Technical Report

FlexPod Solutions Guide

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In Collaboration with Cisco

Industry trends indicate a vast data center transformation toward shared infrastructures. Enterprise customers are moving away from silos of information toward shared infrastructures and virtualized environments, and eventually toward cloud computing to increase agility and reduce costs. This transformation appears daunting and complex because companies must address both organizational and technical resistance to this new IT model. Cisco® and NetApp® have developed FlexPod® to address these virtualization needs and to simplify the evolution to shared, virtualized, and cloud infrastructures.

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1 Introduction

Industry trends indicate a vast data center transformation toward shared infrastructures. Enterprise customers are moving away from silos of information toward shared infrastructures and virtualized environments and eventually toward cloud computing to increase agility and reduce costs. This transformation appears daunting and complex because companies must address both organizational and technical resistance to this new IT model. Cisco and NetApp have developed FlexPod to address these virtualization needs and to simplify the evolution to shared, virtualized, and cloud infrastructures.

FlexPod is a predesigned base configuration that is built on the Cisco Unified Computing System™ (Cisco UCS®), Cisco Nexus® data center switches, NetApp FAS storage components, and software from a range of partners. FlexPod can scale up for greater performance and capacity, or it can scale out for environments that need consistent, multiple deployments. FlexPod is a baseline configuration, but it also has the flexibility to be sized and optimized to accommodate many different business solutions. This document describes how to build several different solutions on top of FlexPod.

Cisco and NetApp have developed FlexPod as a platform that can address current data center needs and simplify the evolution toward an IT-as-a-service (ITaaS) infrastructure.

FlexPod serves as a base infrastructure layer for a variety of IT solutions. A number of solutions built on FlexPod can be found at www.netapp.com/us/technology/flexpod.

Authorized partners can access the FlexPod Implementation Guide, located at the NetApp Field Portal.

1.1 FlexPod Design

Cisco and NetApp have provided documentation for best practices and the deployment collateral necessary to build the FlexPod shared infrastructure stack. As part of the FlexPod offering, Cisco and NetApp have designed a reference architecture with a technical specifications sheet that is highly modular, or podlike. Although each customer's FlexPod unit can vary in its exact configuration to meet their initial use case, once a FlexPod unit is built, it can easily be scaled as requirements and demand change. This includes scaling both up (adding additional resources within a FlexPod unit) and out (adding FlexPod units).

Specifically, FlexPod is a defined set of hardware and software that serves as a foundation for data center deployments. FlexPod includes NetApp storage, Cisco networking, and the Cisco UCS in a single package. The solution can be scaled, while still maintaining its integrity, by augmenting a single FlexPod instance to provide the appropriate network, compute, or storage capacity needed within a single pod or by using the port density of the Cisco Nexus 5000 networking platform to readily accommodate multiple instances of FlexPod. In either case, the flexibility of the pod construct allows numerous solutions to be built on top of one or more FlexPod configurations, providing enterprise flexibility, supportability, and manageability for both virtualized and nonvirtualized environments. Figure 1 shows a base FlexPod configuration with hardware families and solution benefits.

Figure 1) FlexPod components.

The base hardware, which is detailed in the FlexPod technical specifications, includes:

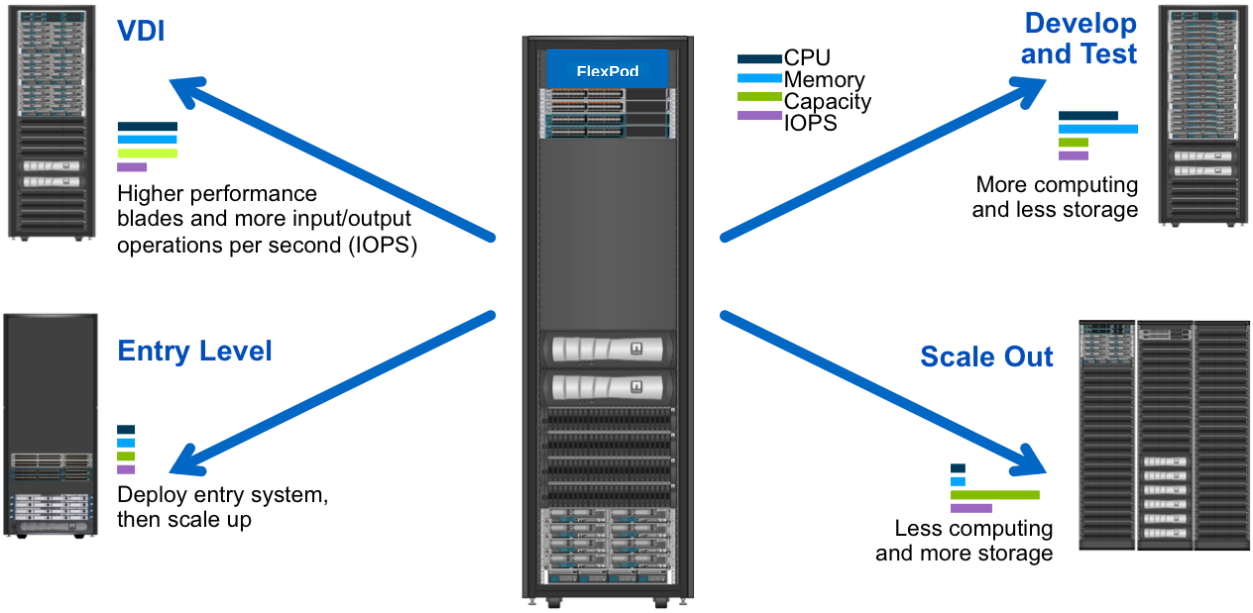
- Two Cisco Nexus switches
- Two Cisco UCS 6248UP fabric interconnects
- Cisco UCS B-Series blades with two fabric extenders per chassis, and/or Cisco UCS C-Series rack servers (C-Series servers also required the Cisco Nexus 2232PP Fabric Extenders)
- NetApp FAS3250 (highly available configuration with dual controllers and dual enclosures)

Storage is provided by a NetApp FAS3250 with accompanying disk shelves. All systems and fabric links feature redundancy, providing end-to-end HA. Although this is the default base design, each of the components can be scaled flexibly to support the customer's specific business requirements. For example, more (or different) blades and chassis can be deployed to increase compute capacity, additional disk shelves can be deployed to improve I/O capacity and throughput, or special hardware or software features can be added to introduce new features, such as NetApp Flash Cache™ for deduplication-aware caching.

Note: If your FlexPod includes clustered Data ONTAP, you will also need a pair of cluster interconnects.

FlexPod can scale up for greater performance and capacity, or it can scale out for environments that need consistent, multiple deployments. Figure 2 shows a few FlexPod scaling options. FlexPod is a baseline configuration, but it also has the flexibility to be sized and optimized to accommodate many different use cases.

Figure 2) Example of scaling a FlexPod configuration.



1.2 Target Audience

This document describes the basic architecture of FlexPod as well as several solutions that can be built on FlexPod. The target audience for this document includes, but is not limited to, sales engineers, field consultants, professional services, IT managers, partner engineering, and customers who want to deploy solutions on top of a FlexPod configuration.

2 Business Benefits

FlexPod solutions offer a variety of business benefits to the consumer. This section describes some of these benefits at a high level.

2.1 Repeatable

The FlexPod architecture and accompanying collateral, delivered by Cisco and NetApp, aid customers, partners, and field personnel with new FlexPod deployments. This configuration provides documentation about sample workloads, required port count, power consumption, and required cooling. For customers who want standard scalable configurations, FlexPod is an excellent choice for their infrastructures because environmental requirements are defined.

2.2 Flexible

One of the founding principles of the FlexPod program is flexibility. The reference architecture serves as a starting point for a variety of workloads but is not mandated as the only way to bundle the FlexPod products. Customers can modify server type and count, storage type and scale, and network switches, for example, based on their specific needs.

2.3 Right-Sized and Scalable

The reference architecture is outlined in detail in TR-3151: FlexPod Data Center Solutions Sizing Guide, which is a starting point for building and sizing shared infrastructure solutions.

The sizing of the reference architecture is based on a design principle of supporting concurrent workloads on a right-sized platform. The FlexPod architecture is designed to concurrently support various applications and use cases such as VMware View™, Microsoft® Exchange Server 2010, Microsoft SharePoint® 2010, SAP®, and many others.

Depending on their application requirements, customers can choose the appropriate hardware for their deployments. This allows them to avoid purchasing an infrastructure stack that is underused.

Note: The sizing data covers typical enterprise workloads; however, individual customers might have lighter or heavier workloads related to the greater headroom required for growth or during system failure. Take these factors into consideration when sizing for individual customers.

2.4 Lower Total Cost of Ownership

Because the FlexPod architecture is repeatable, flexible, and right-sized to application requirements, the purchase cost, deployment time, and provisioning time are all lowered. This standardized approach to the data center also decreases training time for staff and increases their ability to work with tenants' or different business units' equipment. These are substantial benefits to the customer, and when combined with NetApp storage efficiency and Cisco UCS stateless computing, they can lower the total cost of ownership (TCO) of the infrastructure.

3 FlexPod Design Elements

This section describes the elements that compose a FlexPod architecture. Because FlexPod is not a rigid configuration, the customer can build an infrastructure that includes best-in-class technologies from Cisco and NetApp.

3.1 Cisco Unified Computing System

The Cisco UCS is a next-generation data center platform that unites compute, network, storage access, and virtualization into a cohesive system designed to reduce TCO and increase business agility. The system integrates a low-latency, lossless 10 Gigabit Ethernet (10GbE) unified network fabric with enterprise-class, x86-architecture servers. The system is an integrated, scalable, multichassis platform in which all resources participate in a unified management domain. A Cisco UCS deployment consists of Cisco UCS Fabric Interconnects, blade server chassis, B-Series blades, C-Series rack mount servers (with required Cisco Nexus 2232PP Fabric Extenders), and adapter connectivity.

For more information, refer to the following documentation:

- Cisco UCS white papers:
  www.cisco.com/en/US/netsol/ns944/networking_solutions_white_papers_list.html
- Unified Computing and Servers:
  www.cisco.com/en/US/products/ps10265/index.html

Cisco UCS Manager

Cisco UCS Manager (Cisco UCSM) is robust device management software that is embedded in every Cisco UCS deployment and can support up to 160 servers. Cisco UCSM allows management of the entire compute environment from a highly available single pane of glass. Cisco UCS Manager provides flexible role-based and policy-based management of resources through the use of service profiles and templates. The use of service profiles and templates abstracts those elements that typically denote server personality (such as MAC address, WWPN, system UUID, and firmware revisions) from the role that the compute resource serves in the data center. Through this methodology, firmware, boot order, NIC and HBA settings, boot targets, and so on are no longer tied to a specific piece of server hardware. This approach enables IT infrastructure to be deployed in minutes rather than days and allows organizations to focus on strategy rather than on monotonous maintenance tasks.

With respect to element management, Cisco UCS Manager provides:

- Device discovery
- Firmware management
- Inventory
- Kernel-based virtual machine (VM) console access
- Diagnostics
- Quality of service (QoS)
- Monitoring
- Statistics collection
- Auditing

Cisco UCS Fabric Interconnect

The Cisco UCS 6100 or 6200 Series Fabric Interconnects is a core part of the Cisco UCS, providing both network connectivity and management capabilities for the system as this device is where Cisco UCSM resides. Deployed as a clustered pair, the Cisco UCS 6100 or 6200 Series Fabric Interconnects offer line-rate, low-latency, lossless 10GbE and Fibre Channel over Ethernet (FCoE) functions.

The Cisco UCS 6100/6200 Series Fabric Interconnects are the management and communication backbone for the Cisco UCS B-Series Blade Servers, the Cisco UCS 5100 Series Blade Server Chassis, and C-Series Rack-Mount Servers (connected through Nexus 2232PP Fabric Extenders). All chassis, all blades, and all rack-mounts attached to the Cisco UCS 6100/6200 Series Fabric Interconnects become part of a single highly available management domain. In addition, by supporting unified fabric, the Cisco UCS 6100/6200 Series Fabric Interconnects provide both the LAN and the storage area network (SAN) connectivity for all blades within its domain.

Note: The Cisco UCS 6200UP supports unified ports; therefore, ports can be configured to support 10GbE, Fibre Channel (FC), or FCoE.

Cisco UCS B-Series Blades and Blade Server Chassis

The Cisco UCS 5100 Series Blade Server Chassis is a crucial building block of the Cisco UCS, delivering a scalable and flexible blade server chassis for today's and tomorrow's data center while helping to reduce TCO.

Cisco's first blade server chassis offering, the Cisco UCS 5108 Blade Server Chassis, is six rack units high and can be mounted in an industry-standard 19-inch rack. A chassis can house up to eight half-width Cisco UCS B-Series Blade Servers and can accommodate both half-width and full-width blade form factors. There are currently six blade server options for sale from which to choose:

- Cisco UCS B22 M3 blade server
- Cisco UCS B200 M3 blade server
- Cisco UCS B250 M2 Extended Memory blade server
- Cisco UCS B230 M2 blade server
- Cisco UCS B420 M3 blade server
- Cisco UCS B440 M2 High Performance blade server

Four single-phase, hot-swappable power supplies are accessible from the front of the chassis. These power supplies are 92% efficient and can be configured to support nonredundant, N+1-redundant, and grid-redundant configurations. The rear of the chassis contains eight hot-swappable fans, four power connectors (one per power supply), and two input/output (I/O) bays for either the Cisco UCS 2104XP or 2208XP Fabric Extenders.

A passive midplane provides up to 20Gbps of I/O bandwidth per half-width server slot and up to 40Gbps of I/O bandwidth per full-width server slot. The chassis is capable of supporting future 40GbE standards.

Cisco UCS C-Series Rack-Mount Servers

Cisco UCS C-Series Rack-Mount Servers extend unified computing innovations to an industry-standard form factor to help reduce TCO and increase business agility. The innovations embodied in this series include a standards-based unified network fabric, Cisco VN-Link virtualization support, and Cisco Extended Memory Technology. It supports an incremental deployment model and protects customer investment with a migration path to unified computing.

There are currently seven rack mount server options for sale from which to choose:

- Cisco UCS C22 M3 rack server
- Cisco UCS C220 M3 rack server
- Cisco UCS C24 M3 rack server
- Cisco UCS C240 M3 rack server
- Cisco UCS C260 M2 rack server
- Cisco UCS C420 M3 rack server
- Cisco UCS C460 M2 rack server

Each server model addresses varying workload challenges through a balance of processing, memory, I/O, and internal storage resources.

For more information, refer to the following documentation:

- Cisco UCS C-Series Rack-Mount Servers: www.cisco.com/en/US/products/ps10493/index.html

Cisco UCS Virtual Interface Card

Cisco virtual interface cards (VICs) were developed from the ground up to provide acceleration for the various new operational modes introduced by server virtualization. The VICs are highly configurable, self-virtualized adapters that can create up to 128 PCI Express (PCIe) endpoints per adapter. These PCIe endpoints are created in the adapter firmware and present fully compliant standard PCIe topology to the host OS or hypervisor. Versions of the VIC are available for both the B-Series blades and the C-Series rack-mount servers.

Each of the PCIe endpoints created by the VIC can be configured individually for the following attributes:

- **Interface type.** FCoE, Ethernet, or Dynamic Ethernet interface device
- **Resource maps that are presented to the host.** PCIe base address registers, interrupt arrays
- **Network presence and attributes.** Maximum transmission unit, VLAN membership
- **Quality of service parameters.** 802.1p class, enhanced transmission selection (ETS) attributes, rate limiting, and shaping

3.2 Cisco Nexus 5000 and 7000 Series Switches

The networking foundation for any FlexPod deployment is the Cisco Nexus family of switches. The Cisco Nexus 5000 and 7000 Series enable any transport over Ethernet, including Layer 2 and Layer 3 traffic and storage traffic, on one common data center-class platform. Cisco Nexus 5000 and 7000 Series Switches help transform your data center with a standards-based, multipurpose, multiprotocol, Ethernet-based fabric. All switches in the Cisco Nexus family of switches leverage the NX-OS operating system.

Cisco Nexus 5000 Series Switches

Cisco Nexus 5000 Series switches are ideal for enterprise-class data center server access layer and smaller-scale, midmarket data center aggregation layer deployments. These multipurpose, multilayer switches can be deployed across a diverse set of traditional, virtualized, unified, and high-performance computing (HPC) environments.

As part of the foundation for FlexPod, these switches help address business, application, and operational requirements of evolving data centers. They provide:

- Architectural flexibility to support diverse business and application needs
- Infrastructure simplicity to decrease TCO
- Agility for traditional deployments, with easy migration to virtualized, unified, or HPC environments
- Enhanced business resilience with greater operational continuity based on the modular Cisco NX-OS operating system
- Ability to use existing operational models and administrative domains for easy deployment
- Nonblocking, resilient architecture based on Virtual PortChannel (vPC), which removes the dependency on spanning tree

The Cisco Nexus 5000 Series also expands Cisco Fabric Extension technology into the servers and VMs with Cisco Adapter FEX and Cisco VM-FEX.

The switch family's rich feature set makes the series ideal for rack-level, access-layer applications. It protects investments in data center racks with standards-based Ethernet and FCoE features that allow IT departments to consolidate networks based on their own requirements and timing.

The combination of high port density, wire-speed performance, and extremely low latency makes the switch an ideal product to meet the growing demand for 10GbE at the rack level. The switch family has sufficient port density to support single or multiple racks that are fully populated with blade and rack-mount servers.

Built for today's data centers, the switches are designed just like the servers they support. Ports and power connections are at the rear, closer to server ports, helping keep cable lengths as short and efficient as possible. Hot-swappable power and cooling modules can be accessed from the front panel, where status lights offer an at-a-glance view of switch operation. Front-to-back cooling is consistent with server designs, supporting efficient data center hot-aisle and cold-aisle designs. Serviceability is enhanced with all customer-replaceable units accessible from the front panel. The use of Small Form-Factor Pluggable Plus (SFP+) ports offers increased flexibility to use a range of interconnect solutions, including copper for short runs and fiber for long runs.

FCoE and IEEE Data Center Bridging features support I/O consolidation, simplify management of multiple traffic flows, and optimize performance. Although implementing SAN consolidation requires only the lossless fabric provided by the Ethernet pause mechanism, the Cisco Nexus 5500 Series offers additional features that create an even more easily managed, high-performance, unified network fabric.

For more information, refer to the following documentation:

- Cisco Nexus 5500 Series Switches: www.cisco.com/en/US/products/ps9670/index.html

Cisco Nexus 7000 Series Switches

The Cisco Nexus 7000 Series offers a comprehensive, one-platform solution for the data center core network. It also provides aggregation, high density, and end-of-row and top-of-rack server connectivity. For campus core deployments, it offers a scalable, highly resilient, high-performance solution.

The Cisco Nexus 7000 Series platform runs on Cisco NX-OS software. It was specifically designed for the most mission-critical deployments in the data center and campus.

The Cisco Nexus 7000 Series was designed around three principles:

- **Infrastructure scalability**: Virtualization, efficient power and cooling, high density, and performance all support efficient data center infrastructure growth.
- **Operational continuity**: The Cisco Nexus design integrates hardware, NX-OS software features, and management to support zero-downtime environments.
- **Transport flexibility**: You can incrementally and cost-effectively adopt new networking innovations and technologies.

New technologies that you can support include:

- Cisco Overlay Transport Virtualization (OTV)
- Cisco FabricPath
- Fibre Channel over Ethernet (FCoE)
- Cisco Locator/ID Separation Protocol (LISP)

3.3 NetApp Storage Infrastructure

The NetApp Unified Storage Architecture provides customers with an agile and scalable storage platform. All NetApp storage systems use the NetApp Data ONTAP® operating system. Both Data ONTAP 7-Mode and clustered Data ONTAP are supported in FlexPod. Both operating systems provide SAN (FCoE, FC, iSCSI), NAS (CIFS, NFS), and primary and secondary storage in a single unified platform so that all virtual desktop data components can be hosted on the same storage array. A single process for activities such as installation, provisioning, mirroring, backup, and upgrading is used throughout the entire product line, from the entry level to enterprise-class controllers. Having a single set of software and processes brings great simplicity to even the most complex enterprise data management challenges. Unifying storage and data management software and processes reduces the complexity of data ownership, enables companies to adapt to their changing business needs without interruption, and results in reduced TCO.

In a shared infrastructure, the availability and performance of the storage infrastructure are critical because storage outages or performance issues can affect thousands of users. The storage architecture must provide a high level of availability and performance. For detailed documentation about best practices, NetApp and its technology partners have developed a number of best practice documents.

For more information, refer to the following documentation:

- NetApp Data Storage Systems
- TR-3437: Storage Subsystem Resiliency Guide
- TR-3450: High-Availability Pair Controller Configuration Overview and Best Practices
- TR-3633: NetApp Best Practice Guidelines for Oracle Database 11g
- TR-3702: NetApp Storage Best Practices for Microsoft Virtualization and NetApp SnapManager for Hyper-V
- TR-3705: NetApp and VMware View Solution Guide
- TR-3749: NetApp Storage Best Practices for VMware vSphere
- TR-3824: Storage Efficiency and Best Practices for Microsoft Exchange Server 2010

- TR-4068: VMware vSphere 5 on NetApp Clustered Data ONTAP 8.1
- NVA-0005: VMware vSphere on FlexPod. Validated with Clustered Data ONTAP and Data ONTAP Operating in 7-Mode

NetApp Unified Storage Architecture

When it comes to storage platforms, NetApp views simplicity as the key to delivering value to customers. That's why every NetApp storage controller is available with the Data ONTAP operating system. Data ONTAP is the foundation for providing unified storage through multiprotocol support on every platform. The NetApp family of controllers consists of platforms that are capable of serving all business needs. The FlexPod program leverages the FAS3xxx and FAS6xxx product lines to build efficient infrastructures.

RAID-DP

With any shared infrastructure deployment, data protection is critical because any RAID failure could result in hundreds to thousands of end users being disconnected from their virtual desktops or applications, resulting in lost productivity. NetApp RAID-DP® offers performance that is comparable to that of RAID 10, yet it requires fewer disks to achieve equivalent protection. RAID-DP protects against double disk failure, as compared to RAID 5, which can protect against only one disk failure per RAID group. For more information about RAID-DP, refer to TR-3298: RAID-DP: NetApp Implementation of Double-Parity RAID for Data Protection.

Storage Efficiency

One of the critical barriers to adopting shared infrastructure is the increased cost of using shared storage to obtain a highly available enterprise-quality infrastructure. Virtual desktop and other enterprise deployments can create a high level of data redundancy, especially for the VM OS data. With traditional storage, the total storage required equals the sum of the storage required by each VM. For example, if each VM is 20GB in size, and there are 1,000 VMs in the solution, it would require at least 20TB of usable data on the shared storage.

Thin provisioning, data deduplication, and FlexClone® thin-cloning technology are the critical components of the NetApp solution, offering multiple levels of storage efficiency across the virtual desktop OS data, installed applications, and user data. This helps customers save 50% to 90% of the cost associated with shared storage (based on existing customer deployments and NetApp solutions lab validation).

Flexible Volumes and Aggregates

Aggregates are the NetApp virtualization layer, which abstracts physical disks from logical datasets, referred to as flexible volumes (also known as NetApp FlexVol® volumes). Aggregates offer storage administrators pooled disk resources, including input/output operations per second (IOPS). The FlexVol volumes contained in each aggregate have their own unique logical capacity. FlexVol volumes can be thin provisioned and the logical capacity resized as needed by the storage administrator.

FlexVol volumes are shared out as file-level (NFS or CIFS) mount points or are further allocated as LUNs for block-level (iSCSI or FCP) access. FlexVol volumes can be readily offered to the VMware® environment as datastores; NetApp recommends a one-to-one alignment between the FlexVol volume and VMware ESX® datastore assets. Using VMware as an example, alignment makes mapping easy between the VMware server administrator's view and the storage administrator's view of the virtual environment. NetApp also suggests large aggregates to support most VMware environments. VMware environments often have random I/O requirements; large aggregates provide maximum flexibility to VMware administrators because a large pool of I/O resources is made readily available. With NetApp's inherent storage virtualization techniques, which apply to all hypervisors, all datasets or VMs housed in a shared storage infrastructure take advantage of RAID-DP from a performance and protection standpoint.

Thin Provisioning

Thin provisioning is a way of logically presenting more storage to hosts than is physically available. With thin provisioning, the storage administrator can access a pool of physical disks (known as an *aggregate*) to create logical volumes for different applications to use, while not preallocating space to those volumes. The space is allocated only when the host needs it. The unused aggregate space is available for the existing thin-provisioned volumes to expand or for use in the creation of new volumes. For more information about thin provisioning, refer to TR-3563: NetApp Thin Provisioning Increases Storage Utilization with On-Demand Allocation.

NetApp Deduplication

NetApp deduplication saves space on primary storage by removing redundant copies of blocks in a volume that is hosting hundreds of virtual desktops. This process is transparent to the application and user and can be enabled and disabled on the fly. In a virtual desktop infrastructure (VDI) environment, deduplication provides significant space savings, given that each VM has an identical copy of the OS, applications, and patches. The savings are also achieved for the user data hosted on CIFS home directories. For more information about NetApp deduplication, refer to TR-3505: NetApp Deduplication for FAS and V-Series Deployment and Implementation Guide.

Using NetApp deduplication and file FlexClone technology can reduce the overall storage footprint of VDI desktops and improve performance by leveraging transparent storage cache sharing. Data that is deduplicated (or nonduplicated, in the case of file FlexClone data) on disk exists in the storage array cache only once per volume. All subsequent reads from any of the VM disks of a block that is already in cache are read from cache and not from disk, thus improving performance tenfold. Any nondeduplicated data that is not in cache must be read from disk. Data that is deduplicated but does not have as many block references as a heavily deduplicated VM disk (VMDK) appears in cache only once, but based on the frequency of access might be evicted earlier than data that has many references or which is heavily used.

NetApp recommends the following deduplication guidelines:

- Deduplication is configured and operates on the FlexVol volumes only.
- Data can be deduplicated up to 255:1 without consuming additional space.
- Each storage platform has different deduplication limits.
- Each volume has dense and nondense size limits.

Transparent Storage Cache Sharing

Transparent storage cache sharing (TSCS) allows customers to benefit from the storage efficiency of NetApp and at the same time significantly increase I/O performance. TSCS is natively built into the Data ONTAP operating system and works by leveraging block-sharing technologies such as NetApp primary storage deduplication and FlexClone technology to reduce the amount of cache required and eliminate duplicate disk reads. Only one instance of any duplicate block is read into cache, thus requiring less cache than traditional storage solutions. VDI implementations can see up to 99% initial space savings (validated in the NetApp solutions lab) by using space-efficient NetApp cloning technologies. This translates into higher cache deduplication and high cache hit rates. TSCS is especially effective in addressing the simultaneous system boot, or boot storm, of hundreds to thousands of virtual desktop systems that can overload a traditional legacy storage system.

Here are some important aspects to consider for transparent storage cache sharing:

- Requires Data ONTAP 7.2.5.1, 7.3P1, or later.
- Both `a_sis` and NearStore® must be licensed for deduplication to work.
- Run deduplication before creating Snapshot™ copies or running SnapMirror® or SnapVault® updates.

For more detailed information about deduplication, refer to NetApp TR-3505: NetApp Deduplication for FAS and V-Series Deployment and Implementation Guide.

NetApp Flash Cache and FlexScale

NetApp Flash Cache is a hardware device that extends the native Data ONTAP TSCS capabilities. Flash Cache increases the amount of available cache, which helps to reduce virtual desktop storm activities. For more information about NetApp Flash Cache technology, refer to www.netapp.com/us/products/storage-systems/flash-cache/flash-cache-tech-specs.html.

NetApp FlexScale™ is the tunable software component of Flash Cache. It is a licensed feature of Data ONTAP 7.3 and later. FlexScale allows three different caching modes to be used, based on the type of workload:

- Metadata only
- Normal user data
- Low-priority blocks

For example, FlexScale allows system administrators to tune the VMware View environments of their NetApp controllers.

NetApp Virtual Storage Console and Operations Manager

Implementation and management complexities associated with deploying a VDI solution are another potential barrier to VDI adoption. To provide operationally agile management of storage on the vSphere™ platform, the NetApp Virtual Storage Console integrates directly into VMware vCenter™ for rapidly provisioning, managing, configuring, and backing up a VDI implementation.

NetApp Operations Manager offers a comprehensive monitoring and management solution for the storage infrastructure. It provides comprehensive reports of utilization and trends for capacity planning and space usage. It also monitors system performance, storage capacity, and health to resolve potential problems.

For more information about Operations Manager, go to www.netapp.com/us/products/management-software/operations-manager.html.

3.4 Management

Although the element managers discussed in the previous sections provide thorough control of their respective components, there is a need for more integrated management to handle the daily operation of the environment.

FlexPod Management Solutions

To give customers a variety of choices for this role, NetApp and Cisco have joined with trusted partners to form the FlexPod Management Solutions Program, which includes two classes of solutions:

- **FlexPod management solutions.** These solutions, provided by partners, address specific management needs on each of the FlexPod components including Cisco Nexus, Cisco UCS, and NetApp storage controllers. These packages can provide a variety of services, including configuration management, health and performance monitoring, VM lifecycle management, and more.
- **Validated FlexPod management solutions.** These partner solutions have been verified by NetApp and Cisco to fulfill a rigorous set of use case requirements and to provide unified management of the FlexPod environment. Validated solutions must meet a high bar of integration with all of the FlexPod components as well as usability and feature requirements that include:
  - A unified hierarchy of stack resources
  - A service catalog

- A customer-facing API
- Fine-grained resource metering
- The ability to integrate into an existing management environment

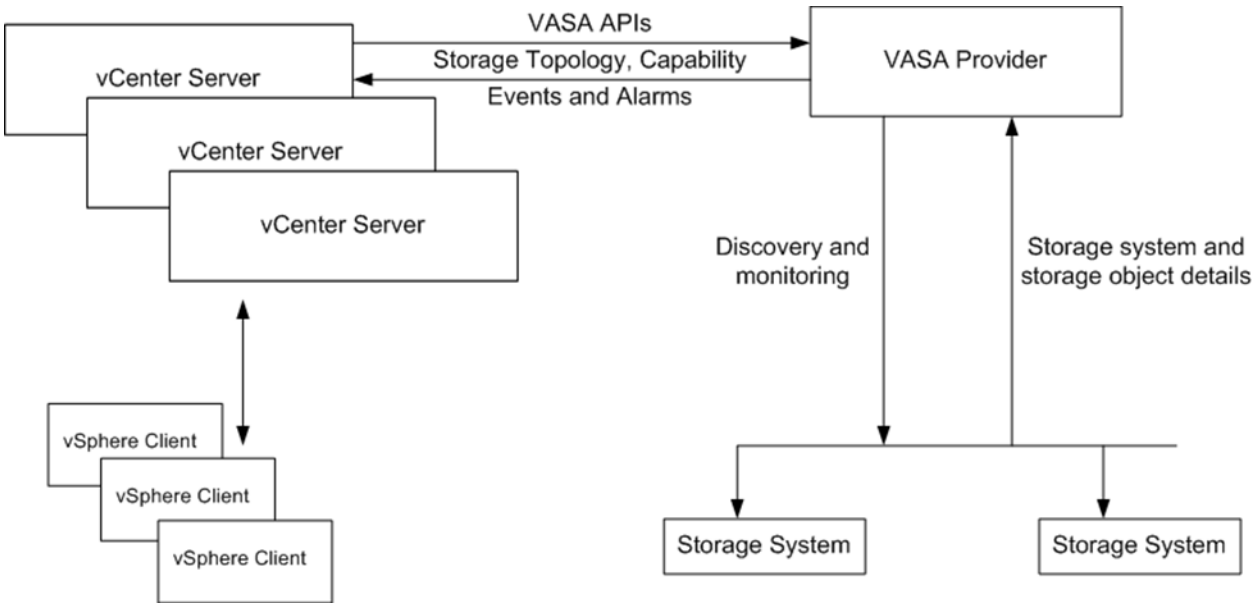
All validated solutions share this core set of capabilities, but our partners also go beyond this prescribed baseline to innovate and differentiate their solutions. This enables customers to compare with confidence and to find the validated solution that matches the needs of their enterprises.

This program allows customers to easily identify FlexPod management solutions from qualified developers, and these validated solutions offer the additional assurance of FlexPod unified management and verification by Cisco and NetApp. For more information about the FlexPod management software ecosystem, refer to http://solutionconnection.netapp.com/flexpod.aspx.

NetApp VASA Provider

vStorage APIs for Storage Awareness (VASA) providers collect information about storage and present that information to vSphere. FAS/V-Series VASA provider architecture includes the storage systems running Data ONTAP, the host system running FAS/V-Series VASA provider, and the vCenter Server that requests storage information from NetApp storage systems. Figure 3 shows how FAS/V-Series VASA provider collects data and delivers that information to the vCenter Server.

Figure 3) VASA provider collects and delivers data to vCenter Server.



4 Data Center Solutions

When deploying a shared infrastructure, customers often have both virtualized and nonvirtualized workloads deployed in their data centers. This section details available solutions and describes how to deploy FlexPod as the basis for any data center workload.

4.1 FlexPod Infrastructure

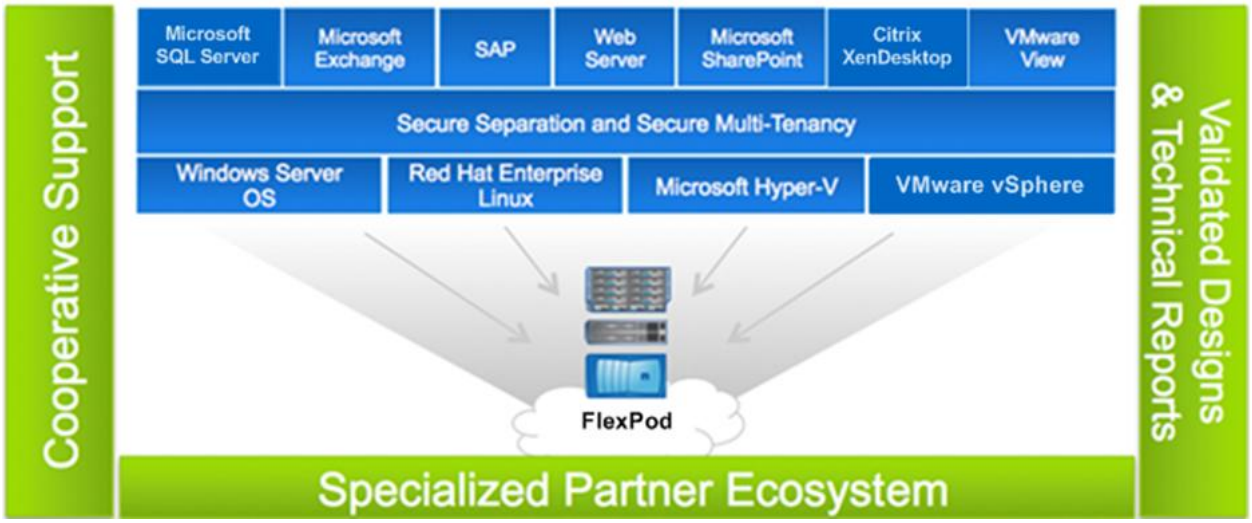
This section describes infrastructure architectures that support both virtualized and nonvirtualized platforms that might be deployed.

Base FlexPod

FlexPod is a predesigned and validated base configuration that leverages the Cisco UCS, Cisco Nexus data center switches, NetApp FAS storage components, and software from a range of partners. FlexPod can scale up for greater performance and capacity, or it can scale out for environments that need consistent, multiple deployments.

FlexPod includes all of the infrastructure elements that serve as the foundation for solution layering. Many customers today require the ability to support a variety of operating systems to satisfy this demand. FlexPod can be deployed as a virtualized, nonvirtualized, or hybrid environment. Multiple documented architectures, including VMware vSphere built on FlexPod, Red Hat Enterprise Linux® built on FlexPod, and SAP applications built on FlexPod, provide fully virtualized, nonvirtualized, and hybrid environments, respectively.

Figure 4) FlexPod solutions and applications.



FlexPod also has the flexibility to be sized and optimized to accommodate many different use cases. For example, a customer who wants a FlexPod solution to satisfy VDI requirements would require higher-performance blades and optimized NetApp Flash Cache technologies. For a development and test environment, a customer would require more compute resources and less storage because of inherent NetApp storage efficiencies and the ability to eliminate redundant data. In contrast, for a data protection and backup environment, a customer would require less computing and more storage capacity. Customers can also start with a small, simple FlexPod configuration and scale up or out, depending on the needs of the business. Figure 4 shows the structure of a single FlexPod configuration with FCoE and its components as defined in the FlexPod technical specifications document. Figure 5 shows the structure of a single FlexPod configuration using iSCSI boot. Native FC is also an option, but requires a switch capable of supporting native FC.

Figure 5) Base FCoE FlexPod infrastructure.

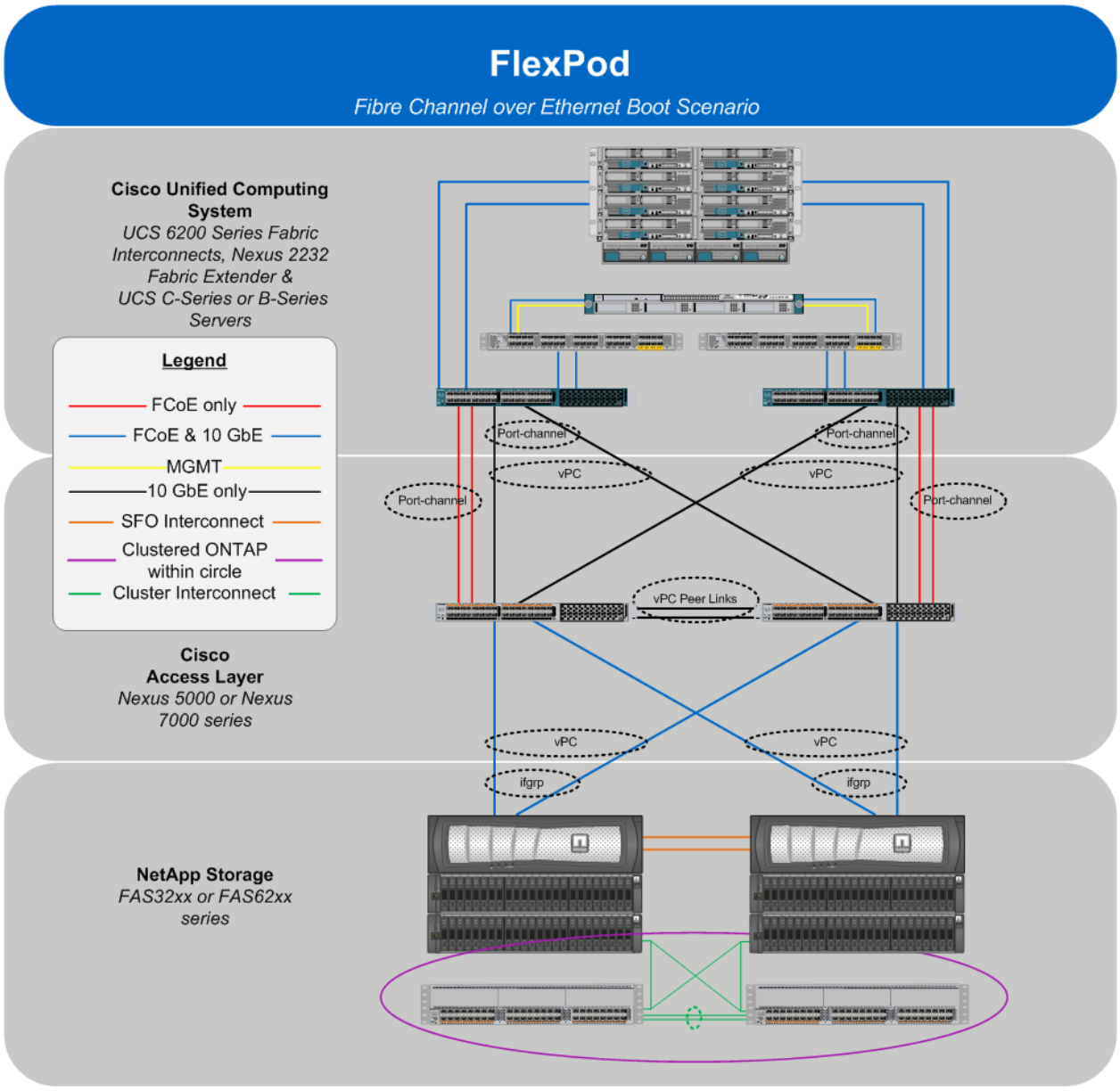
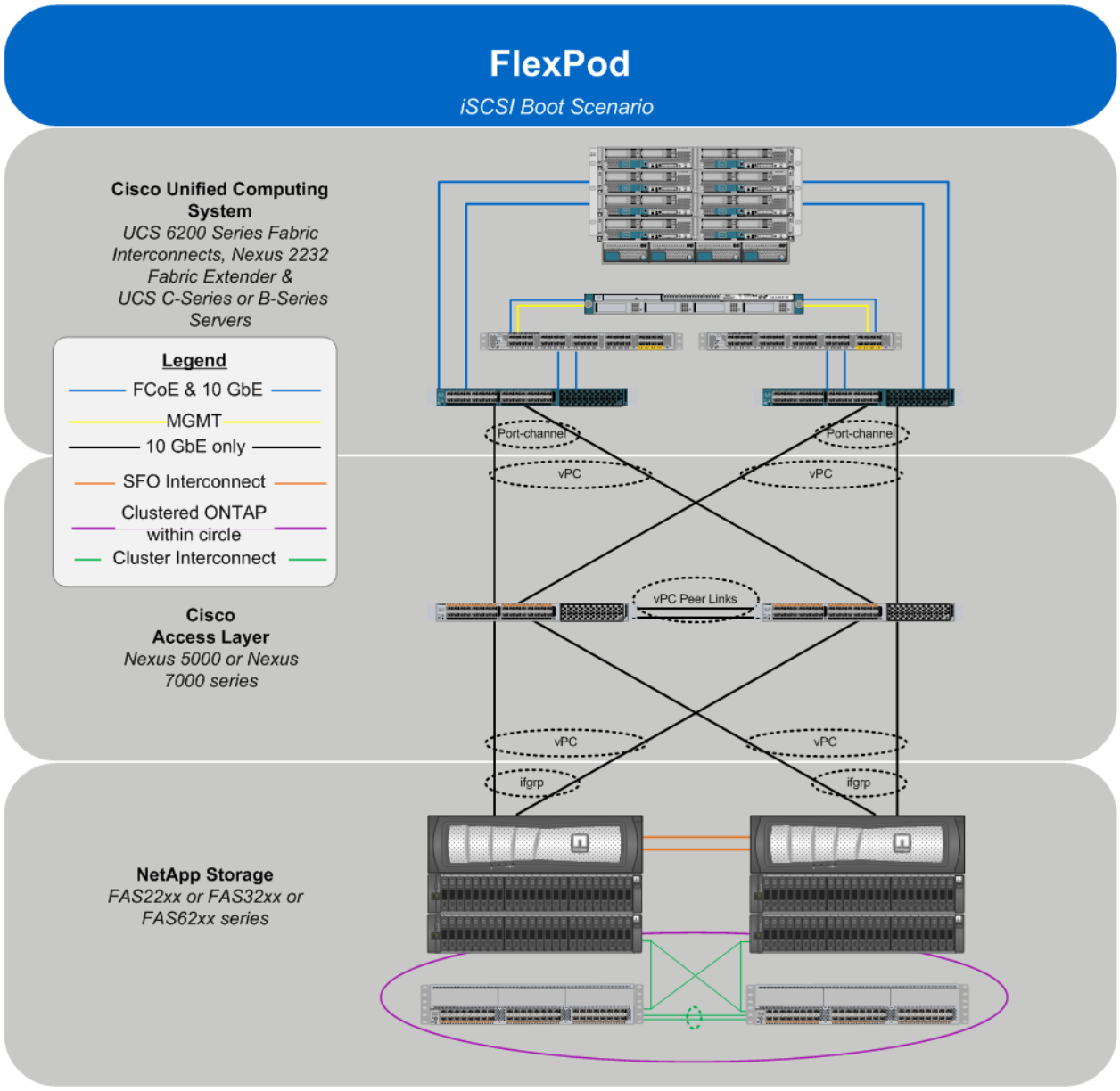


Figure 6) iSCSI boot FlexPod infrastructure.



For more information about this solution, refer to the following documentation:

- CVD: Data ONTAP Design Guide
- CVD: Clustered Data ONTAP Deployment Guide
- CVD: Data ONTAP 7-Mode Deployment Guide
- FlexPod Data Center Platform
- NVA-0003: FlexPod Data Center Solution: VMware vSphere Built on FlexPod – NetApp Verified Architecture
- VMware vSphere Built on FlexPod with IP-Based Shared Storage

VMware vSphere Built on FlexPod

The VMware vSphere built on FlexPod solution architecture layers the VMware vSphere hypervisor on top of the FlexPod infrastructure stack. Cisco, NetApp, and VMware have developed VMware vSphere built on FlexPod to address industry virtualization needs and to simplify the evolution to shared infrastructure and cloud architectures. VMware vSphere built on FlexPod is the foundation for various virtualized application workloads and solutions, including the secure multi-tenancy and disaster recovery configurations described in section 4.3.

In addition to the FlexPod base infrastructure components, this solution includes:

- VMware vSphere ESXi™
- VMware vSphere vCenter Server
- VMware vSphere Client
- NetApp Virtual Storage Console
- Cisco Nexus 1000v Virtual Ethernet Switch

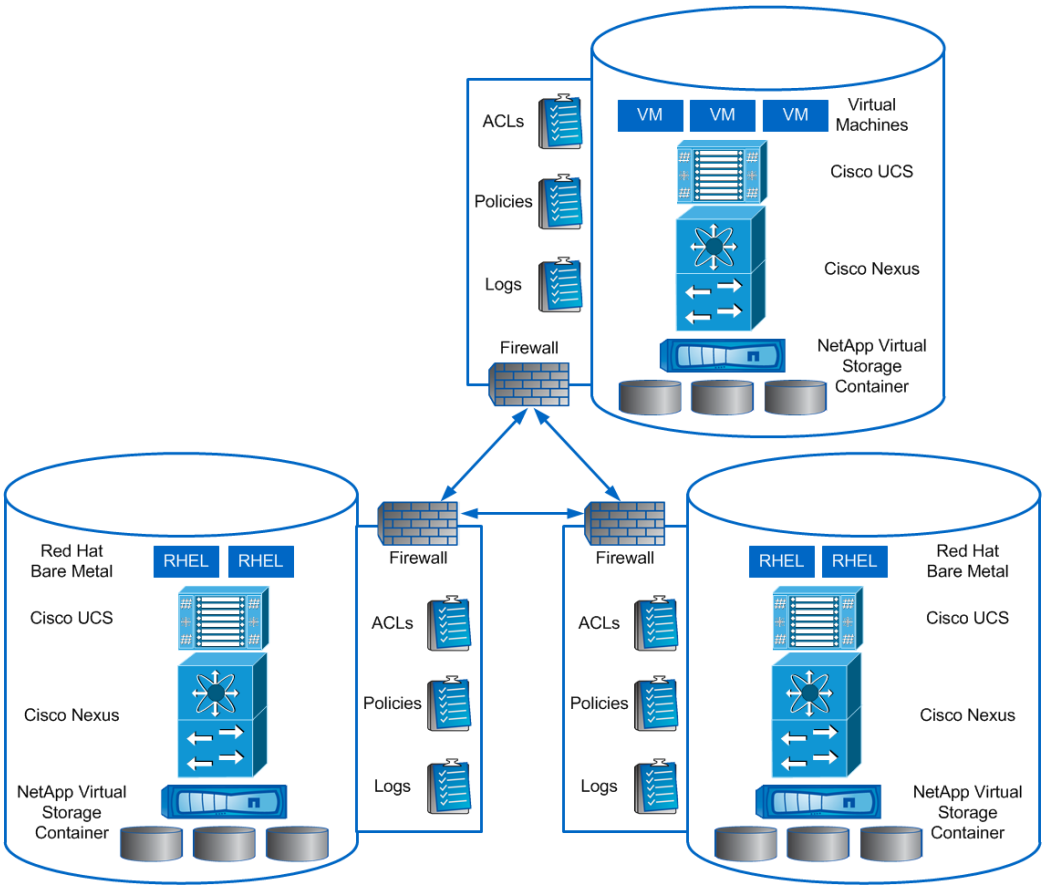
For more information about this solution, refer to the following documentation:

- DS-3105: VMware vSphere Built on FlexPod – Solution Brief
- NVA-0005: FlexPod Data Center Solution: VMware vSphere on FlexPod – NetApp Verified Architecture
- TR-4113: VMware vSphere 5.0 on FlexPod Data ONTAP 7-Mode Deployment Guide
- TR-4114: VMware vSphere 5.0 on FlexPod Clustered Data ONTAP Deployment Guide
- VMware vSphere Built on FlexPod – Data Center Solution Site
- TR-4119: Oracle RAC Built on FlexPod with VMware Solutions Guide

Secure Separation Built on FlexPod Design Guide

Cisco and NetApp, with Red Hat, have jointly designed a best-in-class nonvirtualized FlexPod data center architecture with secure separation and have validated the design in a lab environment. The nonvirtualized environment uses a native operating system (Red Hat Enterprise Linux 6) on Cisco Unified Computing System (Cisco UCS) blades, as opposed to a thin hypervisor. This section provides guidance for implementing securely separated tenants in a nonvirtualized (also known as bare metal) data center built on FlexPod. Tenants can be a group of users, a group of applications, or any group that needs committed resources from the data center.

Figure 7) Secure separation architecture overview.



For more information about this solution, refer to the Secure Separation Built on FlexPod Design Guide.

Red Hat Enterprise Linux Built on FlexPod

The Red Hat Enterprise Linux built on FlexPod solution architecture layers the Red Hat Enterprise Linux operating system on top of the FlexPod infrastructure stack. FlexPod combined with the Red Hat Enterprise Linux operating system and its add-on options such as scalable file system, high availability, and resilient storage can be used as a trusted platform for various mission-critical applications. Red Hat Enterprise Linux built on FlexPod can be used in standalone or cluster configurations on physical Cisco UCS servers or as a guest operating system in virtualized environments.

In addition to the FlexPod base infrastructure components, this solution includes:

- Red Hat Enterprise Linux
- Red Hat Cluster Suite

For more information about this solution, refer to the Red Hat Enterprise Linux Built on FlexPod Deployment Guide.

NetApp Hyper-V Cloud Fast Track with Cisco

NetApp Hyper-V™ Cloud Fast Track with Cisco, a FlexPod data center solution, includes NetApp storage, Cisco networking, Cisco UCS, and Hyper-V virtualization software in a single package, in which the computing and storage fit in one data center rack with the networking residing in a separate rack.

Depending on port density, the networking components can accommodate multiple Fast Track units for Hyper-V configurations.

In addition to the FlexPod base infrastructure components, this solution includes:

- Microsoft Windows Server® 2008 R2 Datacenter Edition
- Microsoft Systems Center 2007
- Microsoft System Center Virtual Machine Manager
- Microsoft Systems Center Operations Manager
- Opalis Integration Server
- NetApp OnCommand® Plug-In for Hyper-V
- NetApp SnapDrive® for Windows®
- NetApp SnapManager® for Microsoft Hyper-V
- NetApp Data ONTAP DSM

For more information, refer to the following documentation:

- NetApp Hyper-V Cloud Fast Track with Cisco Deployment Guide.
- TR-4094i: FlexPod on MS Private Cloud Deployment Guide

FlexPod Datacenter with NetApp MetroCluster Software

A growing segment of the industry is looking to reduce its investment risk by introducing geographical separation between the data centers while logically maintaining a single data center. These virtualized data centers are enabled by the proliferation of dark fiber between cities at ever extending geographical distances. As customers continue to outgrow their existing data centers, they are looking for ways to effectively extend their service offering without forklift data center replacements. The ability to host two data centers in different geographical areas, operating as a single entity, is becoming increasing popular.

The primary benefit of a stretched-cluster model is to enable on-demand and nonintrusive mobility of workloads across two geographically distant sites. By utilizing VMware Metro Storage Cluster (vMSC) design guidance, the workload mobility is combined with active balancing of resources across the two data centers to optimally utilize the data center resources. Some of the key benefits of a multisite data center solution are:

- Workload mobility
- Automated load balancing across sites
- Ease of maintenance
- Avoidance of disaster/downtime

For more information, refer to the following documentation:

- CVD: FlexPod Datacenter with NetApp MetroCluster Software
- TR-3548: Best Practices for MetroCluster Design and Implementation
- TR-4128: vSphere 5 on NetApp MetroCluster Solution

4.2 FlexPod Application Solutions

The previous section explained use cases for deploying FlexPod as the architecture of choice. This section introduces specific application environments with validated best practices that can be built on FlexPod.

SAP Built on FlexPod

Corporations deploying SAP software today are under pressure to reduce cost, minimize risk, and control change by accelerating deployments and increasing the availability of their SAP landscapes. Deployment of business solutions usually exceeds a single production instance of SAP. Business process owners and project managers must coordinate with IT management to optimize the scheduling and availability of systems to support rapid prototyping and development, frequent parallel testing or troubleshooting, and appropriate levels of end-user training. The ability to access these systems as project schedules dictate, with current datasets and without affecting production operations, often determines whether SAP projects are delivered on time and within budget.

To meet this challenge, NetApp and Cisco have collaborated to create SAP built on FlexPod. This solution differs from other virtualized infrastructure offerings by providing:

- Validated technologies from industry leaders in computing, storage, networking, and server virtualization
- A single platform, built from unified computing, fabric, and storage technologies, that scales to meet the largest data center requirements without disruption or architectural changes in the future
- Integrated components that enable administrators to centrally manage all infrastructure pools
- An open design management framework that integrates with existing third-party infrastructure management solutions
- Support of bare metal server VMs and VMs that are based on VMware
- Virtualization on all layers of the solution stack
- Secure multi-tenancy for operating fenced SAP systems or landscapes
- Application and data mobility
- Integrated storage-based backup
- Provisioning of infrastructure components, such as tenants and operating systems
- Automated SAP system copies
- Provisioning of fenced SAP systems based on clones of production systems

SAP built on FlexPod introduces an infrastructure that is based on virtualization technologies on all layers of the solution stack within a pool of shared resources. The SAP systems can run on VMware VMs or on bare metal servers. All management applications are installed in the infrastructure tenant. These management applications run on VMware VMs.

For more information refer to the following documentation:

- FlexPod for SAP Applications
- TR-3921i: SAP Applications Built on FlexPod Implementation Guide

Microsoft Solutions Built on FlexPod

Many customers want to virtualize traditional Microsoft server instances as they move toward a shared infrastructure with lower costs. Many solutions leverage vSphere built on FlexPod as the foundation for these virtualized workloads. As mentioned previously, the VMware portion of vSphere built on FlexPod offers the reduced costs of virtualization and high availability. The Cisco Nexus platform's unified switching fabric allows connections between VMs and storage by using FC, FCoE, iSCSI, NFS, or Common Internet File System (CIFS) over a single network fabric. With the additional purchase of NetApp SnapDrive for Windows, NetApp SnapManager for Microsoft Exchange (SME), SnapManager for SQL Server®, SnapManager for Microsoft Office SharePoint Server, the backup portion of NetApp VSC, and NetApp SnapMirror, advanced backup and recovery solutions can be set up.

TR-3151: "FlexPod Data Center Solutions Sizing Guide", described in section 2.3, specifically addresses sizing of the Microsoft mixed workload applications with VMware built on FlexPod. Customer workload

requirements can be used to customize the compute and storage provided in VMware built on FlexPod to meet those requirements.

Further collateral has been developed describing how to deploy Microsoft SharePoint 2010 for a real-world workload of 50,000 users. This design guide demonstrates how enterprises can leverage best practices for FlexPod technologies and software providers Microsoft and VMware. Design validation was completed using Microsoft Visual Studio® 2010 Ultimate workloads and Visual Studio Load Test agents to simulate a realistic 50,000-user load across SharePoint 2010 Enterprise features. Virtual user connections from branch offices, remote offices, and mobile users were optimized using Cisco Wide Area Application Services (WAAS). Cisco Application Control Engine (ACE) was implemented for Web and application server load balancing in the SharePoint 2010 architecture.

For more information, refer to the following documentation:

- CVD: Microsoft Exchange 2010 with VMware vSphere on Cisco Unified Computing System with NetApp Storage
- CVD: Microsoft SharePoint 2010 on FlexPod for VMware
- TR-3785: Microsoft Exchange Server, SQL Server, and SharePoint Server Mixed Workload on VMware vSphere 4, NetApp Unified Storage (FC, iSCSI, and NFS), and Cisco Nexus Unified Fabric
- CVD: FlexPod for Windows Server 2012 Hyper-V Design Guide

VMware View 4.5 Built on FlexPod

The VMware View 4.5 desktop virtualization platform enables administrators to run virtual desktops in the data center and deliver desktops to employees as a secure managed service. End users gain a familiar, personalized environment that they can access from any number of devices anywhere throughout the enterprise or from home. Administrators gain centralized control, efficiency, and security by having desktop data in the data center.

There are many reasons to consider a virtual desktop solution, such as an ever-growing and diverse base of user devices, management complexity of traditional desktops, security, and user owned/non-IT–supported devices. To design and deploy a successful virtual desktop environment, it is important to understand the requirements of the user community. These are some typical types of users:

- Knowledge workers today don't just work in their offices all day; they attend meetings, visit branch offices, and work from home and even coffee shops. These anywhere workers expect access to all of their applications and data wherever they are.
- External contractors are increasingly part of everyday business. They need access to many applications and data, yet administrators have little control over the devices they use or the locations from which they work. Consequently, IT must trade off the cost of providing these workers with a device versus the security risk of allowing them access from their own devices.
- Task workers perform a set of well-defined tasks. These workers access a small set of applications and have limited requirements for their PCs. Because these workers interact with customers, partners, and employees, they often have access to critical data.
- Road warriors need access to their virtual desktop from everywhere, regardless of how they are connected to a network. These workers expect the ability to personalize their PCs by installing their own applications and storing their own data, such as photos and music, on these devices.
- Shared workstation users are typically found in university and business computer labs, in conference rooms, and in training centers. Shared workstation environments require desktops to be reprovisioned with the latest operating systems or applications, as the needs of the organization change.

The virtual desktop user community requirements drive system design decisions.

For more information about this solution, refer to the VMware View 4.5 on FlexPod for VMware Design Guide.

Citrix XenDesktop with vSphere Built on FlexPod

Citrix XenDesktop is a desktop virtualization solution that delivers Windows desktops as an on-demand service to any user, anywhere. With FlexCast delivery technology, XenDesktop can quickly and securely deliver individual applications or complete desktops to the entire enterprise, whether they are task workers, knowledge workers, or mobile workers. Users now have the flexibility to access their desktops on any device, at any time, with a high-definition user experience. With XenDesktop, IT can manage single instances of each OS, application, and user profile and dynamically assemble them to increase business agility and greatly simplify desktop management. The XenDesktop open architecture enables customers to easily adopt desktop virtualization by using any hypervisor, storage, or management infrastructure.

In this solution, VMware vSphere is the chosen hypervisor. VMware vSphere consists of the management infrastructure or virtual center server software and the hypervisor software that virtualizes the hardware resources on the servers. It offers features such as distributed resource scheduler, VMware VMotion®, high availability, Storage VMotion, VMFS, and a multipathing storage layer. For more information about vSphere, refer to the VMware website.

For more information about this solution, refer to the following documentation:

- CVD: Citrix XenDesktop on FlexPod with Microsoft Private Cloud
- CVD: Citrix XenDesktop Using Cisco UCS, Microsoft Hyper-V, and NetApp Storage
- CVD: Reference Architecture-Based Design for Implementation of Citrix XenDesktop on Cisco Unified Computing System, VMware vSphere, and NetApp Storage

Citrix XenDesktop with XenServer Built on FlexPod

Citrix XenDesktop is hypervisor agnostic and is another example of a hypervisor that can be used to host VDI-based desktops. XenServer is a complete, managed server virtualization platform built on the powerful Xen hypervisor. Xen technology is widely acknowledged as the fastest and most secure virtualization software in the industry. XenServer is designed for efficient management of Windows and Linux virtual servers and delivers cost-effective server consolidation and business continuity. For more information about XenDesktop, refer to the Citrix website.

For more information about this solution, refer to CVD: Reference Architecture-Based Design for Implementation of Citrix XenDesktop on Cisco Unified Computing System, VMware vSphere and NetApp Storage.

4.3 FlexPod Data Center Integration

The solutions outlined in sections 4.1 and 0 are important only because they are integrated into existing data center standards, best practices, and workflows. Common themes in data centers are multi-tenancy, development and testing, and backup and recovery. FlexPod solutions integrate seamlessly with established best practices and procedures.

Secure Multi-Tenancy

IT infrastructure too often suffers from oversegmentation of server, networking, and storage resources. Each organization or customer purchases and uses its own equipment, which leads to low utilization, inefficiency, and the inability to scale properly and to respond quickly to changing business needs. Although virtualization of server and network environments has been effective in increasing the use of storage and network resources, the adoption of cloud computing to deliver ITaaS in data centers promises to complete the vision of a fully virtualized environment.

The biggest obstacle to the adoption of ITaaS has been a lack of confidence that data and applications are securely isolated in a cloud-based infrastructure in which servers, networks, and storage are all shared resources. To address this need, Cisco, NetApp, and VMware have joined together to develop

secure multi-tenancy (SMT) in a virtualized data center, which is a carefully designed and lab-validated solution for the next-generation data center.

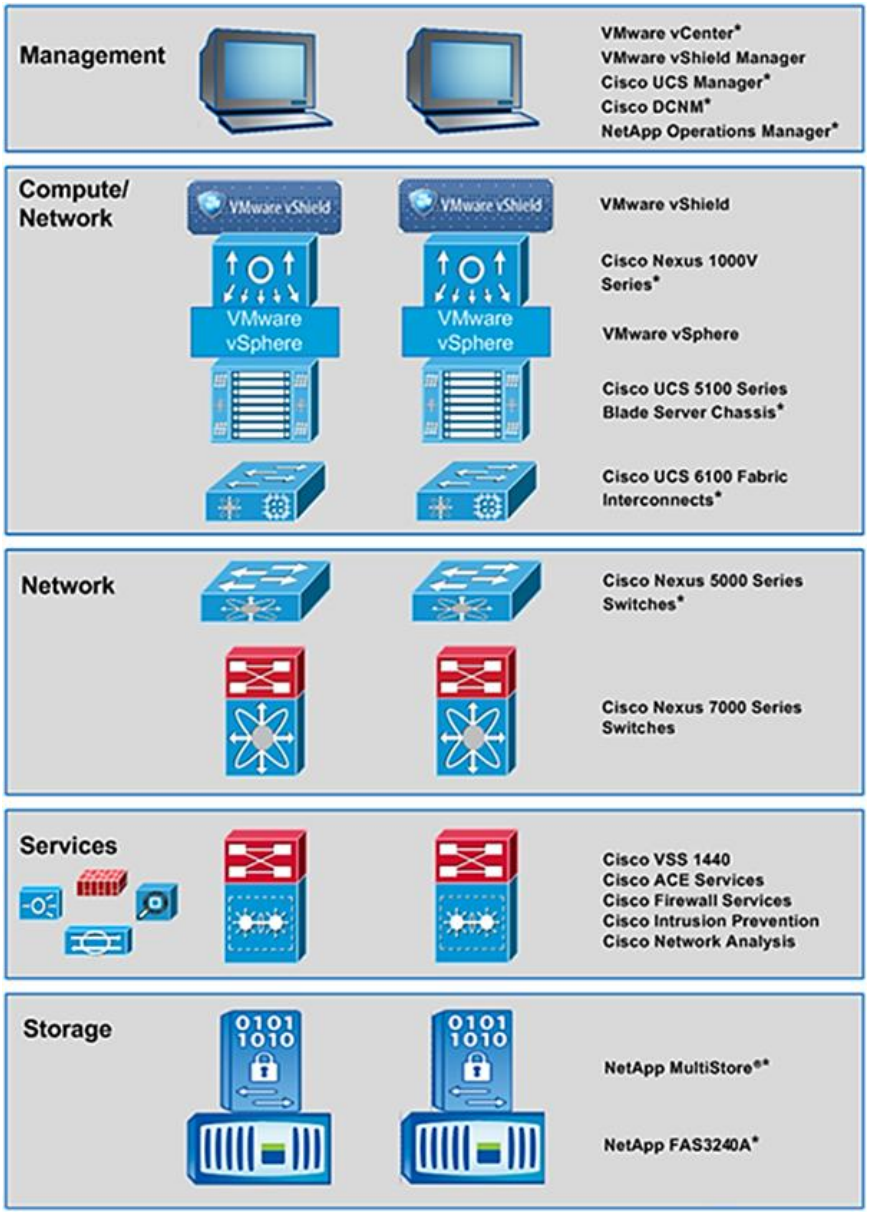
To develop a robust design, organizations must clearly define the requirements and apply proven methodology and design principles. The following four requirements are the critical elements, or pillars, of the SMT architecture:

- **Availability.** This pillar allows the infrastructure to meet the expectation that compute, network, and storage resources will be available even in the event of failure. Each layer has its own method for providing an HA configuration that works cohesively with adjacent layers, similar to the approach used by the secure separation pillar. Security and availability are best deployed in a layered approach.
- **Secure separation.** This pillar makes sure that one tenant does not have access to another tenant's resources, such as VMs, network bandwidth, and storage. Each tenant must be securely separated by using techniques such as access control, virtual local area network segmentation, and virtual storage controllers. Also, each layer has its own means of enforcing policies that help reinforce the policies of the adjacent layers.
- **Service assurance.** This pillar provides isolated compute, network, and storage performance during both steady-state and nonsteady-state operations. For example, the network can provide each tenant with a certain bandwidth assurance by using quality of service measures. Resource pools in VMware help balance and provide CPU and memory resources, and the NetApp FlexShare® quality of service tool can balance resource contention across storage volumes.
- **Management.** This pillar is required to rapidly provision and manage resources and to view resource availability. Domain and element management provide comprehensive administration of the shared resources that compose the secure cloud architecture. The demarcation point for managing this design is defined by the interactive and programmable interfaces delivered by NetApp, VMware, and Cisco. The administrative interfaces and APIs in this portfolio address infrastructure components such as VMware vCenter and vCloud™ Director, Cisco UCS Manager and Data Center Network Manager (DCNM), and the NetApp Manageability Suite. These element managers and their associated open APIs form the foundation for delivery of cohesive service lifecycle orchestration with solution partners.

Figure 8 shows the architectural components of SMT.

Note: The components included in vSphere built on FlexPod are marked with an asterisk in Figure 8.

Figure 8) SMT architectural components.



VMware vSphere 4.1 (or later) built on FlexPod serves as the base layer of this architecture. The additional SMT components can be layered on top of the infrastructure. The additional components are:

- Cisco Nexus 7000 Series switches
- VMware vShield™ App and Edge virtual firewalls
- VMware Site Recovery Manager (required when implementing DR with SMT)
- NetApp SnapDrive and SnapManager products
- Cisco Services layer

The Enhanced Secure Multi-Tenancy Design Guide specifies the setup of Microsoft applications such as Microsoft Exchange, SQL Server, and SharePoint as securely separated tenants. The Enhanced Secure Multi-Tenancy Design Guide also specifies the setup of a disaster recovery (DR) site for recovery of the SMT infrastructure and tenants. To use the DR site equipment during normal operations, follow the

design guide specification to set up a development and testing environment running VMware vCloud at the secondary DR site. During DR failover, the development and testing environment is preempted by the production environment.

For more information, refer to the following documentation:

- CVD: Enhanced Secure Multi-Tenancy Design Guide
- Imagine Virtually Anything with Cisco, NetApp, and VMware
- WP-7083: Delivering IT as a Service for Virtualized Data Centers
- WP-7113: An Overview of the Enhanced Secure Multi-Tenancy Architecture

Development and Testing

For businesses of all sizes, the demand for database application development continues to grow at a dramatic rate. Full or partial production database copies are required for many activities, including application development and testing. Often, many copies of the production database are required to support multiple code streams as part of a modular development process. NetApp solutions can dramatically reduce the time, resources, and effort required for rapid and cost-effective database cloning and deployment. NetApp FlexClone clones require less storage than traditional clones, and they can be created without the need for storage administrator support. In addition, the ability to use NetApp storage efficiency technologies from the VMware vSphere layer itself (through the invocation of storage layer services by the VMware vCenter Server) enables rapid and efficient provisioning of server and storage resources for the development and testing environment.

The server virtualization technologies offered by VMware vSphere enable the creation of a base VM that runs a database application that is properly installed and tested. This base VM, which can actually simulate a real production database system, is stored as a set of files in the shared NetApp storage system. It is self-contained and includes a guest operating system, a database application, and all the data and log partitions. Cloning of the VM using NetApp storage-efficient thin cloning technologies, provided by the NetApp Virtual Storage Console (VSC), provides everything needed for a functional development and testing environment.

Another approach to this solution is to first create cloned development and testing VMs that contain just the guest operating system and the database binaries and then to mount the database clones created from the production database instance by using NetApp thin cloning technologies on the cloned VMs.

Database and VMware administrators can use automated and powerful tools from NetApp such as NetApp SnapManager and VSC provisioning to easily and quickly create database and VM clones, using negligible additional storage and without requiring extensive storage skills or storage administrator support.

The development and testing solution fits very well on top of VMware built on FlexPod. VMware built on FlexPod has the required storage system features licensed, such as NetApp FlexClone, iSCSI, and NFS. The NetApp VSC provisioning module is also included in VMware built on FlexPod and can be used to create space-efficient development and testing clones of production VMs.

Note: NetApp SnapDrive and SnapManager for the database application must be purchased separately.

When NetApp SnapDrive and SnapManager are used, logical unit numbers (LUNs) for the development and testing database clones can either be mapped directly to the VM by using iSCSI or be mapped as VMware iSCSI raw device mapping (RDM) LUNs. With VMware built on FlexPod, space-efficient development and testing clones of production environments can be set up quickly, using very little additional storage, and accelerating the application development and testing cycle.

Also, the server blades in the Cisco UCS can be grouped. Pools of blades can be defined in the development and testing and the production organizations. These organizations physically isolate the development and testing blade resources from the production blade resources, and therefore the

development and testing environment from the production environment. In this setup, the development and testing blades and production blades are in two separate VMware ESXi clusters, further separating the two environments. Another way to accomplish development and testing separation is to put all blades into a single organization and a single VMware ESXi cluster and to use resource pools to control resource use in the cluster, providing virtual isolation of development and testing.

For more information, refer to the following documentation:

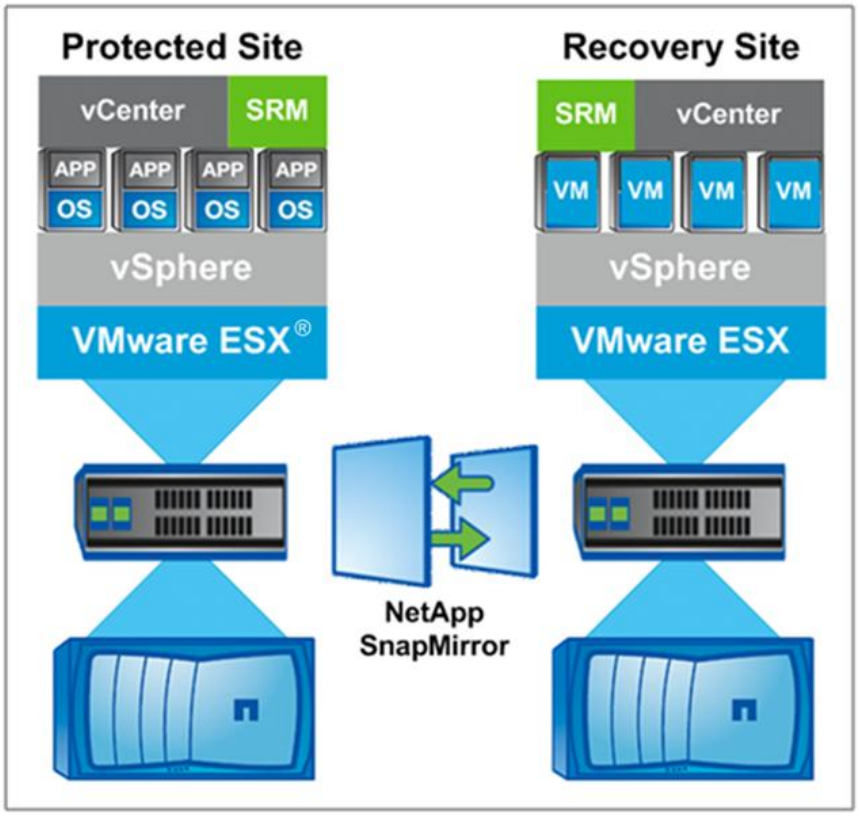
- RA-0005: Accelerating Development of Microsoft SQL Applications in Heterogeneous Environments
- TR-3861: Oracle Dev/Test on VMware vSphere and NetApp Storage Solutions Overview
- TR-3742: Using FlexClone to Clone Files and LUNs

Disaster Recovery

Setting up a disaster recovery (DR) environment involves setting up a secondary or recovery data center site with hardware (compute, network, and storage) that closely mirrors the hardware in the primary or protected data center. In the event of failure of the protected data center, the VMs that were running in the protected data center can be brought up and into production on the hardware at the recovery data center. VMs and VM application data are periodically replicated from the protected data center storage to the recovery data center storage. In addition, a test environment can be brought up at the recovery data center to test the disaster recovery plan. Finally, one recovery data center can serve as the DR site for multiple protected data centers.

A FlexPod configuration can function as a recovery DR site. An ideal situation is to have one or more such configurations at the protected site with one or more FlexPod for VMware configurations at the recovery DR site. The configuration for this solution is simplified because the sites can be set up as mirror images of each other. To implement DR on VMware built on FlexPod, the VMware Site Recovery Manager (SRM) must be purchased, and the NetApp adapter for the VMware SRM must be added to the environment to automatically manage the DR plan and to implement offline tests of this plan at the recovery site. Additionally, the backup portion of NetApp VSC (previously NetApp SnapManager for Virtual Infrastructure) must be purchased, as well as NetApp SnapMirror, SnapDrive, and the appropriate SnapManager products to back up and replicate VMs and VM data to the DR site. The recovery site networking and VMware environment must be manually set up, similarly to the protected site setup. Figure 9 shows a logical representation of a DR setup. VMware built on FlexPod configurations can be used for both the protected site and the recovery site with the purchase of the software listed earlier in this paragraph.

Figure 9) VMware SRM with NetApp storage.



For more information, refer to the following documentation:

- TR-3671: VMware vCenter Site Recovery Manager in a NetApp Environment
- TR-3822: Disaster Recovery of Microsoft Exchange, SQL Server, and SharePoint Server Using VMware vCenter Site Recovery Manager, NetApp SnapManager and SnapMirror, and Cisco Nexus Unified Fabric

5 Conclusion

NetApp and Cisco have combined their technologies to develop FlexPod, a new solution for virtual computing. FlexPod is a defined set of hardware and software that serves as an integrated infrastructure stack for all virtualization solutions. Combining best-in-class compute, network, and storage elements, FlexPod offers an uncompromising infrastructure solution for customers who want to deploy virtualized, nonvirtualized, and hybrid infrastructure solutions for a variety of enterprise applications.

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- TR-3749: NetApp Storage Best Practices for VMware vSphere
  www.netapp.com/us/system/pdf-reader.aspx?pdfuri=tcm:10-104655-16&m=tr-3749.pdf
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  www.netapp.com/us/system/pdf-reader.aspx?pdfuri=tcm:10-61277-16&m=tr-3824.pdf
- TR-4068: VMware vSphere 5 on NetApp Clustered Data ONTAP 8.1
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