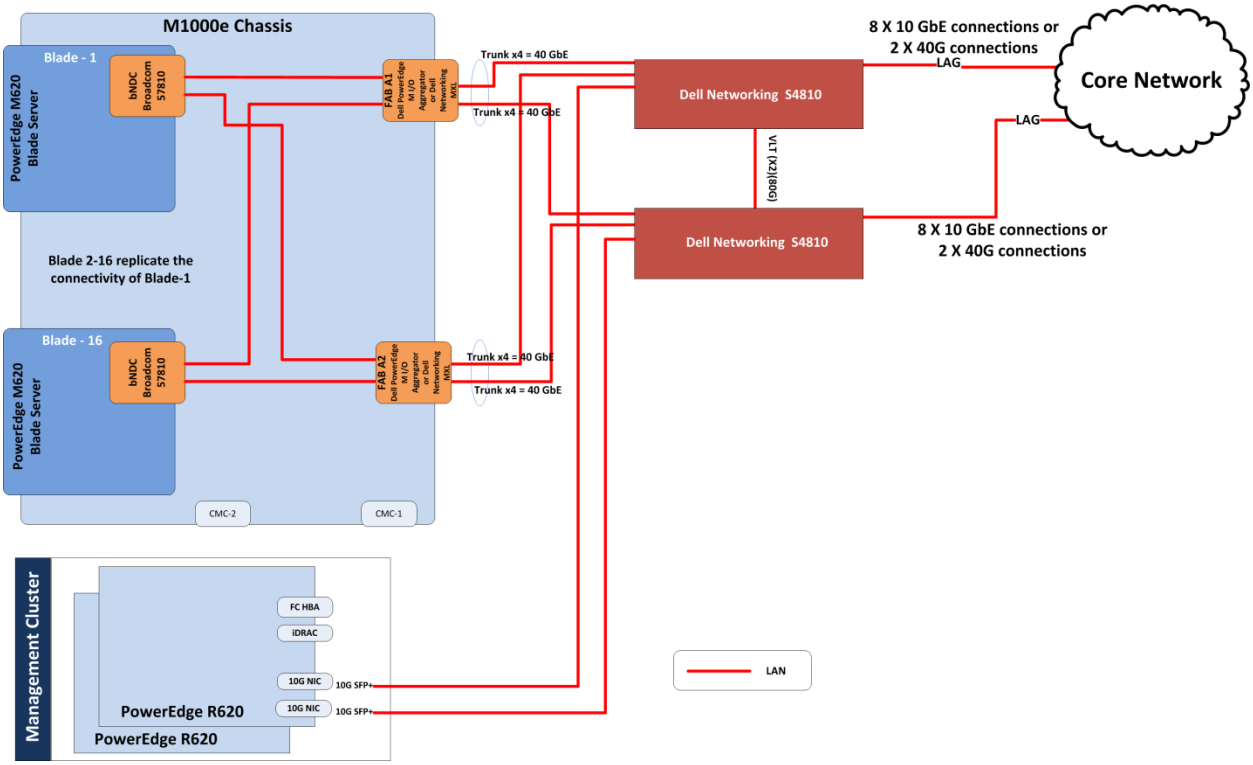
Each host network adapter in both the compute and management hosts utilizes network teaming technology to provide highly available network adapters to each layer of the networking stack. The teaming architecture closely follows the *Building Your Cloud Infrastructure: Converged Data Center without Dedicated Storage Nodes*, but is modified slightly to provide fabrics for iSCSI to guest VMs and to include the iSCSI HBA built into the bNDC.

The 10GbE bNDC supports network partitioning (NPAR) which allows splitting the 10GbE pipe with no specific configuration requirements in the switches. With NPAR, administrators can split each 10GbE port into 4 separate partitions or physical functions and allocate the desired bandwidth and resources as needed. Each of these partitions is enumerated as a PCI Express function that appears as a separate physical NIC in the server's system ROM, operating systems, and hypervisor.

As mentioned previously, each PowerEdge M620 blade server is configured with a Broadcom BCM57810 bNDC providing two 10GbE ports. These ports are wired to the Dell I/O modules in Fabric A and the corresponding ports on A1 and A2 modules are connected with the two Dell Networking S4810 switches outside the blade chassis enclosure. Meanwhile, each PowerEdge R620 rack server is configured with a Broadcom BCM57810 Add-in NIC providing two 10Gb SPF+ ports, and they are connected with the two S4810 switches. The two S4810 switches are configured with Virtual Line Trunking (VLT) using two 40 Gbps QSFP+ links. VLT Interconnects are created between the two 40 Gbps QSFP+ ports, providing a

path for communication across the switches. Network connectivity for the M620 is illustrated in Figure 4 below.

Figure 4: Dell Active System Blade LAN Connectivity Overview



On both the PowerEdge M620 and PowerEdge R620 servers, each of their 10GbE ports is partitioned into four ports using NPAR and a total of eight NICs are created on each server. Two NICs are used to create a switch independent team using Windows Native NIC team, and two NICs are used for VM ISCSI traffic. The additional four NICs remain unused. Figure 5 illustrates the network configuration on a Dell PowerEdge M620 blade server and Figure 6 illustrates the configuration of the PowerEdge R620 management servers.

A virtual switch is created using the teamed adapter and different VLAN IDs are assigned to the virtual NICs to segregate the traffic on the host and provide the segmentation necessary for cluster management, Live Migration (LM), cluster private, virtual machine, and other types of traffic as described in Table 2 below. Two additional virtual switches must also be created and bound to the two NICs dedicated to iSCSI traffic. The VLAN configuration used in the Dell Active System configuration is listed in Table 3.

Figure 5: NPAR and VLAN Configuration on a PowerEdge M620 Blade Server

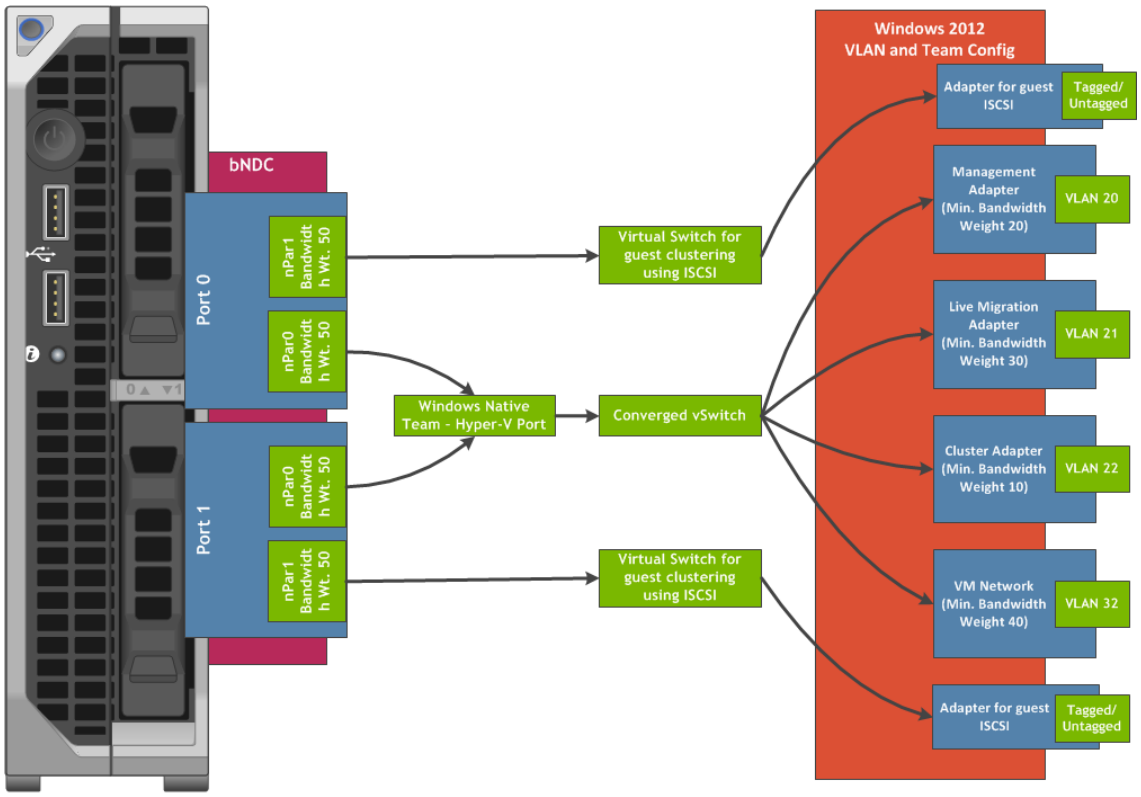


Figure 6: NPAR and VLAN Configuration on a PowerEdge R620 Management Server

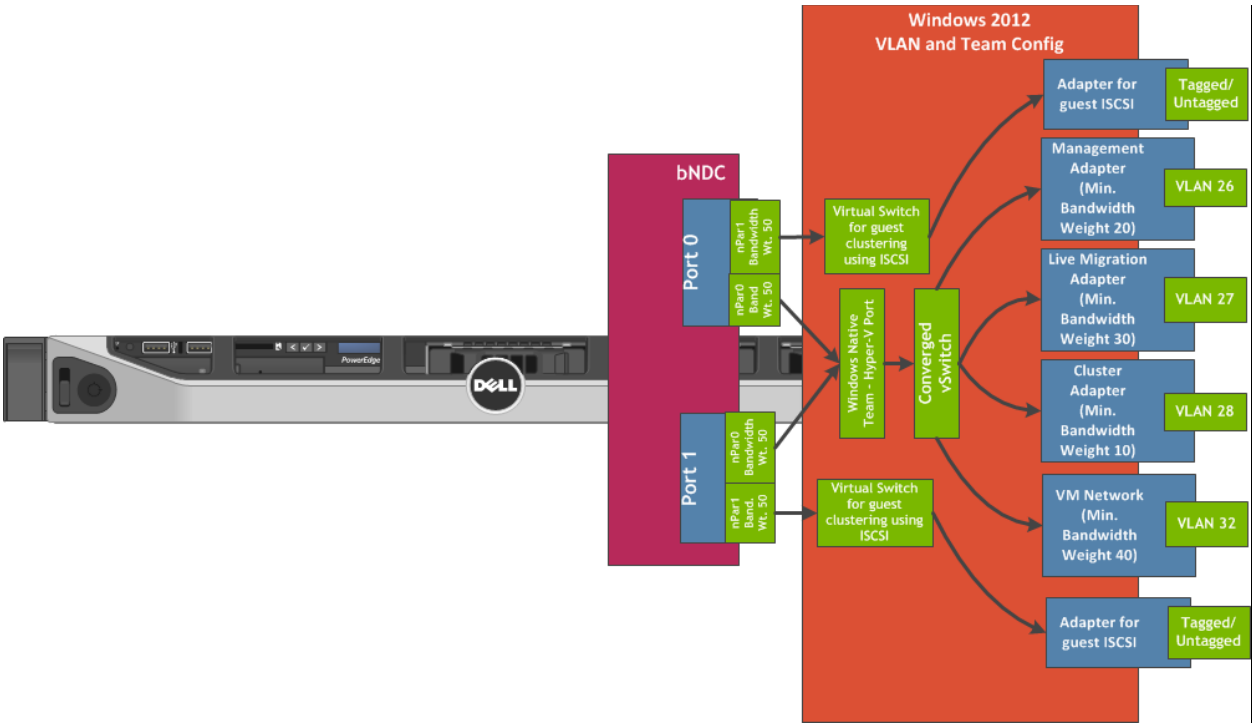


Table 2: Traffic Description

Traffic Type	Use
Compute Node Hypervisor (Mgmt)	Supports virtualization management traffic and communication between the host servers in the cluster.
Compute 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.
Compute Cluster Private	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.
Management Node Hypervisor	Supports virtualization management traffic and communication between the management servers in the cluster.
Management Cluster Private	Supports private cluster traffic for the management clusters.
Management Live Migration	Supports migration of VMs between the management servers in the cluster.
Management VM	Supports the virtual machine traffic for the management virtual machines.

Table 3: Sample VLAN and subnet configuration

Traffic Type	Sample VLAN
Out-of-Band Management	24
Compute Node Management	20
Compute Live Migration	21
Compute Cluster Private	22
Compute VM Network	23
Management Hypervisor	26
Management Cluster LM	27
Management Cluster Private	28
SQL Clustering	30
Management VM Network	32
iSCSI-1	25
iSCSI-2	33

6.3 Server / Blade Storage Connectivity

In the Active System configuration, each PowerEdge M620 and PowerEdge R620 server uses an internal RAID controller PERC H710 and is 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 a dual port 8 Gbps Fibre Channel adapter for attaching to SAN volumes and dual port 10 GbE network adapters for passing iSCSI traffic through to the guest VMs.

6.4 Server /Blade HA and Redundancy

The PowerEdge M620 blade chassis enclosure PowerEdge M1000e is designed with redundant power supplies and redundant fans. Each PowerEdge M620 uses a PERC H710 RAID controller and two hard drives configured in a RAID-1 which hosts the parent operating system.

The design of PowerEdge R620 servers includes 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.

6.5 Storage Architecture

This section describes the storage architecture of Active System 1000m.

6.5.1 Storage Options

The Dell Active System for Enterprise Virtualization uses the Dell Compellent SC8000 for shared SAN storage. The SC8000 provides the solution with both Fibre Channel and iSCSI front end storage connectivity options. The Fibre Channel is used for hypervisor connectivity and provides a dedicated SAN fabric for the storage traffic. This gives the hypervisors dedicated bandwidth to provide the VMs a very low latency and high bandwidth option for storage connectivity. The iSCSI interfaces are added to the Compellent SC8000 to provide an interface for the VMs to have direct access to enable in-guest clustering.

This solution also gives an option of adding Dell Compellent storage controllers for specific configurations which require high IOPS. These optional configurations are different from default configurations in terms of storage only. The remaining components are unchanged in optional configurations.

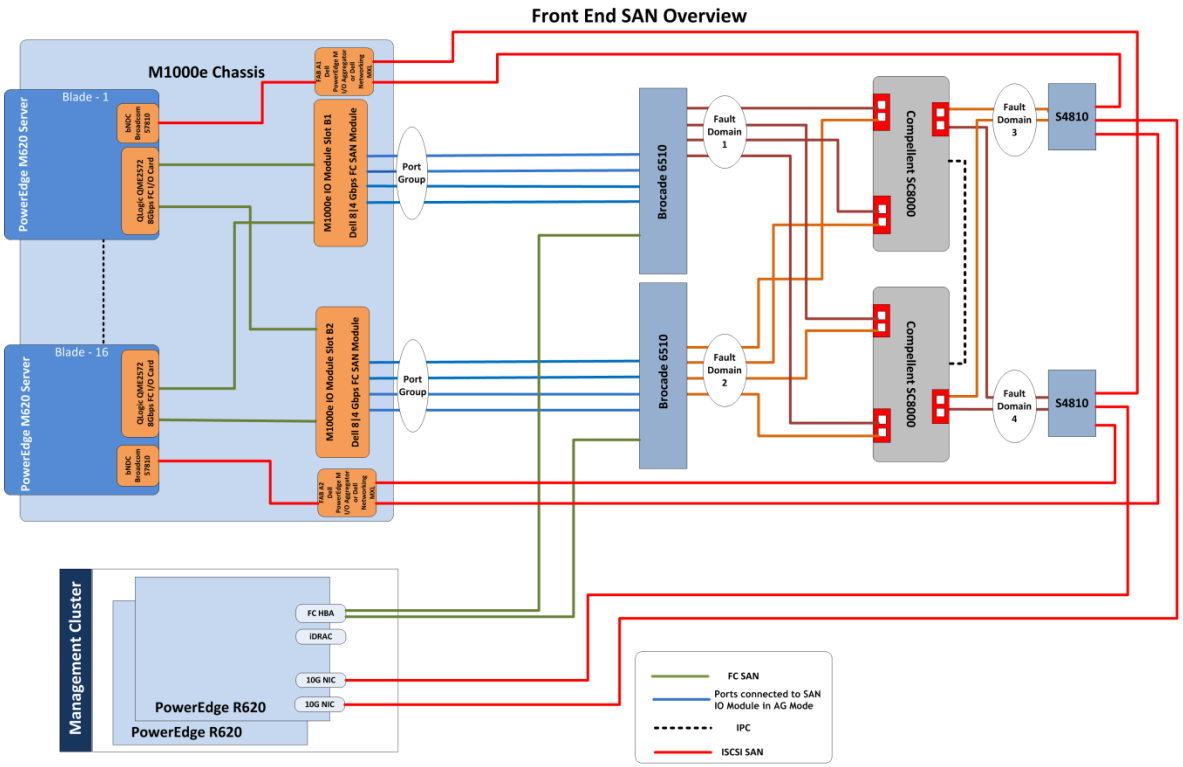
6.5.2 SAN Storage Protocols

This Dell Active System solution utilizes both Fibre Channel and iSCSI protocols. The Fibre Channel storage, being a low-latency and ultra-high performance infrastructure, is used for the parent to storage connectivity. The host-to-array Fibre Channel is in the 8Gbps form. For Hyper-V, iSCSI-capable storage provides an advantage in that it is the protocol that can also be utilized by Hyper-V guest virtual machines for guest clustering. This requires that VM storage traffic and other network traffic flow over the same interface; however this contention is mitigated through the use of VLANs and NPAR on the network adapter.

6.5.3 Storage Network

Each PowerEdge M620 blade server is configured with a QLogic dual port QME2572 8 Gb FC mezzanine card. Each FC port is wired across the PowerEdge M1000e mid-plane to the Dell 8|4 FC SAN modules in Fabric B. The SAN modules are Access Gateways connected to Brocade 6510 Fibre Channel switches. Brocade Access Gateway is a Fabric OS feature used to configure Enterprise fabric to handle additional devices instead of domains. Switches in AG mode are transparent to the host and the fabric. The number of hosts having access to the fabric can be increased without increasing the number of switch domains. The front end FC ports of Compellent SC8000 are connected to the 6510 FC SAN switches. For the management servers, each PowerEdge R620 server is configured with a QLogic QLE2562 8 Gb FC I/O Card and connected to the Brocade 6510 Top of Rack SAN switches. To further support the Fabric Management guest cluster, the PowerEdge R620 server is also configured with iSCSI connectivity to the Compellent by using its dual port Broadcom BCM57810 10GbE Add-in card. Both ports are configured with NPAR and dedicated to iSCSI traffic. The connectivity to the Compellent iSCSI front-end is established via the two Dell Networking S4810 switches. To provide the fully redundant and independent paths for storage I/O, MPIO is enabled by the iSCSI initiator on the host. The iSCSI traffic on PowerEdge R620 is segregated by the implementation of NPAR and VLAN. QoS is provided by the bandwidth settings in NPAR and OS bandwidth management.

Figure 7: Active System SAN Connectivity Overview



6.5.4 Performance

Dell Compellent SC8000, with the dual-controller configuration, 8 Gb Fibre Channel interconnects provides high bandwidth for data flows. This bandwidth is complemented with a large variety of drives in multiple speeds and sizes. The Compellent SC8000 also uses virtual port IQNs and WWNs, thereby enabling higher throughput and fault tolerance.

6.5.5 Drive Types

Dell Compellent storage enclosures feature 6Gb SAS interconnects, so organizations can scale up and out with ease. Administrators can mix SSD and SAS drives in the same system, as well as SAS drives with the same form factor (but different speeds and capacities) in the same storage enclosure.

The Dell Active System for Enterprise Virtualization base solutions are based upon the number of compute nodes. As an example, the 16 blade configuration utilizes three 24 bay 2.5" SAS drive enclosures and the fourth enclosure uses the one bay 3.5" SAS drives. The 2.5" drives selected are 300GB 15K RPM SAS and the 3.5" drives are 2TB 7K RPM SAS. This provides a balance of space and IOPS.

Compellent Fluid Data storage dynamically moves data to the optimal tier based on actual usage. The most active blocks reside on high-performance SSD, FC, or SAS drives, while infrequently accessed data migrates to lower-cost, high-capacity SAS or SATA drives.

In the 16 blade configuration example, three enclosures are configured with 15K 300GB 2.5" SAS drives and are designated as Tier-1. One enclosure is configured with 7K 1TB 2.5" SAS drives and is designated as Tier-3. Compellent Storage Center automatically configures RAID levels for these tiers and automatically moves the data between the tiers based on access patterns. For more details refer to the Automated Tiered Storage web page.

6.5.6 RAID Array Design

Dell Compellent SC8000 supports RAID 5, 6 and 10. The Compellent Storage Center will dynamically set up RAID based upon the demand of the storage.

6.5.7 Cluster Shared Volumes

Cluster Shared Volumes (CSV) are the storage volumes of choice for Hyper-V clusters. Developed by Microsoft exclusively for Hyper-V, they enable multiple Hyper-V cluster nodes to simultaneously access VMs. The CSVs are used throughout the Active System for an Enterprise Cloud solution for both the fabric and fabric management servers.

6.5.7.1 CSV Limits

The below limitations are actually imposed by the NTFS file system and are inherited by CSV.

Table 4: CSV Limits

CSV parameter	Limitation
Maximum Volume Size	No Restriction
Maximum # Partitions	128
Directory Structure	Unrestricted
Maximum Files per CSV	4+ Billion
Maximum VMs per CSV	Unrestricted

6.5.7.2 CSV Requirements

- All cluster nodes must use Windows Server 2012.
- All cluster nodes must use the same drive letter for the system disk.
- All cluster nodes must be on the same logical network subnet. Virtual LANs (VLANs) are required for multi-site clusters running CSV.
- NT LAN Manager (NTLM) authentication in the local security policy must be enabled on cluster nodes.
- Server Message Block (SMB) must be enabled for each network on each node that will carry CSV cluster communications.
- "Client for Microsoft Networks" and "File and Printer Sharing for Microsoft Networks" must be enabled in the network adapter's properties to enable all nodes in the cluster to communicate with the CSV.
- The Hyper-V role must be installed on any cluster node that may host a VM.

6.5.7.3 CSV Volume Sizing

Because all cluster nodes can access all CSV volumes simultaneously, standard LUN allocation methodologies are used and are based on performance and capacity requirements of the workloads running within the VMs themselves. Generally speaking, isolating the VM Operating System I/O from the application data I/O is a good start, in addition to application-specific I/O considerations such as segregating databases and transaction logs and creating SAN volumes and/or Storage Pools that factor in the I/O profile itself (i.e., random read and write operations vs. sequential write operations).

CSV's architecture differs from other traditional clustered file systems, which frees it from common scalability limitations. As a result, there is no special guidance for scaling the number of Hyper-V Nodes or VMs on a CSV volume other than ensuring that the overall I/O requirements of the expected VMs running on the CSV are met by the underlying storage system and storage network.

Each enterprise application that is planned to run within a VM may have unique storage recommendations and even perhaps virtualization-specific storage guidance. That guidance applies to use with CSV volumes as well. It is important to keep in mind that all VM's virtual disks running on a particular CSV will contend for storage I/O.

Also worth noting is that individual SAN LUNs do not necessarily equate to dedicated disk spindles. A SAN Storage Pool or RAID Array may contain many LUNs. A LUN is simply a logical representation of a disk provisioned from a pool of disks. Therefore, if an enterprise application requires specific storage IOPS or disk response times, all the LUNs in use on that Storage Pool must be considered. An application which would require dedicated physical disks, were it not virtualized, may require dedicated Storage Pools and CSV volumes running within a VM.

6.5.8 High Availability

In order to maintain continuous connectivity to stored data from the server, the controller level fault domains are established to create redundant I/O paths. These fault domains provide for continuous connectivity with no single point of failure. Domain 1 includes connections through the top 6510, then to each of the two Compellent controllers. Domain 2 includes connections through the bottom 6510, then to each of the two Compellent controllers. In this implementation, if one physical port fails, the virtual port will move to another physical port within the same fault domain and on the same controller.

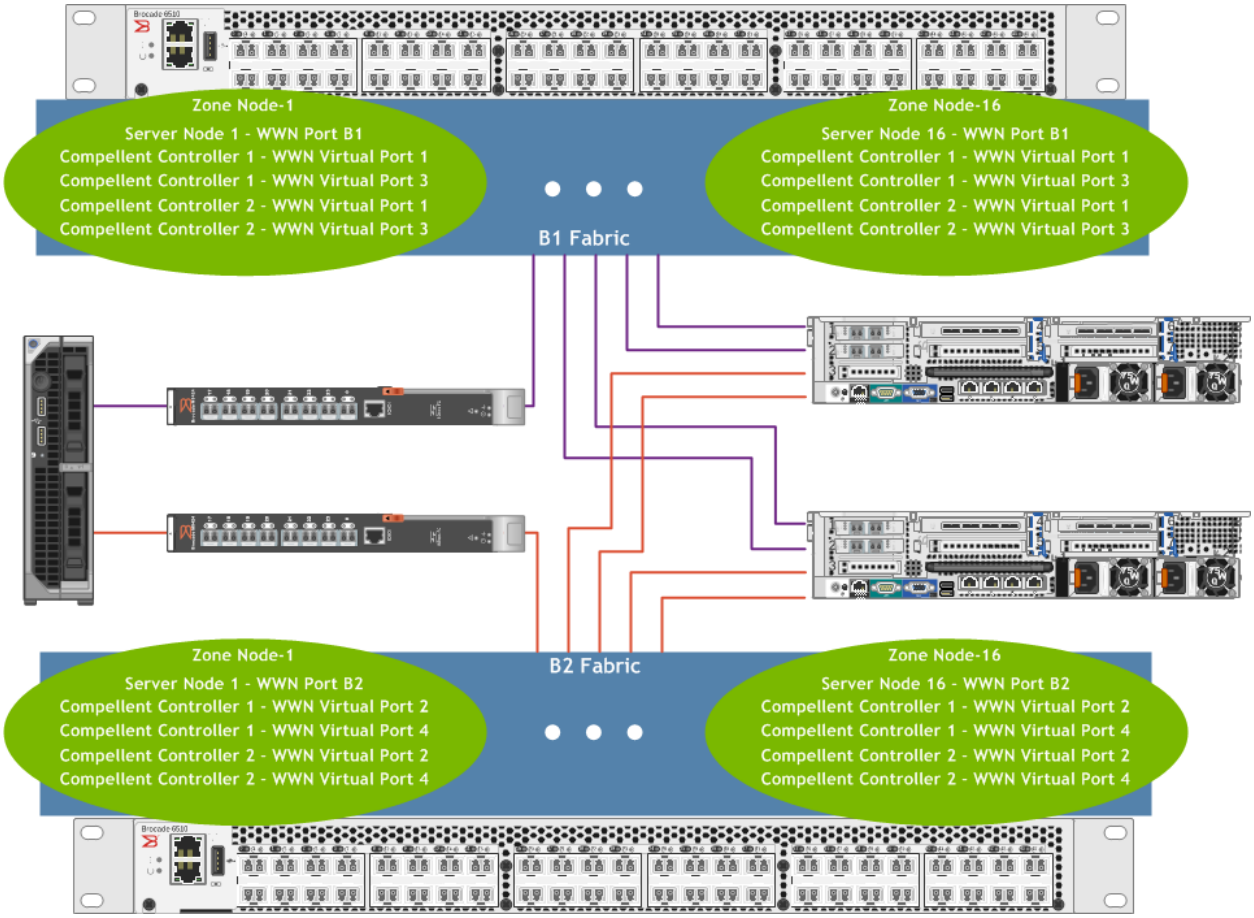
6.5.9 Multi-pathing

For Windows Server 2012, the built-in generic Microsoft Device Specific Module (MSDSM) provides functionality for Dell Compellent. The multi-pathing solution uses the Round Robin load balancing algorithm to utilize all available paths.

6.5.10 Fibre Channel Zoning

In the Dell Active System for Enterprise Cloud, FC zones are created on the Brocade 6510 FC SAN switches, such that each zone consists of one initiator (one HBA port per server) and the Compellent FC ports.

Figure 8: SAN's FC Network and Zoning



6.5.11 iSCSI

In Dell Active System for Enterprise Cloud, iSCSI connectivity to SAN is presented to tenant VMs to create guest clusters. The traffic separation is implemented by the VLAN.

6.5.12 Encryption and Authentication

Challenge Handshake Authentication Protocol (CHAP) is available for use on the Compellent Storage Center.

6.5.12.1 Jumbo Frames

In the 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 Compellent interfaces.

6.5.12.2 Thin Provisioning

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

Dell Compellent Thin Provisioning delivers the highest enterprise storage utilization possible by eliminating pre-allocated but unused capacity. The software, Dynamic Capacity, completely separates allocation from utilization, enabling users to provision any size volume upfront yet only consume disk space when data is written. Thin Write technology assesses the incoming payload and designates capacity for each write on demand, leaving unused disk space in the storage pool for other servers and applications.

6.5.12.3 Volume Cloning

Compellent offers the Remote Instant Replay™ feature to support volume cloning. Remote Instant Replay leverages space-efficient snapshots between local and remote sites for cost-effective disaster recovery and business continuity. Following initial site synchronization, only incremental changes in enterprise data need to be replicated, minimizing capacity requirements and speeding recovery. Known as Thin Replication, this unique approach enables network storage administrators to choose between Fibre Channel and native IP connectivity for data transfer.

Volume Cloning is another common practice in Virtualization environments. This can be used for both Host and VM volumes, dramatically increasing Host installation times and VM provisioning times.

6.5.12.4 Volume Snapshots

SAN Volume snapshots are a common method of providing a point-in-time, instantaneous backup of a SAN Volume or LUN. These snapshots are typically block-level and only utilize storage capacity as blocks change on the originating volume. Some SANs provide tight integration with Hyper-V, integrating both the Hyper-V Microsoft Volume Shadow Copy Service (VSS) Writer on Hosts and Volume Snapshots on the SAN. This integration provides a comprehensive and high-performing backup and recovery solution.

Dell Compellent Replay Manager is powerful snapshot-consistency software that integrates with VSS to ensure the integrity of Exchange Server, SQL Server and Hyper-V data. By initiating snapshots when the I/O is quiesced, Replay Manager provides time-consistent snapshots even if the application or virtual machine (VM) is running during the process. The application-aware technology leverages Data Instant Replay, which creates space-efficient snapshots for recovery of most volumes to a server in less than 10 seconds.

Figure 9: Compellent Snapshot Consistency

6.5.12.5 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 Compellent Fluid Data storage dynamically moves enterprise 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, with overall storage costs cut by up to 80%.

7 Management Infrastructure

This section discusses the components and connectivity of the management infrastructure.

7.1.1 Management Components

The various management components that were introduced in the Overview section are described here in more detail.

System Center 2012 SP1 Virtual Machine Manager Component (VMM 2012): 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.

Compellent Enterprise Manager: Compellent Enterprise Manager simplifies storage management by providing a single, centralized console for the administration of multiple local and remote Compellent systems. Users can configure and verify remote replication processes, monitor storage capacity and disk utilization in real time, and generate comprehensive enterprise storage usage and performance reports.

Dell Lifecycle Controller: This helps reduce operating costs by simplifying deployment and management. Key features include diagnostics, self-update (UEFI, Driver Pack update), firmware updates (BIOS, NIC FW, RAID Controllers), and hardware configuration.

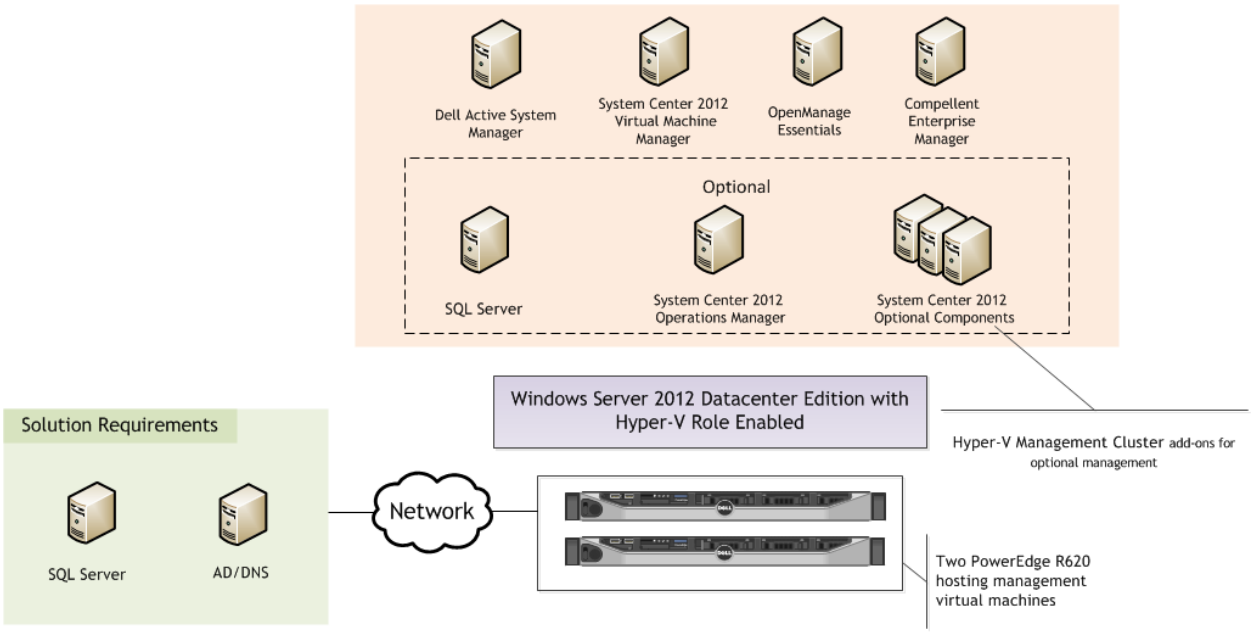
Out-of-band CMC and iDRAC: The CMC provides a single, secure interface to manage the inventory, configuration, monitoring, and alerting for chassis components (iKVM, CMC), I/O modules, servers, and iDRAC. It also provides excellent real-time power management, monitoring, and alerting capabilities. The Dell chassis provides users with system-level power limiting, slot-based prioritization, and dynamic power engagement functionalities. The iDRAC on each server provides the flexibility to remotely manage the server through Console redirection and Virtual CD-ROM/DVD/Floppy/Flash capabilities.

Dell | System Center 2012 SP1 Integration: Dell provides management packs for the optional System Center components to monitor servers, storage, and networking components. These packs allow System Center 2012 Operations Manager (SCOM) to monitor, report on, and take actions based upon alerts generated by the individual components. 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 Compellent also includes management tools for automating the deployment of virtual machines with VMM 2012 and the System Center 2012 Service Manager Self-Service Portal. These optional components are beyond the scope of this document. Additional information can be obtained from your Dell Sales or Services representative.

The management applications discussed above are installed as virtual machines in PowerEdge R620 server management cluster. Figure 10 below illustrates the Virtual Machines used in the management cluster along with optional components.

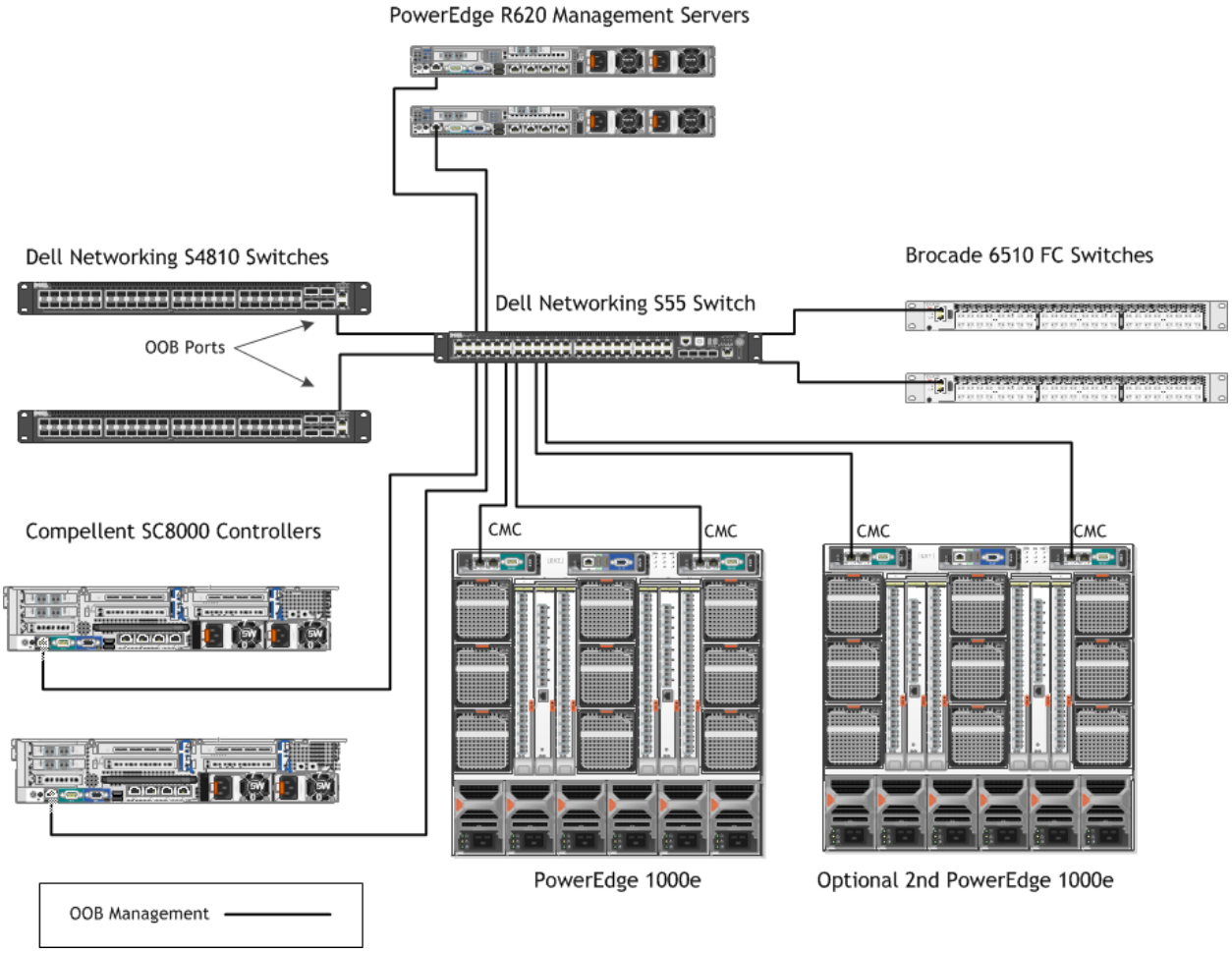
Figure 10: Management Architecture



7.1.2 Management Connectivity

The Dell Networking S55 switch is used as a 1GbE out-of-band management switch. Each of the solution components is connected to the S55, as shown in Figure 11.

Figure 11: Connectivity of management components.



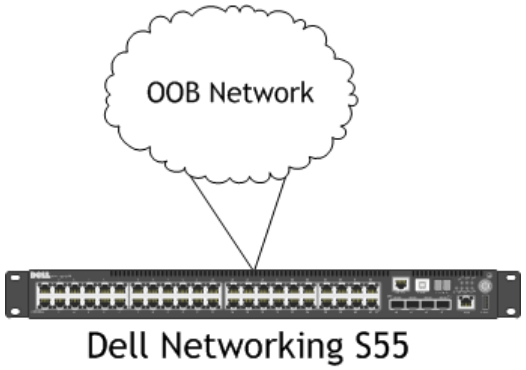
8 Connecting Active System 1000 to Datacenter Network

It's likely that an Active System 1000 is connected into a data center infrastructure that consists of Dell Networking switches, Cisco switches, or those of some other vendor. Active System uses Dell Networking S4810 as the ToR switch and Dell Networking 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 S55 OOB switch to Datacenter Network

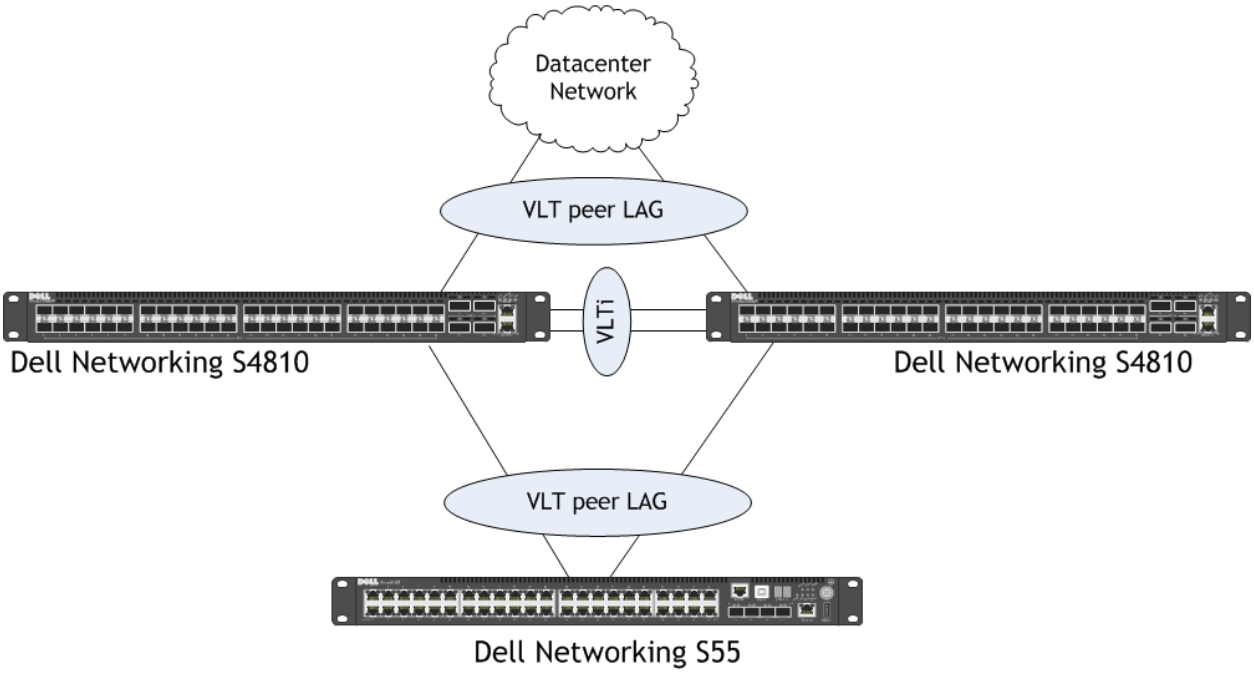
A Dell Networking S55 switch needs to be connected to the datacenter out of band network, if available, using two 1Gb uplinks from the S55 switch. This is shown in Figure 12.

Figure 12: S55 Connectivity to Datacenter OOB Network (Default Option)



If the datacenter OOB network is not available, the S55 switch can alternatively be connected to the S4810 switches for OOB connectivity to the datacenter, as show in Figure 13.

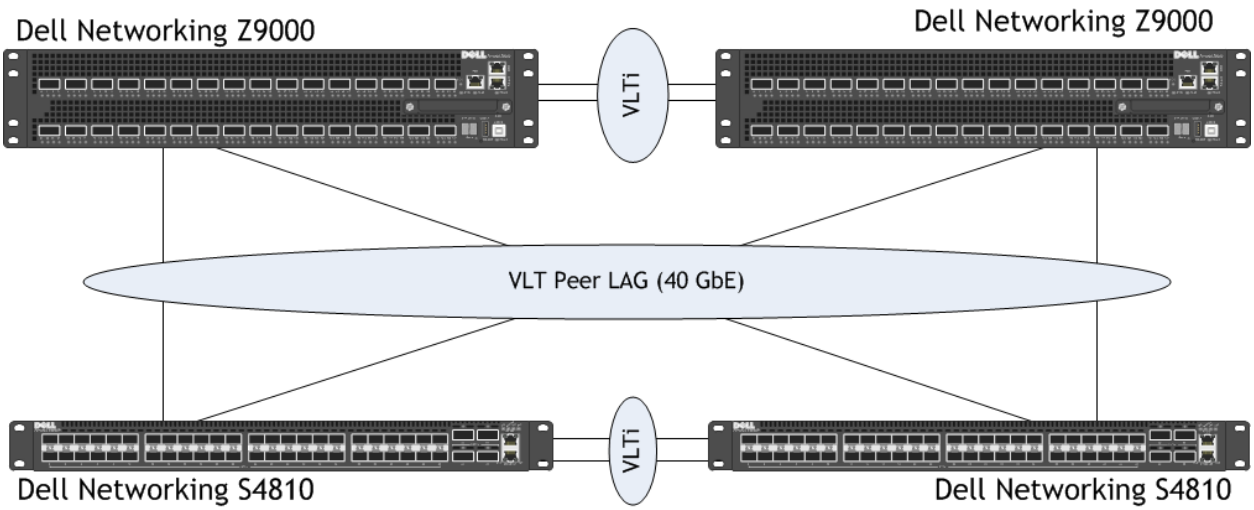
Figure 13: Alternative OOB Connectivity - S55 Switch to S4810 Switches



8.2 Connecting to a Dell Networking Datacenter Network

Figure 14 below demonstrates an example with Dell Networking Z9000 switches. The two Z9000 switches can be 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 14: Active System 1000m connectivity to Dell Networking Z9000 Switch

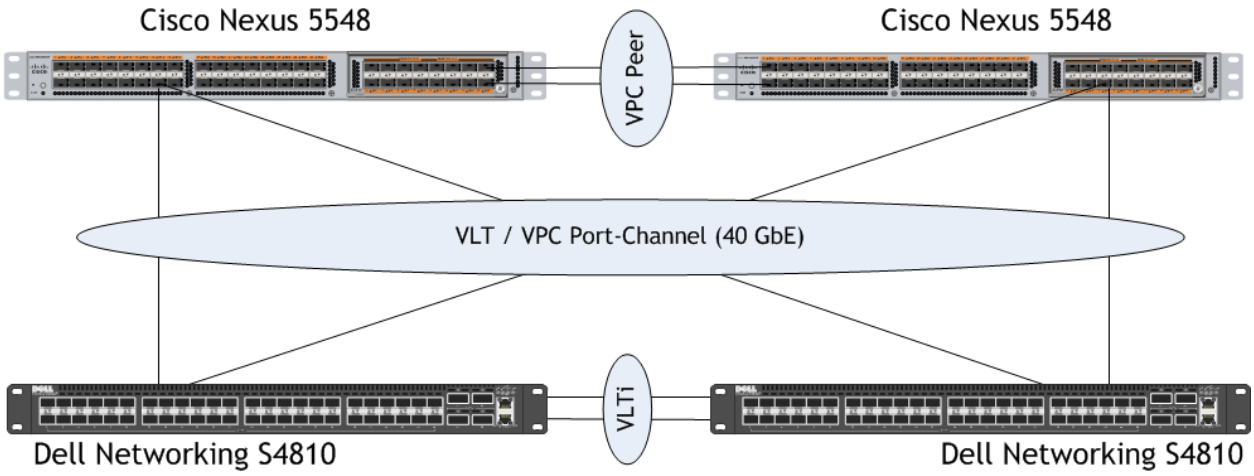


8.3 Connecting to a Cisco Nexus Datacenter Network

Figure 15 below demonstrates an example with Cisco Nexus 5548 switches. The Dell Networking S4810 switches in the Active System 1000 have a 4-port LAG/Port Channel linking into the two Cisco Nexus switches. The number of links is flexible and can be changed according to use cases. Also in this example, four ports were used for the vPC "Peer Link". The vPC Peer Link will be sharing VLAN traffic from the vPC uplinks, so they should be planned in an appropriate manner to avoid oversubscription. The "Peer Keep-Alive" link is suggested to be configured to utilize the management port (this is the default) and will send little layer 3 traffic between the switches.

The two Cisco Nexus 5000 Series switches are configured with vPC and a high availability aggregation pair.

Figure 15: Active System 1000m 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: This solution is configured with two S4810 network switches. Up to two PowerEdge M1000e chassis can be added to the two Dell Networking switches. In order to scale the compute nodes beyond two chassis, new S4810 switches need to be added.

Scaling Storage Resources: Compellent storage can be scaled seamlessly and independent of the compute and network architectures. Additional drives and enclosures can be added to the existing controllers. New volumes can be created or existing volumes can be expanded to utilize the capacity in the added enclosures. This design is currently limited to four additional enclosures in the single rack configuration and eight additional enclosures in the two rack configurations. The Compellent SC8000 controllers can scale up to a maximum of 960 drives. To scale beyond these limits, additional racks and controllers can be added to the solution and connected to the Brocade 6510 switches.

10 Delivery Model

This Reference architecture can be purchased as a complete solution, the Active System 1000m. This solution is available to be racked, cabled, and delivered to the customer site, to speed deployment. Dell Services will deploy and configure the solution tailored to the business needs of the customer and based on the architecture developed and validated by Dell Engineering. For more details or questions about the delivery model, please consult with your Dell Sales representative.

Figure 16 below shows the Active System 1000m solution with a single chassis and up to 16 compute hosts in a one rack configuration that also contains supporting Compellent storage. Figure 17 shows Active System 1000m with two chassis with up to 32 compute hosts and maximum of 16 storage enclosures in a two rack configuration. Figure 18 shows the configuration with one chassis and 16 compute hosts and four storage controllers available with the Active System 1000m solution. Note that switches shown in figures are shown mounted forward for representation. In actual use, ports face the back of the rack. PDUs shown are for illustration and will vary by region or customer power requirements. Additional PDUs are utilized within the rack.

Figure 16: Active System 1000m Rack and Component Overview

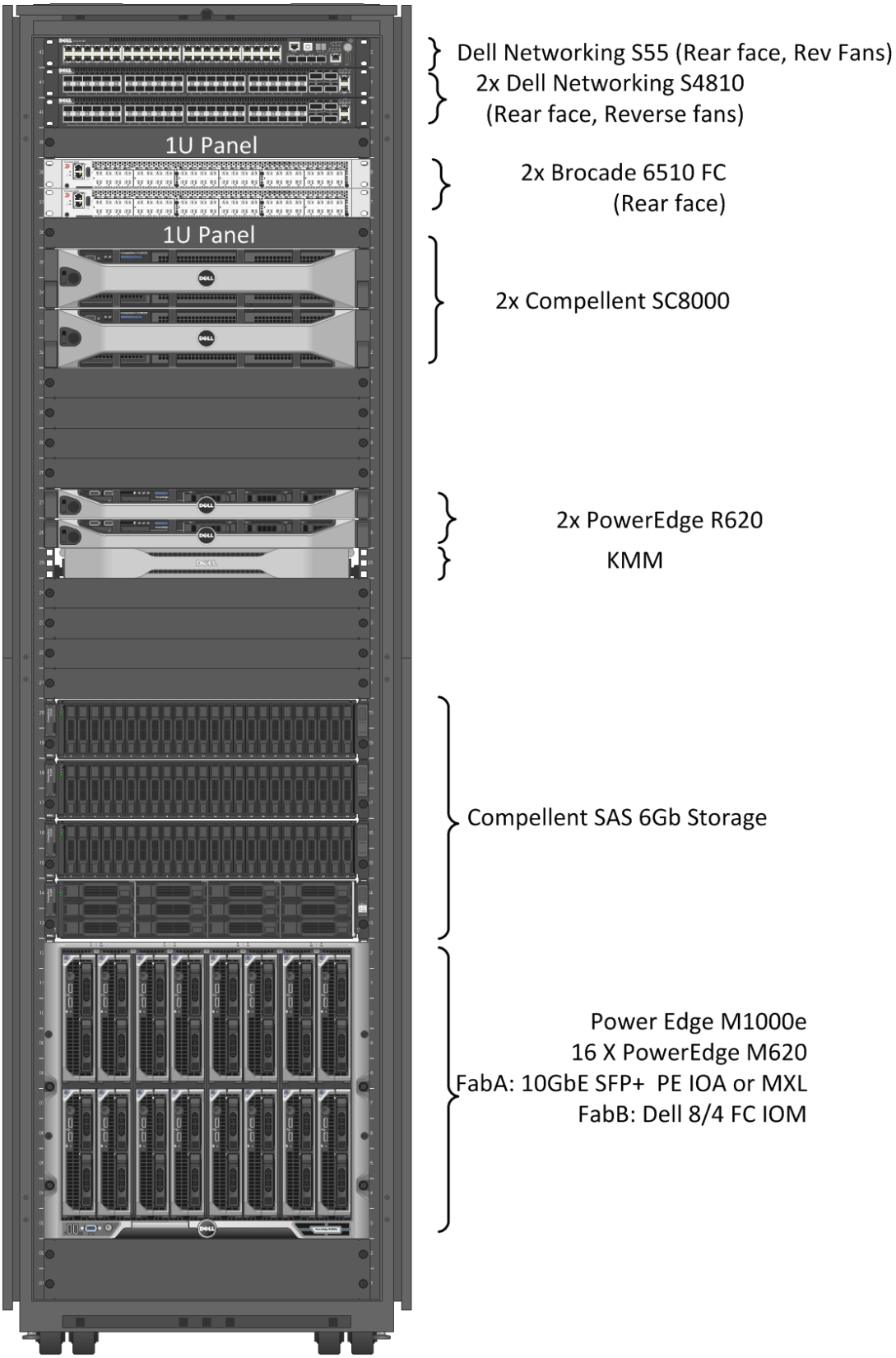


Figure 17: Active System 1000m Maximum 2 Rack Component Overview

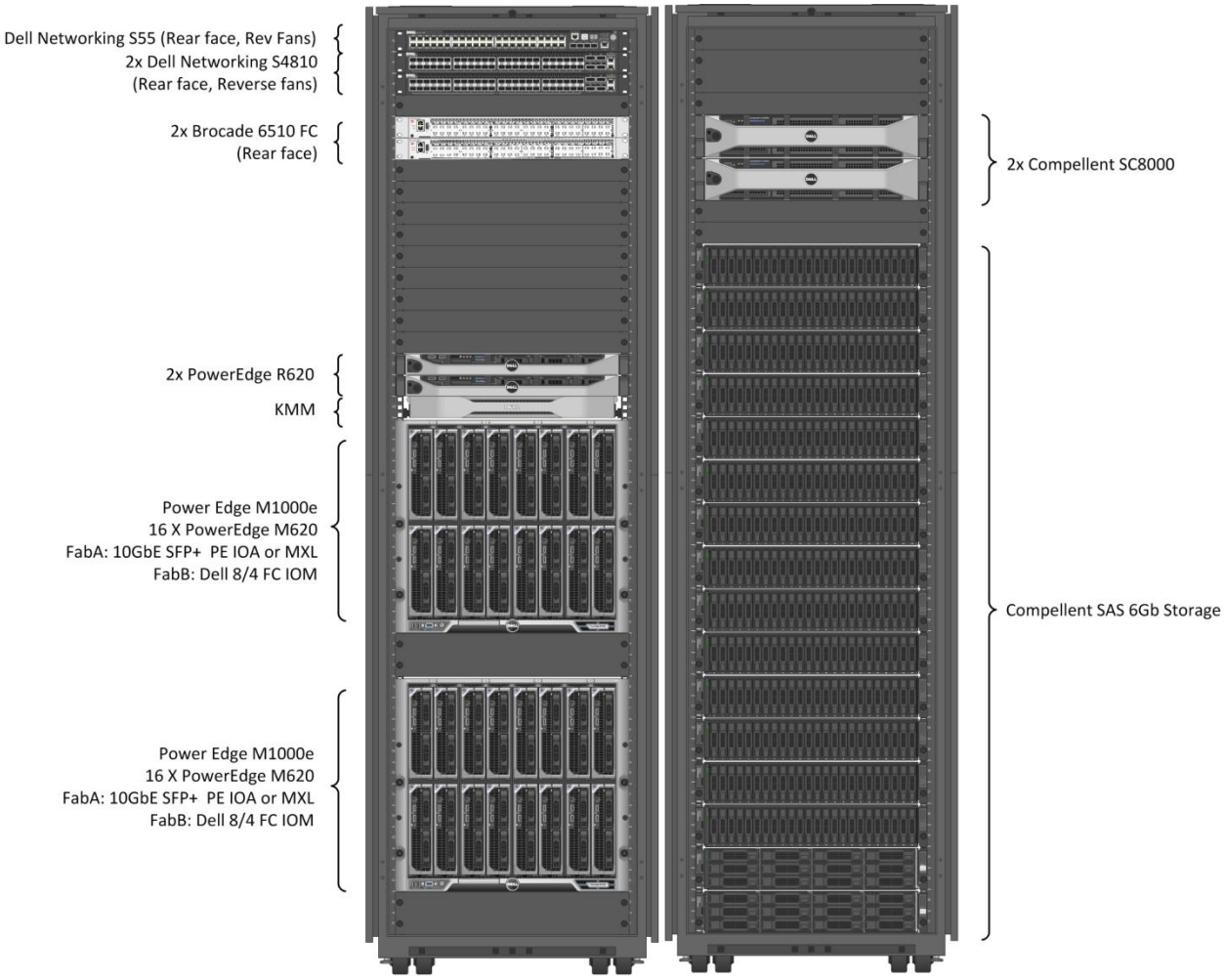
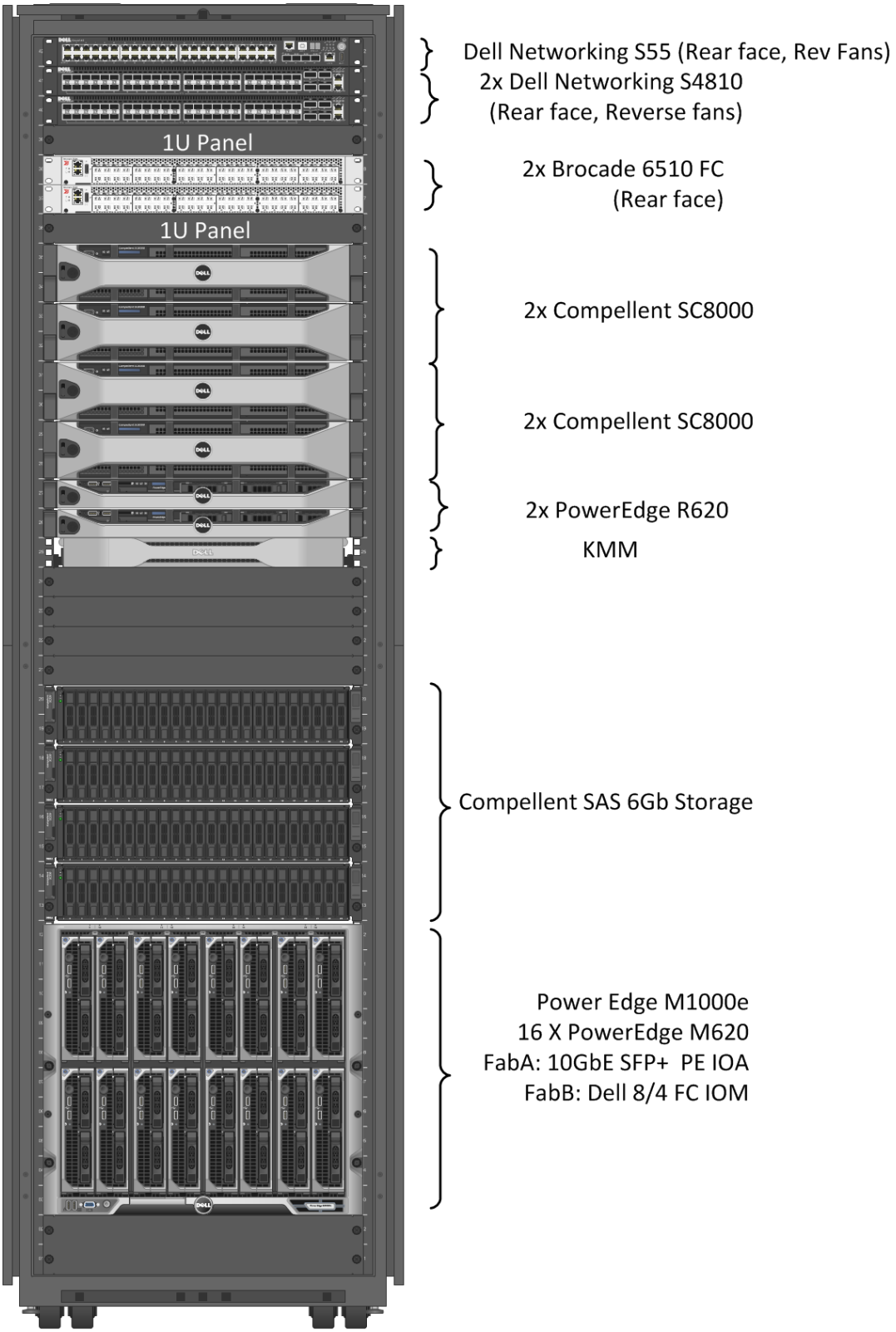


Figure 18: Active System 1000m Configuration for additional storage requirements: Rack Overview



11 Additional Supported Configurations

Dell Active System 1000 supports two additional network configurations. Dell Active System 1000 supports two additional network configurations. The customer can choose to have a Dell Networking S5000 (1U 10/40GbE LAN/SAN switch equipped with native FC and FCoE capabilities) switch as a LAN Top of Rack switch or a Cisco Nexus 5548 (1RU 10 Gigabit Ethernet, Fibre Channel, and FCoE) switch as LAN Top of Rack switch. These switches are not pre-racked with Active System 1000 solution.

11.1 Dell Networking S5000 as LAN Top of Rack Switch

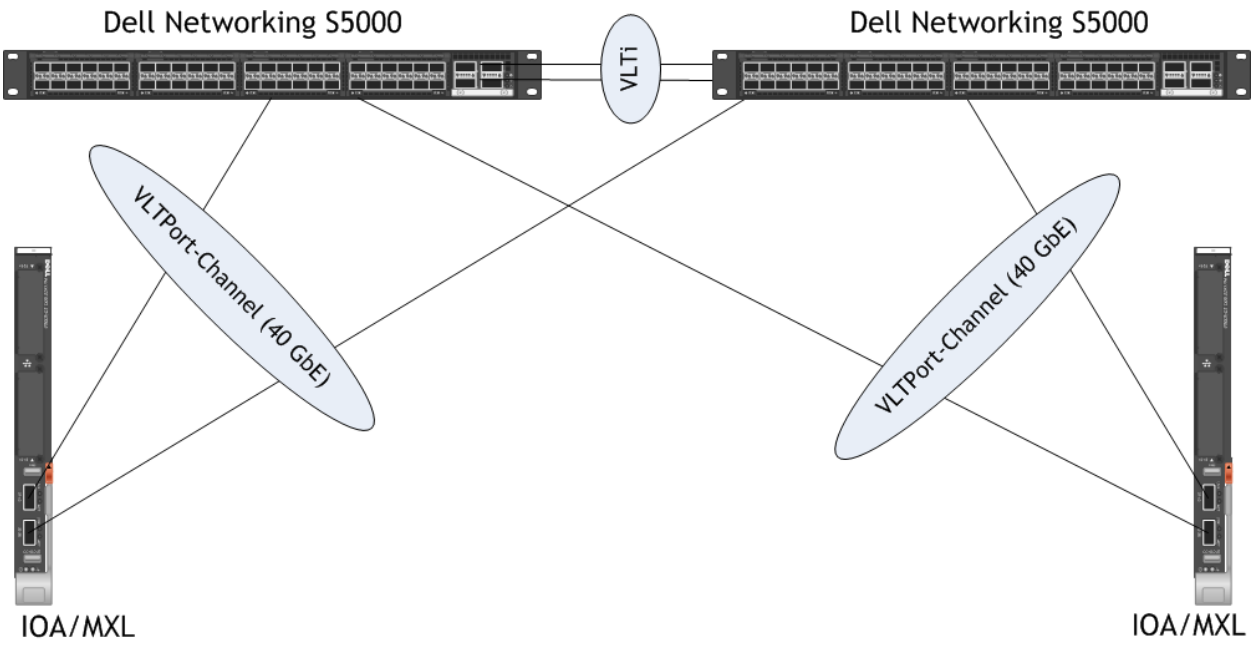
The Dell Networking S5000 is a first-of-its-kind modular, 1 rack unit (RU) 10/40GbE top-of-rack (ToR) LAN/SAN switch equipped with native FC and Fiber Channel over Ethernet (FCoE) capabilities. The S5000 switch's innovative system design is powered by an industry-hardened and feature-rich operating system for maximum dependability and uptime. Dell Open Automation framework provides integrated automation, scripting, and programmable management for enhanced network flexibility in virtualized environments.

Key features include:

- **Pay-as-you grow modularity, designed to scale** – provides for greater deployment flexibility and IT budget allocation compared to fixed-port switches. The S5000 switch accommodates four modules allowing customers to populate a single module and add modules as necessary instead of buying all four modules at once.
- **High-density LAN/SAN convergence** – saves on the number of switches and rack space required, the S5000 switch has up to 1.3 to 2.6 times the port density per rack unit compared to industry alternatives. The S5000 switch has a maximum of 64 x 10GbE ports, or 48 x Ethernet/FC ports with 16 x 10GbE ports.
- **Feature-rich storage networking** – complete support for iSCSI, RDMA over Converged Ethernet (RoCE), Network Attached Storage (NAS), FCoE, and FC fabric services, all on the same platform.
- **Future-proof design for maximum investment protection** – with the modularity and system design, the S5000 switch hardware is future-proofed to support newer features and options when released without needing to sacrifice existing infrastructure investment.
- Easy integration and proven interoperability with leading adapter, switch, and storage vendors including Broadcom, Brocade, Emulex, Intel, and Qlogic.

The connectivity between the Dell Networking S5000 switch and the blade I/O modules is similar to the connectivity between the S4810 switch and the blade I/O modules. The blade I/O modules connect to the S5000 ToR switch through the 40Gb ports on the I/O modules to 40Gb ports on the S5000 switch. The two Dell Networking S5000 switches are configured with Virtual Line Trunking (VLT) using two 40 Gbps QSFP+ links. VLT Interconnects are created between the two 40 Gbps QSFP+ ports, providing a path for communication across the switches. Figure 19 below shows the connectivity between S5000 switches and blade I/O modules.

Figure 19: Active System 1000m using S5000 as ToR Switch



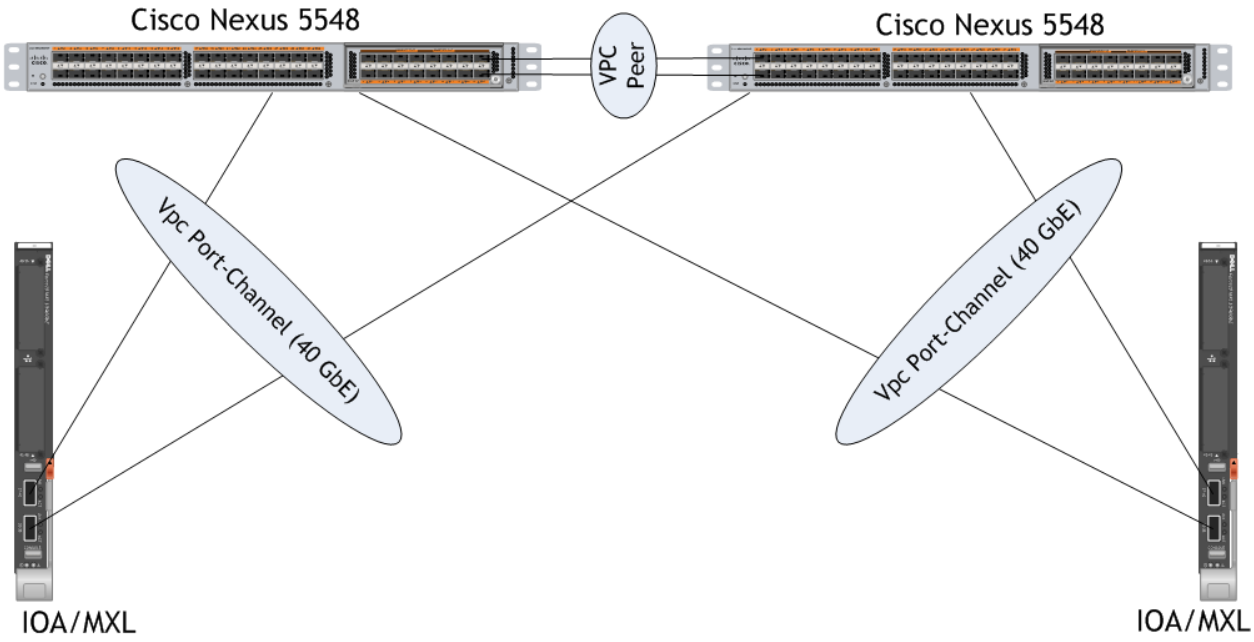
11.2 Cisco Nexus 5548 as LAN Top of Rack Switch

The Cisco Nexus 5548 is a 1RU 10 Gigabit Ethernet, Fibre Channel, and FCoE switch offering up to 960 Gbps of throughput and up to 48 ports. The switch has 32 fixed ports and one expansion slot. The Cisco Nexus 55000 Series switch enables consistent low-latency Ethernet solutions, with front-to-back or back-to-front cooling, and with data ports in the rear, bringing switching into close proximity with servers and making cable runs short and simple. The switch series is highly serviceable, with redundant, hot-pluggable power supplies and fan modules. It uses data center-class Cisco® NX-OS Software for high reliability and ease of management. The Cisco Nexus 5500 platform is well suited for enterprise-class data center server access-layer deployments across a diverse set of physical, virtual, storage-access, and high-performance computing (HPC) data center environments.

For more information on Cisco Nexus switches, see
http://www.cisco.com/en/US/products/ps9670/index.html.

The connectivity between the Cisco Nexus 5548 switch and the blade I/O modules is also similar to the connectivity between the S4810 switch and the blade I/O modules. The only difference is that the blade I/O modules connect to the Cisco Nexus 5548 switch using FC transceivers and FC breakout cables. The 40Gb ports on the I/O modules have a Dell 40Gb FC transceiver. The 40Gb FC breakout cables connect to the Cisco Nexus 5548 switches. The two Cisco Nexus 5548 switches are configured as vPC peers. The Dell I/O modules connecting to the Cisco Nexus 5548 are vPC port-channels with a throughput of 40Gbps. Figure 20 below shows the connectivity between Cisco Nexus 5548 switches and blade I/O modules.

Figure 20: Active System 1000m using Cisco Nexus 5548 as ToR Switch



12 Reference

12.1 Dell Active System Manager

Specification for the Dell Active System Manager can be found here.
http://content.dell.com/us/en/enterprise/d/shared-content~solutions~en/Documents~active-system-manager-spec-sheet.pdf.aspx

12.2 Dell Active Infrastructure Wiki

Wiki articles on Dell Active Infrastructure can be found here.
http://en.community.dell.com/techcenter/converged-infrastructure/w/wiki/default.aspx

12.3 Dell PowerEdge Server Documentation and Hardware/Software Updates

For Drivers and other downloads: Visit
http://www.dell.com/support/home/us/en/04?c=us&l=en&s=bsd, enter a server service tag or select "Servers, Storage & Networking" product category, then select the server model and operating system version.

12.4 Dell Virtualization Documentation

Dell TechCenter Microsoft Windows Server 2012 Blogs/Wiki Site:
http://en.community.dell.com/techcenter/os-applications/w/wiki/3458.microsoft-windows-server-2012.aspx

Microsoft® Windows Server® 2012 With Hyper-V™ for Dell™ PowerEdge™ Systems Important Information Guide:
http://support.dell.com/support/edocs/SOFTWARE/WS2012/

12.5 Microsoft® Hyper-V Documentation

Hyper-V Getting Started Guide:
http://technet.microsoft.com/library/hh846766.aspx

Hyper-V: Using Hyper-V and Failover Clustering:
http://technet.microsoft.com/library/hh831531

Building Your Cloud Infrastructure: Converged Data Center without Dedicated Storage Nodes
http://technet.microsoft.com/en-us/library/hh831829.aspx

12.6 Microsoft® Management Software

Microsoft System Center 2012:
http://www.microsoft.com/en-us/server-cloud/system-center/datacenter-management.aspx

System Center 2012 Virtual Machine Manager Deployment:
http://technet.microsoft.com/en-us/library/gg610669

12.7 Microsoft® Roles and Features

Failover Clustering in Windows Server 2012:
http://technet.microsoft.com/library/hh831579