FlexPod Datacenter with VMware vSphere 5.1 Update 1 and Cisco Nexus 9000 Series Switches

Overview

The IT industry today faces the challenge of transitioning to shared, virtualized, and cloud-based data center infrastructure for improved efficiency, agility, and cost-effectiveness. To enable this migration with reduced risk and cost, Cisco, in partnership with NetApp, has developed the FlexPod Datacenter solution. FlexPod is a predesigned unified computing, storage, and network infrastructure composed of Cisco Unified Computing System™ (Cisco UCS®) servers, Cisco UCS Manager, Cisco Nexus® switches, and NetApp fabric-attached storage (FAS) arrays. FlexPod Datacenter provides a standard, flexible building block that can be used to build an optimized data center to support a variety of workloads and applications.

Cisco, through its Cisco® Validated Designs, offers a comprehensive suite of pretested FlexPod Datacenter solutions, developed using various system components, configurations, and hypervisor and application software. Using a solution based on the Cisco Validated Design for FlexPod Datacenter as the baseline platform, IT customers can deploy a virtualized and cloud-enabled data center quickly, with low risk and cost. The FlexPod Datacenter solution described in this document implements a storage system based on IP storage protocols, eliminating the cost and complexity associated with traditional Fibre Channel–based data center storage infrastructure.

Benefits of the Cisco Validated Design for FlexPod Datacenter with Cisco Nexus 9000 Series Switches and IP-Based Storage

- **Reduced risk:** Prevalidated configurations help ensure proper deployment of the current applications on the new infrastructure.
- **Accelerated deployment:** Unified and standard architecture reduces transition downtime. Flexibility: A wide variety of applications and workloads are supported through proven hardware and software combinations.
- **Scalability:** Modular architecture supports future expansion through scale-up and scale-out strategies.
- **Lower total cost of ownership (TCO):**
  - IP storage protocols provide simple and cost-effective storage solutions.
  - Standardized architecture reduces management and training overhead.
  - Modular infrastructure enables IT to build a right-sized data center and avoid underutilization of resources.
  - Pretested solutions reduce deployment, procurement, and setup times

FlexPod Datacenter Design Elements

FlexPod is a unified data center platform composed of Cisco UCS servers, Cisco Nexus network switches, and NetApp storage array elements, as shown in Figure 1. The FlexPod modules can be configured to support a variety of applications by mixing and matching the component families and versions to achieve optimal capacity, price, and performance targets. The solution can be scaled by augmenting the elements of a single FlexPod Datacenter instance and by adding multiple FlexPod Datacenter instances to build numerous solutions for virtualized and nonvirtualized data centers.

Figure 1. FlexPod Datacenter Design Elements
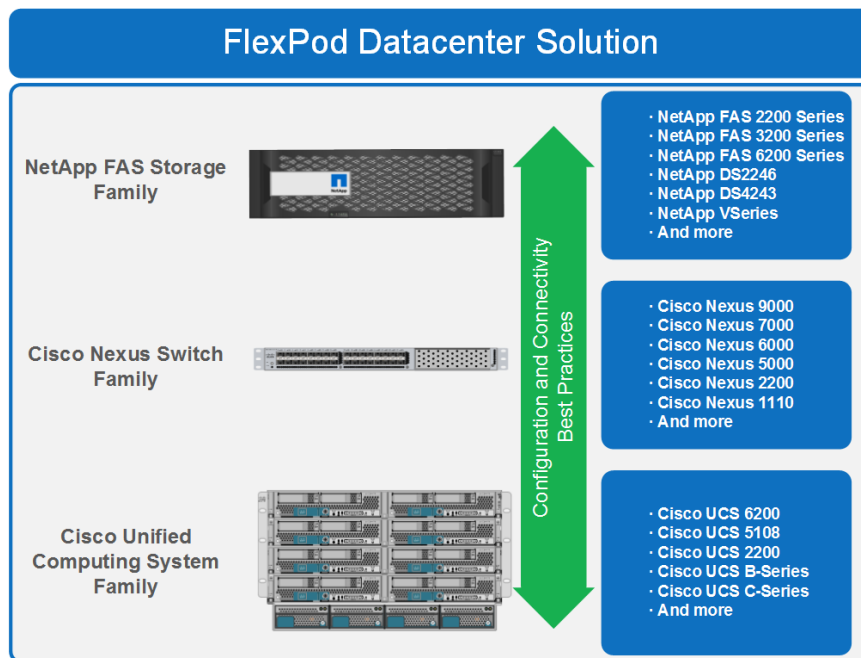
Cisco UCS Family

Cisco UCS is a next-generation data center platform that unites computing, networking, and storage access and virtualization into a cohesive server system for superior performance and cost-effectiveness. All resources participate in a unified management domain in an integrated multichassis platform. The system integrates a low-latency, lossless 10 Gigabit Ethernet unified network fabric with enterprise-class, x86-based servers. This platform is composed of Cisco UCS B-Series Blade Servers and C-Series Rack Servers, fabric interconnects, blade server chassis, and adapter connectivity.

Cisco UCS fabric interconnects are the communication and management backbone for the Cisco UCS solution, providing LAN and SAN connectivity to the server blades. The fabric interconnects connect the Cisco UCS B-Series and C-Series servers (optionally connected through Cisco Nexus 2200 platform fabric extenders or directly to the fabric interconnects) and the blade server chassis to form a unified fabric, which becomes a single management domain, providing high availability and simplicity of management.

Cisco UCS B-Series Blade Servers are an enterprise-class computing platform designed to deliver a broad range of IT workloads, from web infrastructure to distributed databases, efficiently.

Cisco UCS C-Series Rack Servers extend the unified computing model to further increase scalability and business agility. The C-Series implements innovative technologies, including a standards-based unified network fabric.

Cisco Data Center Virtual Machine Fabric Extender (VM-FEX) virtualization, and Cisco Extended Memory Technology are supported by the Cisco B-Series and C-Series.

Cisco UCS Manager device management software enables unified management of the entire computing environment. It provides role-based and policy-based management by using the service profiles of the resources, reducing maintenance overhead.

Cisco UCS Central Software supports multiple data centers by centrally managing multiple Cisco UCS domains and resources.

Cisco UCS Director for FlexPod Datacenter simplifies management through centralized automation from a unified, single view.

For more information about Cisco UCS servers, refer to www.cisco.com/en/US/products/ps10265/index.html.

Cisco Nexus Switches

The Cisco Nexus family of switches forms the networking foundation for a FlexPod Datacenter deployment. These switch platforms consist of Layer 2 and 3 nonblocking Ethernet switches with the ability to support Fibre Channel over Ethernet and enable a unified data center–class platform. They help transform the data center network into a standards-based, multipurpose, multiprotocol, Ethernet-based fabric. All switches in the Cisco Nexus family use the Cisco NX-OS Software operating system.

The Cisco Nexus 9000 Series Switches used in this FlexPod Datacenter validation are state-of-the-art switches that form the foundation for Cisco's Application Centric Infrastructure (ACI). ACI is a holistic architecture with centralized automation and policy-driven application profiles. It offers a comprehensive platform for a next-generation, virtualized, scalable data center core network with centralized management.

The Nexus 9000 Series provides flexibility by supporting existing traditional switches while also offering a migration path to the Cisco ACI based data center. It offers both modular (9500 level) and fixed (9300 level) switches to support two modes of operation: NX-OS standalone mode and ACI mode.

In standalone mode, the Nexus 9000 Series provides state-of-the-art switch capabilities, including high port density, low latency, and 40 Gigabit Ethernet connectivity.

In ACI mode, the Nexus 9000 Series runs in fabric mode, which enables centralized automation and management through application-driven policy profiles and multi-tenancy in hardware.

Note that this Cisco Validated Design uses the standalone mode of the Nexus 9000 Series only.

The primary features of the Cisco Nexus 9000 Series include:

- Modular and fixed-port switch configurations: Enable a cost-effective, high-performance, application-centric infrastructure.
- Nonblocking 10/40 Gigabit Ethernet configurations: Help provide a seamless transition to support increased bandwidth demands of scale-out, multimode application environments.
- Predictable high performance: Delivers up to 60 terabytes per second with a latency of less than 5 microseconds to enable data centers that can be scaled to more than 200,000 server ports.

- Flexible and power-efficient chassis: The chassis design, with a superior airflow model, offers future expansion through the ability to add high-bandwidth line cards and fabric modules and power supplies.

- Seamless migration toward ACI: The architecture supports a traditional switch mode of operation (using the standalone configuration) with flexibility to migrate to the fabric mode of operation through an ACI configuration.

- Link aggregation and resiliency: Along with Cisco UCS, the switches support active port channeling using the Link Aggregation Control Protocol and virtual PortChannel capability and offer excellent link fault tolerance and load balancing.

- Operational continuity: Integrates hardware, Cisco NX-OS features, and management to support zero-downtime environments.

For more information about the Cisco Nexus 9000 Series, refer to http://www.cisco.com/c/en/us/products/switches/nexus-9000-series-switches/index.html.

NetApp FAS Storage

NetApp FAS forms the scalable storage element in a FlexPod Datacenter platform. Using the NetApp Data ONTAP operating system, this FlexPod design supports both the Data ONTAP 7-Mode and the Clustered Data ONTAP Mode. Both operating system modes support SAN (Fibre Channel, iSCSI) and network-attached storage (NAS) (CIFS, NFS), and enable primary and secondary storage in a single unified platform so that all virtual desktop data components can be hosted on the same storage array.

The NetApp FAS2000 Series and FAS3000 Series support midsize enterprises, and the FAS6000 Series supports large enterprises. The NetApp FAS storage controllers provide hot-swappable, redundant components with fault tolerance through clustered storage controllers that offer scalability of up to several terabytes (TB).

For additional information about NetApp storage systems, refer to:
http://www.netapp.com/us/products/storage-systems.

Cisco Validated Design for FlexPod Datacenter with Cisco Nexus 9000 Series Switches: New Features
- The solution includes Cisco Nexus 9000 Series Switches, which form the foundation for Cisco ACI and enable seamless and easy migration to a future ACI-based data center architecture.
- Through a single IP-based storage architecture, the solution supports both NAS datastores and iSCSI-based SAN logical unit numbers (LUNs) to create an Ethernet-based cost-effective data center module.
- Cisco UCS service profiles support iSCSI boot of native operating systems and, along with unified storage, deliver on-demand stateless computing resources to enable a highly scalable architecture.
- Cisco Nexus 9000 Series provides end-to-end IP-based storage supporting SAN using iSCSI.
- NetApp FAS storage systems support flash memory and enterprise clustering to build agile, scalable, shared storage infrastructure.
- The latest release of the NetApp Data ONTAP 8.2 operating system supports the 7-Mode and the Clustered Data ONTAP Mode of operation, offers unified scale-out storage deployment with up to tens of petabytes of storage, and supports midsize to large enterprises.
- VMware vSphere 5.1U1, coupled with NetApp Virtual Storage Console (VSC), offers an end-to-end virtual machine management system and enables awareness for VMware vSphere environments running on top of NetApp storage.

Cisco Validated Design for FlexPod Datacenter

The Cisco Validated Design for FlexPod Datacenter validates the cohesive operation of industry-standard hypervisors and applications running on various FlexPod Datacenter configurations. Figure 2 provides a comprehensive list of supported hypervisors, management, and FlexPod Datacenter design elements and versions.

The highlighted components make up the Cisco Validated Design described in this solution brief. This Cisco Validated Design illustrates a typical FlexPod Datacenter architecture with shared storage using IP storage protocols such as iSCSI, CIFS, and NFS and provides a simple, cost-effective solution compared to a traditional Fibre Channel SAN architecture. The objective of this verification is to functionally validate the FlexPod Datacenter solution with IP-based storage architecture that can support VMware vSphere 5.1 Update 1 (U1), VMware vCenter with NetApp plug-ins, and NetApp OnCommand.

This FlexPod Datacenter architecture serves as the foundation for an end-to-end IP-based storage solution that can migrate to an ACI-based data center in the future. It supports SAN access using iSCSI. The solution provides 10 and 40 Gigabit Ethernet capable uplinks to the Cisco UCS fabric interconnects and the NetApp FAS storage controllers and provides an extendable VMware vSphere solution for mixed workloads and applications.

Figure 2. Components of the Cisco Validated Design for FlexPod with Nexus 9000 Series Switches and IP-Based Storage
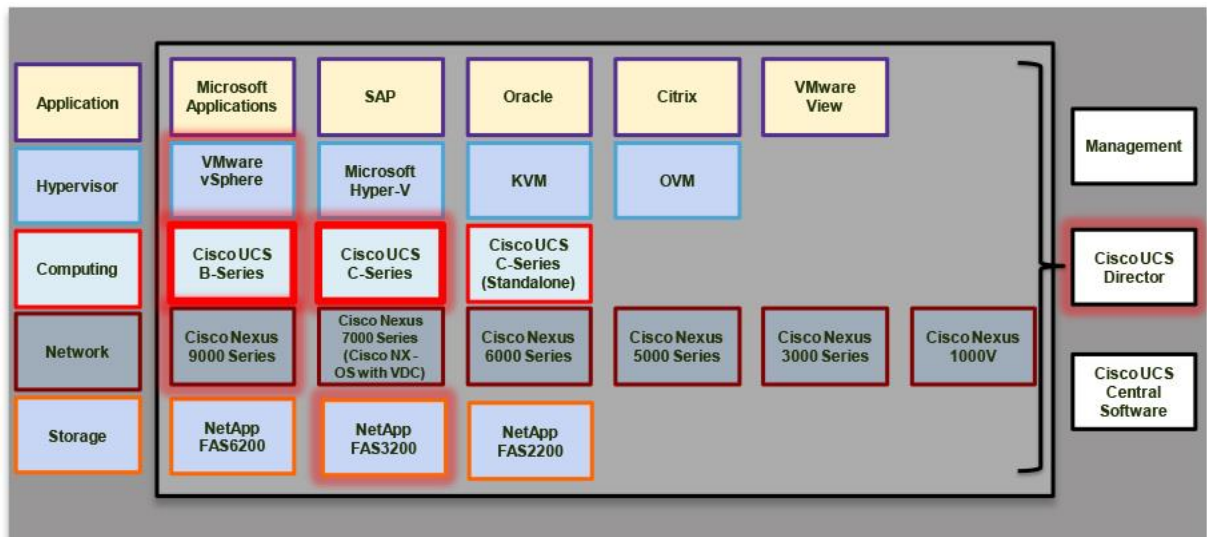
This FlexPod Datacenter with IP-based storage reference architecture includes the Cisco UCS C-Series servers with the Cisco UCS Virtual Interface Card (VIC), the Cisco UCS B-Series servers, the Cisco Nexus 9000 Series Switches, the Cisco Nexus 2232 10 Gigabit Ethernet fabric extenders, and the NetApp FAS3200 family of storage controllers.

The FlexPod Datacenter design elements support active port channeling using 802.3d standard Link Aggregation Control Protocol (LACP) to achieve load balancing and fault tolerance. The reference architecture uses Cisco virtual PortChannel (vPC) technology for link aggregation across the two physical switches. The architecture also uses Cisco UCS service profiles to support iSCSI boot-up of the native operating system and enables iSCSI-booted hosts with file-level and block-level access to IP-based data stores. It uses IP-based storage features such as iSCSI boot-up of Cisco UCS hosts; virtual machine data store provisioning through NFS; and application access

though iSCSI, CIFS, or NFS while using NetApp FAS unified storage. Ethernet-based storage is achieved in a simple and unified manner by using features such as virtual interfaces and virtual LANs, which provide superior performance compared to the traditional Fibre Channel–based storage.

This infrastructure provides iSCSI-booted hosts with file-level and block-level access to shared storage data stores. It addresses the design considerations for an Ethernet storage system to increase the performance of servers for storage systems.

VMware vSphere 5.1U1 features used in this validation include VMware ESXi and vCenter Server. VMware vSphere along with NetApp VSC provide end-to-end virtual machine management.

The hardware components used in the reference design for VMware vSphere 5.1U1 on FlexPod Datacenter with IP-based storage include:

- Two Cisco Nexus 9000 Series Switches
- Two Cisco Nexus 2232 fabric extenders
- Two Cisco UCS 6248UP 48-Port Fabric Interconnects
- Cisco UCS C220 Rack Servers
- Cisco UCS B-Series Blade Servers
- NetApp FAS3250-AE (high-availability pair)

The FlexPod Datacenter storage configurations used in this validation effort are:

- FlexPod Datacenter with Cisco Nexus 9000 Series standalone design with NetApp Clustered Data ONTAP Mode
- FlexPod Datacenter with Cisco Nexus 9000 Series standalone design with NetApp Data ONTAP operating in 7-Mode

Figures 3 and 4 illustrate the FlexPod Datacenter configurations for IP-based storage in the NetApp Clustered Data ONTAP Mode and the NetApp Data ONTAP 7-Mode, respectively, and show the design elements used in each mode. Note that the configurations of Cisco UCS and Cisco Nexus elements are identical in both topologies. The FlexPod Datacenter architecture uses an Ethernet virtual device context on each Cisco Nexus 9000 Series Switch to provide virtualization and operational efficiency to the data center infrastructure.

The NetApp FAS controller topology is different in these two configurations. In NetApp Clustered Data ONTAP Mode, Cisco Nexus 5596UP Switch cluster interconnects are used as shown in Figure 3, to network the NetApp FAS controllers and the disk storage to create a storage pool. These clustered storage pools can easily be scaled out to multiple petabytes by adding storage capacity to an existing high-availability pair or by adding additional storage clusters.

In NetApp Data ONTAP 7-Mode, the disk storage connects to the NetApp FAS controllers using dedicated links, as shown in Figure 4. The FlexPod Datacenter design can support Cisco UCS C-Series Rack Servers using single-wire management, providing further consolidation of the infrastructure and improved rack-mount server density.

Figure 3.   VMware vSphere 5.1U1 Built on FlexPod Datacenter with IP-Based Storage and Nexus 9000 Series in Standalone Mode: NetApp Clustered Data ONTAP Mode
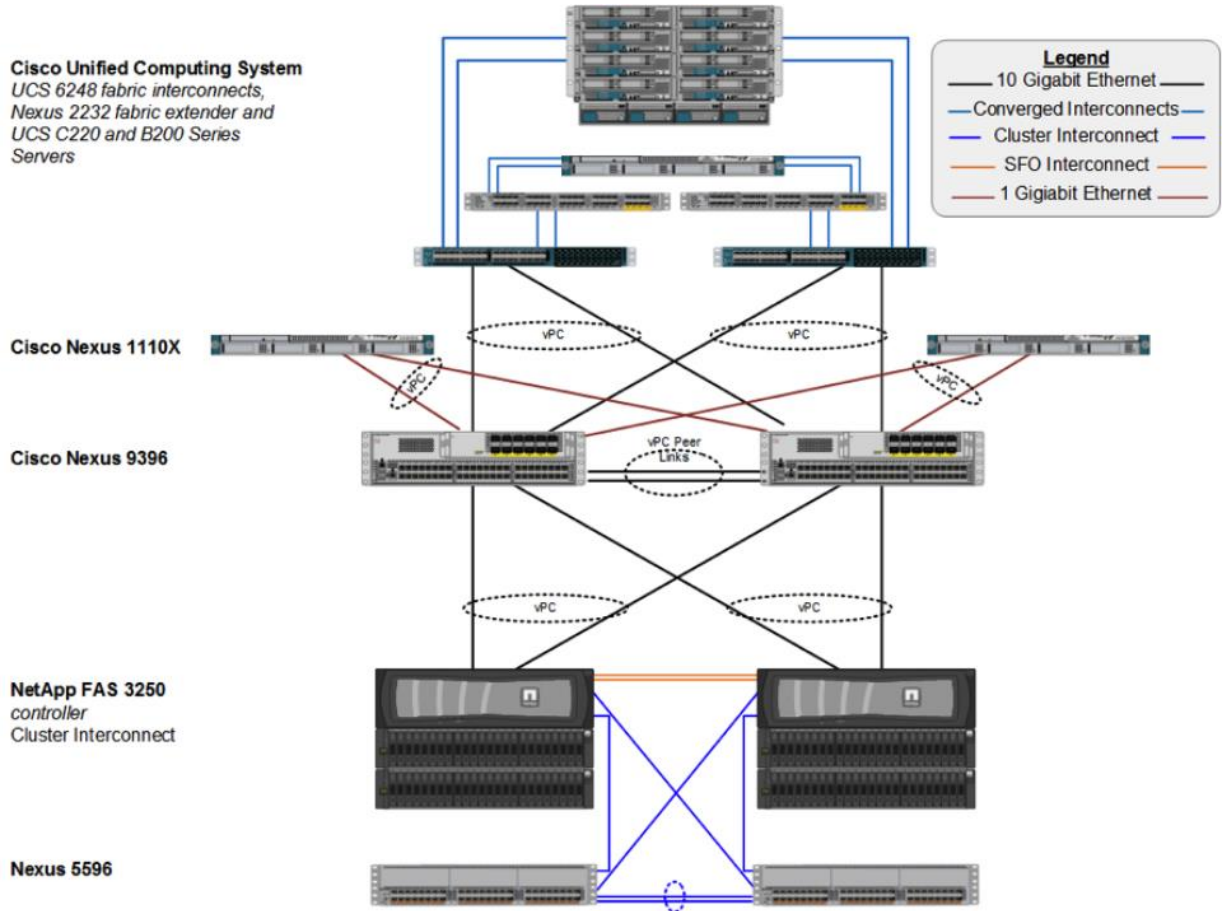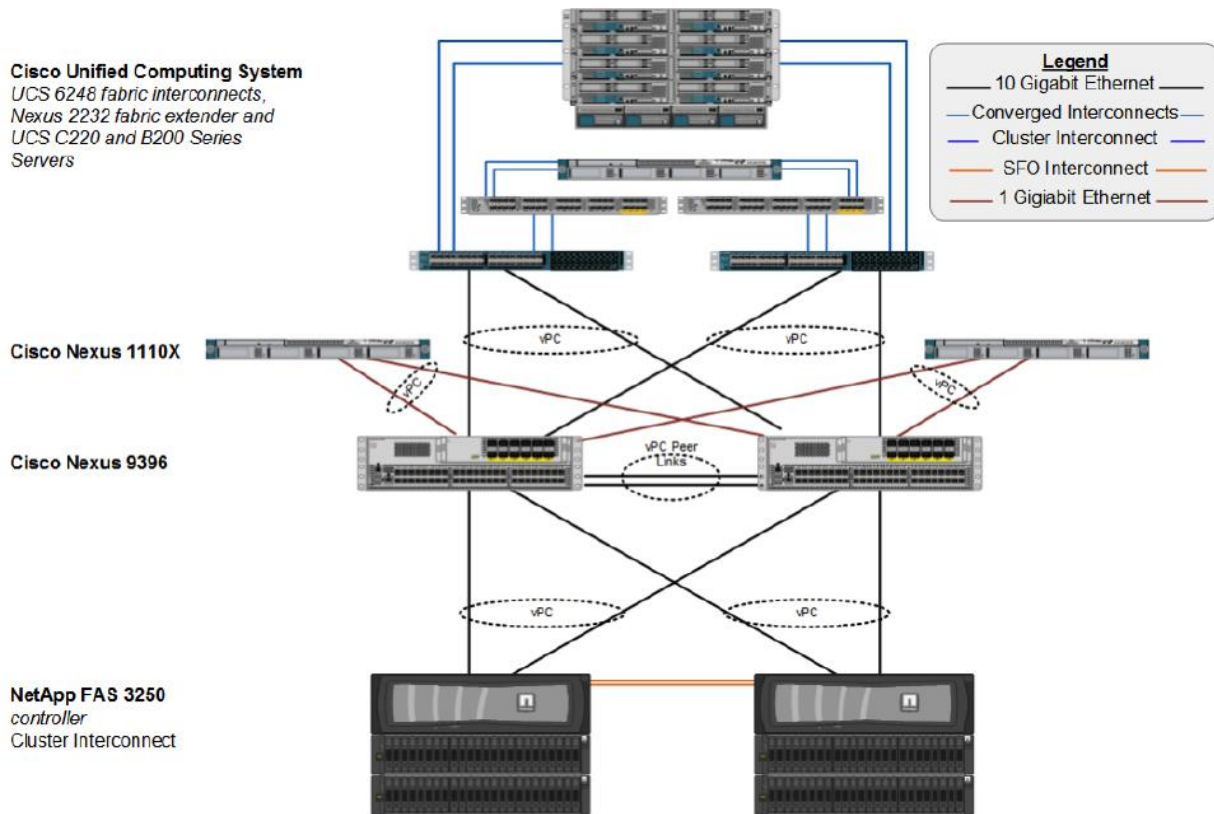
Figure 4. VMware vSphere 5.1U1 Built on FlexPod Datacenter with IP-Based Storage and Cisco Nexus 9000 Series in Standalone Mode: NetApp Data ONTAP Operating in 7-Mode

Hardware and Software Versions Used in the Cisco Validated Design for VMware vSphere 5.1U1 on FlexPod Datacenter with IP-Based Storage

Table 1 lists the hardware and software versions used in the Cisco Validated Design VMware vSphere 5.1 on FlexPod Datacenter with IP-Based Storage.

Table 1.   Hardware and Software Versions

Layer	Device	image	Comments
Compute	Cisco UCS 6200 Series Fabric Interconnects, UCS B200 M3, UCS C220 M3	2.1(3a)	Includes the Cisco UCS-IOM 2208XP, Cisco UCS Manager, and UCS VIC 1240
	Cisco eNIC	2.1.2.38	
	Cisco Nexus 1000v	4.2(1)SV2(2.1a)	
	Cisco Nexus 1110-X	4.2(1)SP1(6.2)	
Network	Cisco Nexus 1110-X	4.2(1)SP1(6.2)	
Storage	NetApp FAS 3250-AE	Data ONTAP 8.2 P5	
	Nexus 5596 Cluster Switches	5.2(1)N1(1)	
Software	VMware vSphere ESXi	5.1U1	
	VMware vCenter	5.1U1	
	OnCommand Unified Manager for Clustered Data ONTAP	6	
	NetApp Virtual Storage Console (VSC)	Console (VSC)	
	Cisco UCS Director	4.1	

In addition to the configurations discussed so far, FlexPod supports a wide range of other hardware and software versions. To verify support for a specific implementation of FlexPod and to identify compatible hardware and software configurations, refer to the following compatibility guides:

- NetApp Interoperability Matrix Tool: http://support.netapp.com/matrix/
- Cisco UCS Hardware and Software Interoperability Tool: www.cisco.com/web/techdoc/ucs/interoperability/matrix/matrix.html
- VMware Compatibility Guide: www.vmware.com/resources/compatibility/search.php

Note: The FlexPod Cooperative Support model applies to both the FlexPod Datacenter architecture component versions validated in this Cisco Validated Design and the individual component versions listed as supported in the interoperability matrix. Cooperative support is available for all FlexPod components and versions so long as customers have purchased the appropriate levels of support contracts. This approach allows customization of the FlexPod Datacenter solution according to the organization's specific requirements.

Conclusion

FlexPod Datacenter is an integrated, standardized, and prevalidated data center module that can be used to build a right-sized data center for a variety of IT applications. Its flexible architecture is composed of Cisco UCS servers, Cisco Nexus network switches, and NetApp FAS arrays. By selecting the appropriate versions of these design elements, the customer can deploy a flexible and scalable data center optimized to meet the customer's workload requirements. The Cisco Validated Design discussed in this document focuses on the case in which VMware vSphere 5.1U1 is run on FlexPod Datacenter with Nexus 9000 Series switches to provide an end-to-end IP-based shared storage solution. Using this Cisco Validated Design for FlexPod Datacenter as the foundation, customer IT departments can transition to a Cisco ACI-based virtualized data center implementing an IP-based shared storage system in a cost-effective manner.

For More Information

FlexPod Datacenter with VMware vSphere 5.1U1 and Cisco Nexus 9000 Series Switches deployment guide: http://www.cisco.com/c/dam/en/us/td/docs/unified_computing/ucs/UCS_CVDs/flexpod_esxi51_n9k_design.pdf

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