NetApp Verified Architecture

FlexPod Express with Cisco UCS C-Series and NetApp FAS2500 Series

NVA Design

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Executive Summary

Industry trends indicate a vast data center transformation toward shared infrastructure and cloud computing. Enterprise customers are moving away from silos of IT operation toward more cost-effective virtualized environments, leading eventually to cloud computing to increase agility and reduce costs. This transformation appears daunting and complex because companies must address resistance to change in both their organizational and their technical IT models. To accelerate this process and simplify the evolution to a shared cloud infrastructure, Cisco and NetApp developed a solution called the FlexPod® data center platform.

FlexPod is a predesigned, best practice data center architecture that is built on the Cisco Unified Computing System (UCS), the Cisco Nexus family of switches, and NetApp fabric-attached storage (FAS). FlexPod is a suitable platform for running a variety of virtualization hypervisors as well as bare-metal operating systems and enterprise workloads. FlexPod delivers a baseline configuration and also has the flexibility to be sized and optimized to accommodate many different use cases and requirements.

2 Program Summary

2.1 NetApp Verified Architecture Program

The NetApp Verified Architecture program offers customers a validated architecture for NetApp solutions. NVAs provide customers with a NetApp solution architecture that is:

- Thoroughly tested
- Prescriptive in nature
- Minimizes deployment risks
- Accelerates customers’ time to market

This document is for NetApp and partner solution engineers and customer strategic decision makers. It describes the architecture design considerations used to determine the specific equipment, cabling, and configuration required in a particular environment.

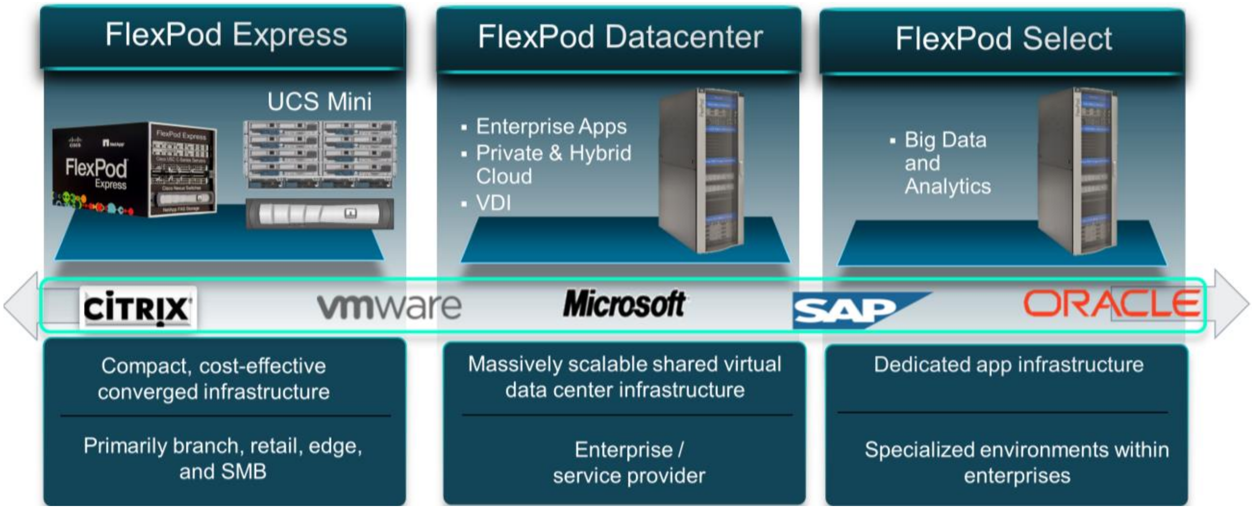
2.2 FlexPod Converged Infrastructure Program

FlexPod delivers key technologies from Cisco and NetApp. FlexPod reference architectures are often delivered as Cisco Validated Designs (CVDs) or NetApp Verified Architectures (NVAs). Deviations because of customer requirements from a given CVD or NVA are encouraged, provided that variations do not result in the deployment of unsupported configurations.

As depicted in Figure 1, the FlexPod program includes three solutions: FlexPod Express, FlexPod Datacenter, and FlexPod Select.

- **FlexPod Express** offers customers an entry-level solution consisting of technologies from Cisco and NetApp.
- **FlexPod Datacenter** delivers an ideal multipurpose foundation for a variety of workloads and applications.
- **FlexPod Select** incorporates the best aspects of FlexPod Datacenter and tailors the infrastructure to a given application.

Figure 1) FlexPod portfolio.



The solution discussed in this design guide is part of the FlexPod Select family. Optimizing Oracle databases can include changes in the compute, network, and storage layer. As such, the design outlined in this document dives into architecture tied to specific performance criteria.

3 Solution Overview

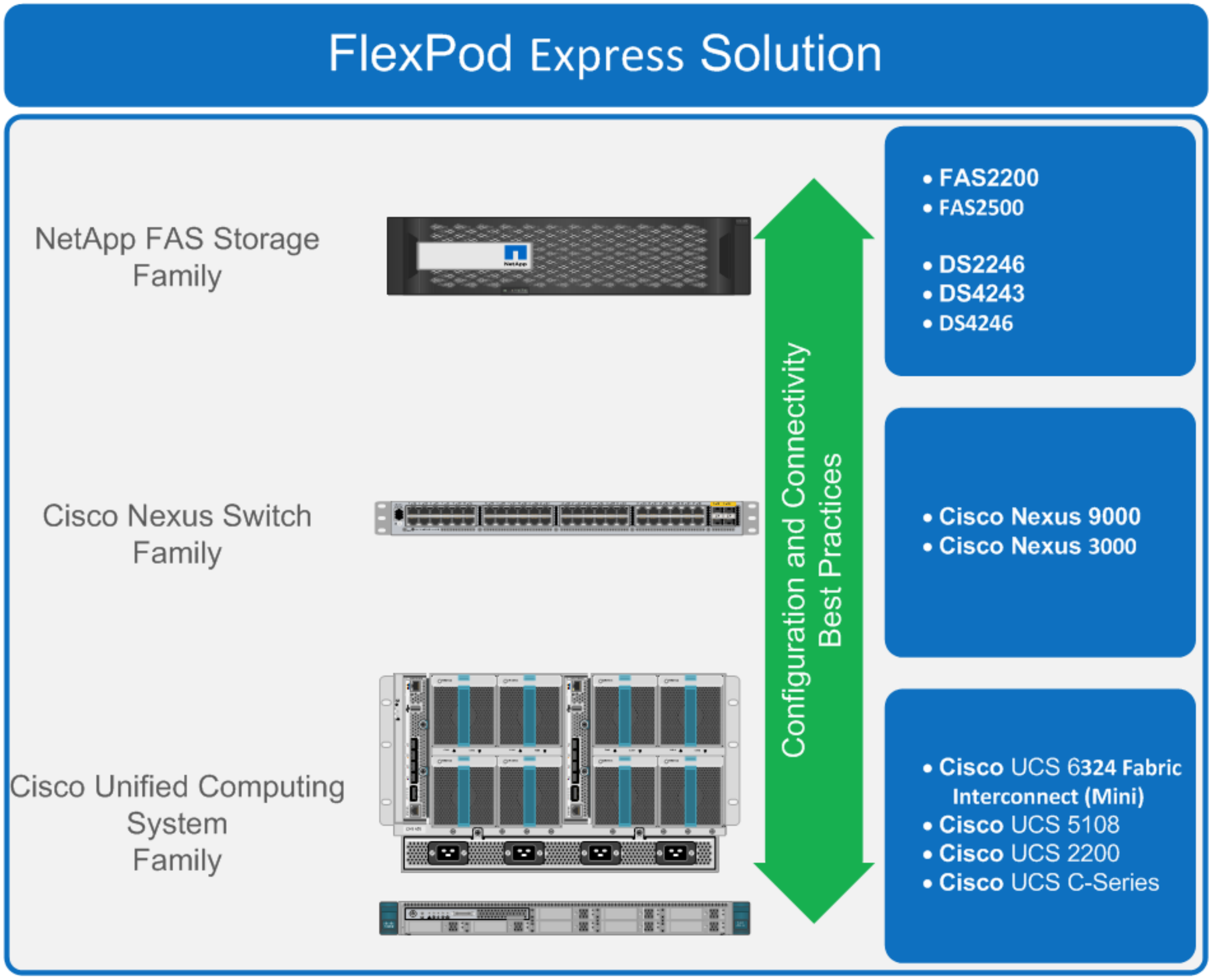
FlexPod Express is a suitable platform for running a variety of virtualization hypervisors as well as bare-metal operating systems and enterprise workloads. FlexPod Express delivers not only a baseline configuration, but also the flexibility to be sized and optimized to accommodate many different use cases and requirements. The small, medium, and large FlexPod Express configurations are low-cost, standardized infrastructure solutions developed to meet the needs of small and midsize businesses. Each configuration provides a standardized base platform capable of running a number of business-critical applications while providing scalability options to enable the infrastructure to grow with the demands of the business.

FlexPod Express:

- Combines all application and data needs into one platform
- Is suitable for small to midsize organizations, remote and departmental deployments
- Provides easy infrastructure scaling
- Reduces cost and complexity

Figure 2 shows the FlexPod Express component families that include Cisco UCS, Cisco Nexus, and NetApp FAS.

Figure 2) FlexPod Express component families.



FlexPod Express supports Cisco UCS C-Series standalone servers and Cisco UCS Mini (UCS managed). This solution validates FlexPod Express with VMware vSphere 6.0 and Microsoft Windows Hyper-V 2012 R2. iSCSI SAN boot and local boot options are also considered as part of the design.

The Cisco UCS Mini fits into the FlexPod Express large configuration provided it is managed by Cisco UCS Manager, which also hosts the Cisco Nexus 3524 10G switching platform. For more details, refer to the following Cisco Validated Design:
http://www.cisco.com/c/dam/en/us/td/docs/unified_computing/ucs/UCS_CVDs/flexpod_express_ucsmini_esxi55_fc.pdf

3.1 Target Audience

NetApp recommends this document for the following audiences:

- Customer and partner architects
- Customer IT business leaders
- Sales engineers, field consultants, and professional services personnel

3.2 Solution Technology

FlexPod Express configurations are built using Cisco UCS C-Series rack servers or Cisco UCS Mini for the compute infrastructure. They also use Cisco Nexus switches and NetApp FAS unified storage systems running the NetApp clustered Data ONTAP® operating system in switchless cluster mode.

FlexPod Express is classified into three categories: small, medium, and large. Both VMware vSphere and Microsoft Windows Hyper-V solutions are available in these variants.

Note: Figures 3 through 5 depict the Cisco UCS C-Series rack servers as the compute infrastructure.

Figure 3) Small configuration.

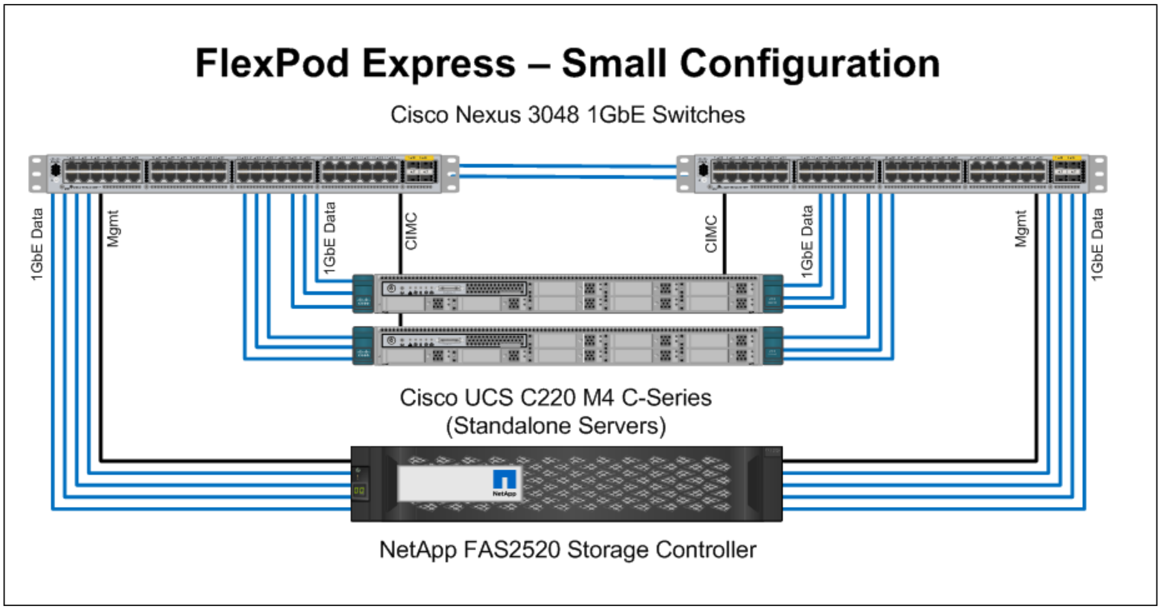


Figure 4) Medium configuration.

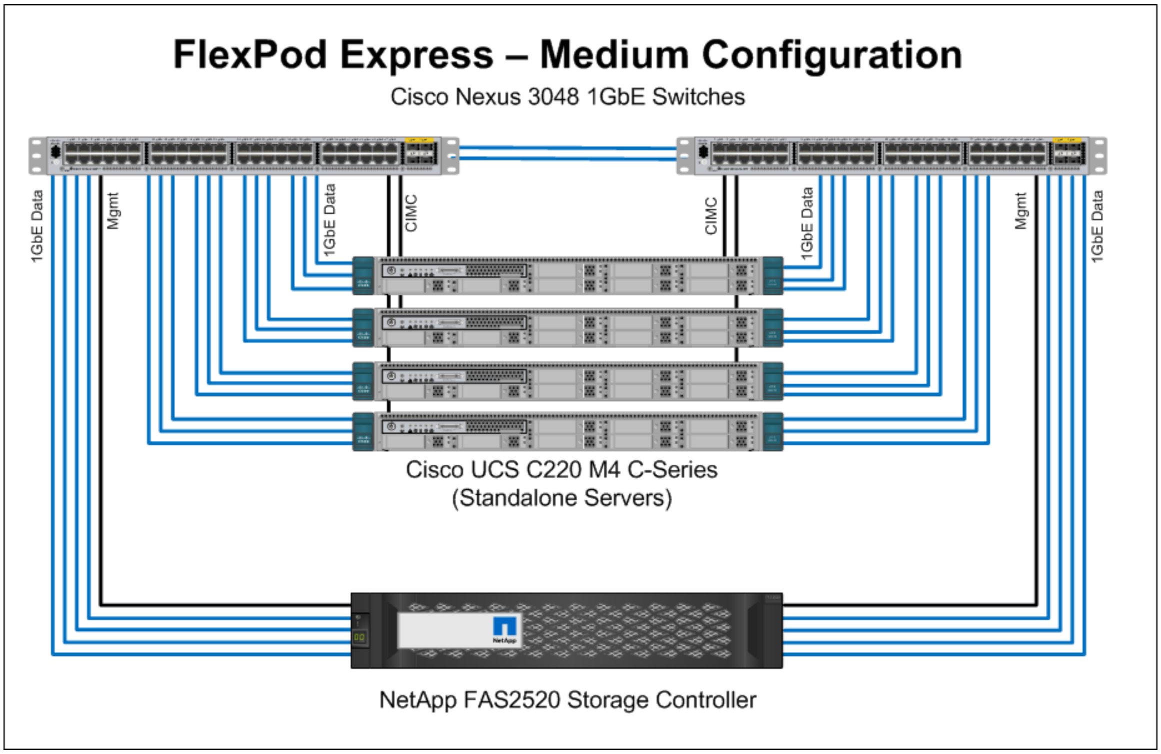


Figure 5) Large configuration.

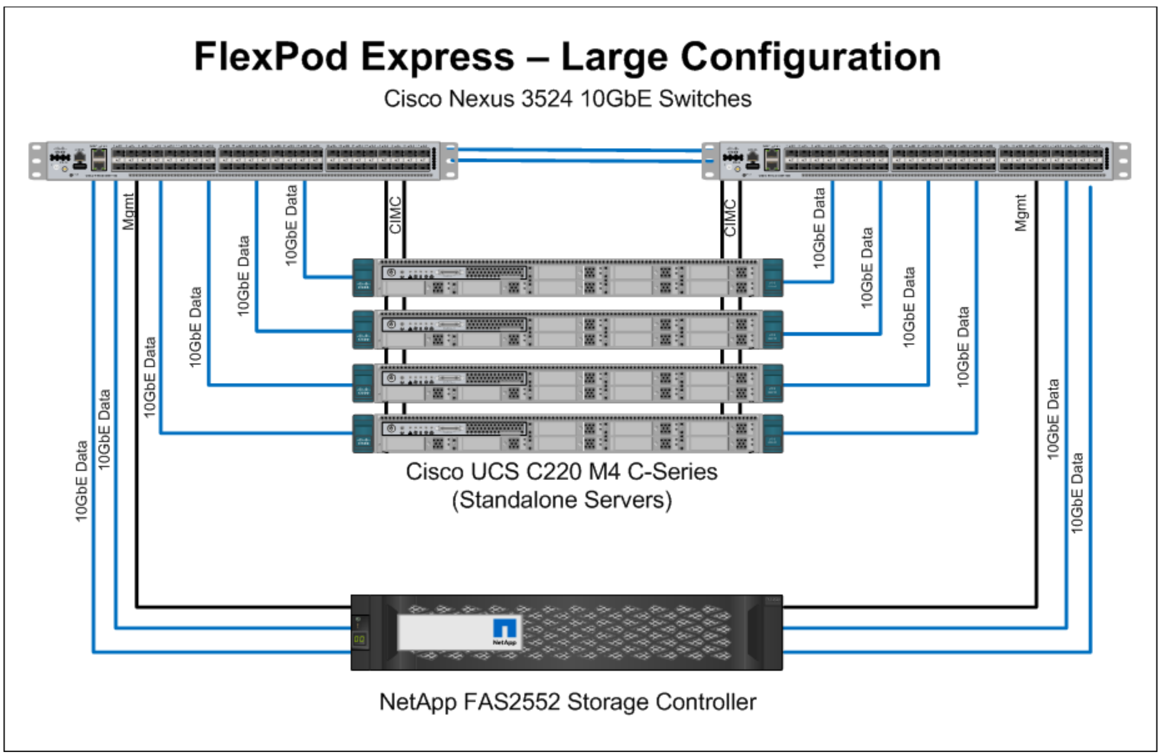


Table 1 lists the hardware components that are essential to build the small, medium, and large FlexPod Express configurations.

Table 1) FlexPod Express configuration.

Small	Medium	Large
NetApp FAS2520	NetApp FAS2520	NetApp FAS2552/2554
Cisco Nexus 3048 switch (1G)	Cisco Nexus 3048 switch (1G)	Cisco Nexus 3524/9396PX switch (10G)
Cisco UCS C-Series servers	Cisco UCS C-Series servers	Cisco UCS C-Series servers/Cisco UCS Mini

3.3 Integrated System Components

The following components are required to deploy the distinct uplink design:

- Cisco Unified Computing System
- Cisco Nexus 3000 and 9000 series switches
- NetApp FAS storage systems
- VMware vSphere/Microsoft Windows Server 2012 Hyper-V

Cisco Unified Computing System

The Cisco Unified Computing System is a next-generation solution for blade and rack server computing. It is an innovative data center platform that unites compute, network, storage access, and virtualization into a cohesive system designed to reduce total cost of ownership (TCO) and increase business agility. The system integrates a low-latency lossless 10-Gigabit Ethernet 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. Managed as a single system whether it has 2 servers or 160 servers with thousands of virtual machines, Cisco UCS decouples scale from complexity. Cisco UCS accelerates the delivery of new services simply, reliably, and securely through end-to-end provisioning and migration support for both virtualized and nonvirtualized systems.

Cisco C-Series M4 Rack Servers

Cisco UCS C-Series rack servers deliver unified computing in an industry-standard form factor to reduce total cost of ownership and increase agility. Each product addresses varying workload challenges through a balance of processing, memory, I/O, and internal storage resources.

Cisco UCS C-Series rack servers provide the following benefits:

- Form-factor-agnostic entry point into Cisco UCS
- Simplified and fast deployment of applications
- Extension of unified computing innovations and benefits to rack servers
- Increased customer choice with unique benefits in a familiar rack package
- Reduction in total cost of ownership (TCO) and increase in business agility

The Cisco UCS C220 M4 rack server is the most versatile general-purpose enterprise infrastructure and application server in the industry. It is a high-density two-socket enterprise-class rack server that delivers industry-leading performance and efficiency for a wide range of enterprise workloads, including virtualization, collaboration, and bare-metal applications. You can deploy Cisco UCS C-Series rack servers as standalone servers or as part of Cisco UCS. Doing so enables you to take advantage of Cisco's standards-based unified computing innovations that help reduce total cost of ownership and increase business agility.

The enterprise-class Cisco UCS C220 M4 server is a one-rack-unit (1RU) form factor. It provides:

- Dual Intel Xeon E5-2600 v3 processors for improved performance suitable for nearly all 2-socket applications
- Next-generation double-data-rate 4 memory and 12Gbps SAS throughput
- Innovative Cisco UCS virtual interface card (VIC) support in PCIe or modular LAN on motherboard form factor

The Cisco UCS C220 M4 server also offers maximum reliability, availability, and serviceability features, including:

- Tool-free CPU insertion
- Easy-to-use latching lid
- Hot-swappable and hot-pluggable components
- Redundant Cisco Flexible Flash SD cards

NetApp FAS Technologies

NetApp solutions offer increased availability and consume fewer IT resources. A NetApp solution includes NetApp FAS controllers and disk storage and the NetApp Data ONTAP operating system. Data ONTAP runs on NetApp storage controllers. NetApp has a diverse hardware portfolio that gives customers the flexibility to select the right storage controllers to support their business requirements. The storage efficiency built in to Data ONTAP provides substantial space savings, which enables more data to be stored at a lower cost.

NetApp offers the NetApp Unified Storage Architecture that simultaneously supports storage area network (SAN), network-attached storage (NAS), and iSCSI across many operating environments, including VMware, Windows, and UNIX. This single architecture provides access to data by using industry-standard protocols, including NFS, CIFS, iSCSI, and FCP. Connectivity options include standard Ethernet (10/100/1000, or 10GbE) and Fibre Channel (2, 4, 8, or 16Gbps). In addition, all systems can be configured with high-performance solid-state drives (SSDs) or serial ATA (SAS) disks for primary storage applications. They also can be configured with low-cost SATA disks for secondary applications (backup, archive, and so on) or with a mix of the different disk types.

For more information, refer to NetApp Data ONTAP 8.3 Operating System.

The NetApp FAS family of controllers consists of several different sizes of controllers to meet the needs of a wide range of customers. For the FlexPod Express architecture, NetApp recommends the FAS2520, FAS2552, FAS2554, or FAS8020 controller to support a remote office solution. NetApp recommends the FAS2520 for FlexPod Express small and medium configurations and the FAS2552/FAS2554 for FlexPod Express large configurations.

The FAS2552 is a 2-rack-unit controller that includes 2 controllers and 24 2.5" disks in a single chassis. The FAS2554 is a 4-rack-unit controller that includes 2 controllers and 24 3.5" disks in a single chassis. The FAS8020 is a 3-rack-unit controller that has no disks in the chassis. The FAS2552 and FAS2554 both support a maximum of 5 external disk shelves, and the FAS8020 supports up to 20 external disk shelves.

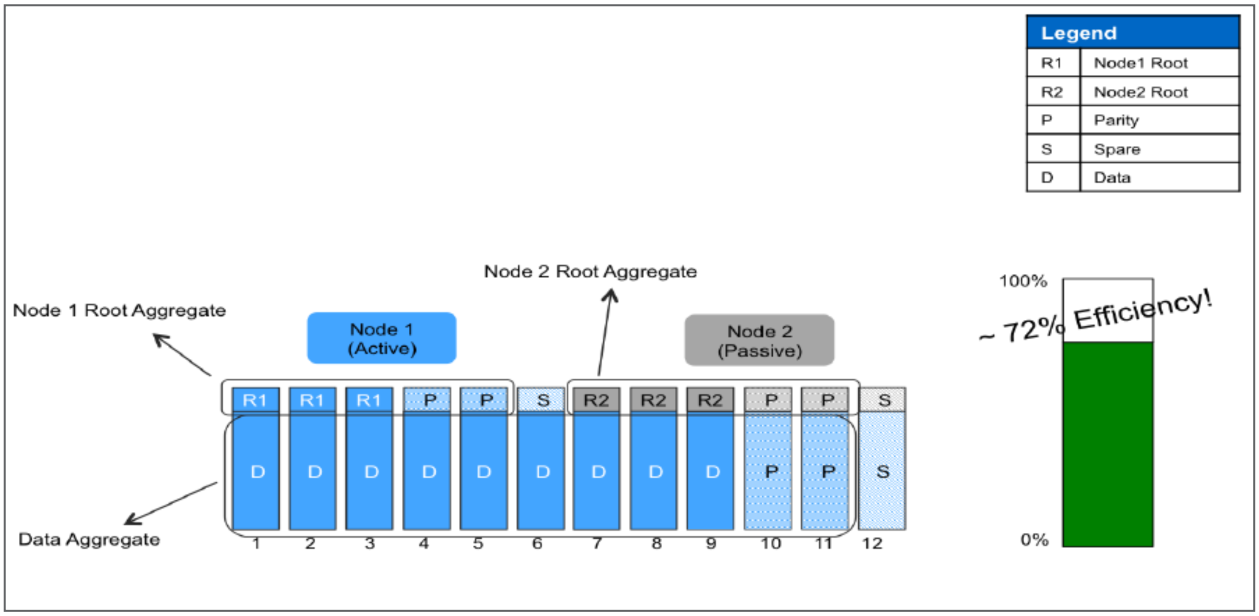
NetApp Clustered Data ONTAP Overview

With clustered Data ONTAP, NetApp provides enterprise-ready, unified scale-out storage. Developed from a solid foundation of proven Data ONTAP technology and innovation, clustered Data ONTAP is the basis for large virtualized shared storage infrastructures architected for nondisruptive operations over the system's lifetime. Controller nodes are deployed in HA pairs that participate in a single storage domain or cluster.

Data ONTAP scale-out offers a method to respond to growth in a storage environment. Growth can encompass adding new remote office locations, adding individual disk shelves, or adding additional controllers to an existing system. As the storage environment grows, additional controllers are added seamlessly to the resource pool residing on a shared storage infrastructure. Host and client connections as well as datastores can move seamlessly and nondisruptively anywhere in the resource pool. This capability enables existing workloads to be easily balanced over the available resources and new workloads to be easily deployed. Technology refreshes (such as replacing disk shelves or adding or completely replacing storage controllers) are accomplished while the environment remains online and continues serving data. Data ONTAP is the first product to offer a complete scale-out solution, and it offers an adaptable, always-available storage infrastructure for today's highly virtualized environments.

Advanced Drive Partitioning (ADP) is a new feature in Data ONTAP 8.3. This feature addresses the storage efficiency challenges in the entry space, increases cache allocation flexibility, and reduces overall $/GB across All Flash FAS platforms. Each HDD is divided into two partitions: root and data. The root aggregate spans the root partition of HDDs, which allows more storage for data partition. Figure 6 shows the storage efficiency reached by using the ADP feature in entry-level FAS systems.

Figure 6) FAS2520 active-passive configuration (with ADP).



Cisco Nexus Switches

FlexPod Express supports Cisco Nexus 3000 and Cisco Nexus 9000 switches. An organization might consider using a Cisco Nexus 3000 series switch as a valid option to meet budgetary constraints. Cisco Nexus 9000 switches can be used in NX-OS mode and Application Centric Infrastructure (ACI) mode.

Cisco Nexus 3000 Series

Cisco Nexus 3000 series switches extend the Cisco Unified Fabric to the data center. Highly programmable, these dense fixed-port switches offer simplified management, enhanced network visibility, and advanced monitoring, all supported by a consistent Cisco NX-OS. This family includes the Cisco Nexus 3000, high-density Cisco Nexus 3100, and ultra-low-latency Cisco Nexus 3500 switches.

Cisco Nexus 9000 Series

The Cisco Nexus 9000 series switches deliver proven high performance and density, low latency, and exceptional power efficiency in a broad range of compact form factors. Operating in Cisco NX-OS software mode (standalone mode) or in Application Centric Infrastructure (ACI) mode, these switches are ideal for traditional or fully automated data center deployments.

The Cisco Nexus 9000 standalone mode FlexPod Express design includes a single pair of Cisco Nexus 9000 top-of-rack switches. When in ACI mode, Cisco Nexus 9500 and 9300 switches are deployed in a spine-leaf architecture.

Application Centric Infrastructure (ACI) is a holistic architecture with centralized automation and policy-driven application profiles. ACI delivers software flexibility with the scalability of hardware performance. Key characteristics of ACI include:

- Simplified automation by an application-driven policy model
- Centralized visibility with real-time application health monitoring
- Open software flexibility for DevOps teams and ecosystem partner integration
- Scalable performance and multi-tenancy in hardware

The future of networking with ACI is about providing a network that is deployed, monitored, and managed in a manner that supports DevOps and rapid application change.

Users will also be able to start with Cisco Nexus 9000 switches in a standalone mode and easily migrate to ACI mode.

VMware vSphere

VMware vSphere is a virtualization platform for holistically managing large collections of infrastructure resources—CPUs, storage, networking—as a seamless, versatile, and dynamic operating environment. Unlike traditional operating systems that manage an individual machine, VMware vSphere aggregates the infrastructure of an entire data center. This approach creates a single powerhouse with resources that you can allocate quickly and dynamically to any application in need.

VMware vSphere provides revolutionary benefits, but with a practical, nondisruptive evolutionary process for legacy applications. You can deploy existing applications on VMware vSphere with no changes to the application or the OS on which they run.

VMware vSphere provides a set of application services that enable applications to achieve unparalleled levels of availability and scalability. As illustrated below, VMware vSphere delivers core capabilities to meet numerous application and enterprise demands. The VMware vSphere 6.0 built on FlexPod Express integrated system highlights the following vSphere features:

- Availability
  - Workload mobility is enabled through VMware vMotion.
  - High availability is provided through vSphere FDM technology, which offers virtual machine resiliency in the event of physical server or guest OS failure.
- Automation
  - VMware Distributed Resource Scheduler (DRS) offers dynamic workload distribution to align resource use with business priorities and compute capacity. DRS provides efficient use of compute resources and, later, power consumption.
- Compute
  - VMware vSphere ESXi hypervisor provides efficient memory, storage, and compute abstraction through VMs.
- Storage
  - Thin provisioning enables overprovisioning of storage resources to improve storage use and improve capacity planning.
  - Virtual Machine File System (VMFS) is a clustered file system that gives multiple hosts simultaneous read and write access to a single volume on a SCSI-based device through FC, FCoE, or iSCSI. VMFS-5 supports a maximum of 32 hosts connected to a single volume that can be up to 64TB in size.

The VMware vSphere environment delivers a robust application environment. For example, VMware vSphere High Availability (HA) protects all applications from downtime without the complexity of conventional clustering. In addition, applications can be scaled dynamically to meet changing loads with capabilities such as Hot Add and VMware DRS.

For more information, refer to http://www.vmware.com/in/products/vsphere/.

Windows Server 2012 R2 Hyper-V

Windows Server 2012 R2 Hyper-V provides significant scalability and expands support for host processors and memory. Windows Server 2012 R2 Hyper-V includes the following new features:

- Support for up to 64 processors and 1 terabyte (TB) of memory for Hyper-V VMs, in many cases supporting 4 to 16 times the density of processors, memory, cluster nodes, and running VMs.
- Support for innovative server features, including the capability to project a virtual nonuniform memory access topology onto a VM to provide optimal performance and workload scalability in large VM configurations.
- Improvements to dynamic memory, including minimum memory and Hyper-V smart paging. Minimum memory enables Hyper-V to reclaim the unused memory from VMs to enable higher VM consolidation numbers. Smart paging is used to bridge the memory gap between minimum and start-up memory. This feature enables VMs to start reliably when the minimum memory setting indirectly led to an insufficient amount of available physical memory during restart.
- Run-time configuration of memory settings, including increasing the maximum memory and decreasing the minimum memory of running VMs.

The following updated features help the virtualization infrastructure to support the configuration of large high-performance VMs to maintain demanding workloads:

- VHDX offers higher capacity (up to 64TB of storage), helps provide additional protection from inconsistency from power failures, and prevents performance degradation on large-sector physical disks by optimizing structure alignment.
- VFC support offers VMs unmediated access to SAN LUNs. VFC enables scenarios such as running the Windows Failover Cluster Management feature inside the guest OS of a VM connected to shared FC storage. VFC supports Microsoft Multipath I/O (MPIO), N_Port ID virtualization for one-to-many mappings, and up to four VFC adapters per VM.

Windows Server 2012 R2 includes the following networking enhancements:

- Support for single-root I/O virtualization
- Third-party extensions to the Hyper-V extensible switch
- Quality of service minimum bandwidth
- Network virtualization
- Data center bridging

The virtualization layer is one of the primary enablers in environments with greater IT maturity. The decoupling of hardware, OSs, data, applications, and user state offers a wider range of options for easier management and distribution of workloads across the physical infrastructure. The capability of the virtualization layer to migrate running VMs from one server to another without downtime, along with many other features provided by hypervisor-based virtualization technologies, enables a rich set of solution capabilities. These capabilities can be used by the automation, management, and orchestration layers to maintain desired states and proactively address decaying hardware or other issues that would otherwise cause faults or service disruptions.

Like the hardware layer, the automation, management, and orchestration layers must be able to manage the virtualization layer. Virtualization provides an abstraction of software from hardware that moves the majority of management and automation to software instead of requiring users to perform manual operations on physical hardware.

With this release, Windows Server 2012 Hyper-V introduces a number of improvements in both virtualization features and scale.

The Hyper-V host cluster requires different types of network access, as described in Table 2.

Table 2) Host cluster networks.

Network Access Type	Purpose of Network Access Type	Network Traffic Requirements	Recommended Network Access
VM access	Workloads running on VMs usually require external network connectivity to service client requests.	Varies	Public access that can be teamed for link aggregation or to fail over the cluster
Clusters and CSVs	• Preferred network used by the cluster for communications to maintain cluster health. Also used by CSV to send data between owner and nonowner nodes. If storage access is interrupted, this network is used to access CSV or to maintain and back up CSV. • The cluster should have access to more than one network for communication to make it highly available.	Usually low bandwidth and low latency; occasionally high bandwidth	Private access
SMB 3.0	Access storage through SMB 3.0.	High bandwidth and low latency	Usually dedicated and private access
Live migration	Transfer VM memory and state.	High bandwidth and low latency during migrations	Private access
Storage	Access storage through iSCSI.	High bandwidth and low latency	Usually dedicated and private access
Management	Manage the Hyper-V management OS; this network is used by Hyper-V Manager.	Low bandwidth	Public access that can be teamed to fail over the cluster

Highly available host servers are one critical component of a dynamic virtual infrastructure. A Hyper-V host failover cluster is a group of independent servers that work together to increase the availability of applications and services. The clustered servers (nodes) are connected physically. If one cluster node fails, another node begins to provide service. In the case of a planned live migration, users experience no perceptible service interruption.

FlexPod Express Hyper-V Storage Options

Storage for virtual disks (VHDX files) can be provided from the NetApp storage system in the following ways:

- Block-level LUN over iSCSI attached directly to Hyper-V servers, presented as volumes on a standalone Hyper-V server or as CSVs in a Microsoft failover cluster
- File-level storage on NetApp SMB 3.0 continuously available file share

NetApp to Windows Server 2012 R2 Integration

NetApp provides tight integration between storage (block or file level) and the Windows Server 2012 R2 host through the following technologies and products:

- The offloaded data transfer (ODX) feature works transparently on a Windows Server 2012 host and provides much faster provisioning of VMs from the master image. This work includes migrating, moving, importing, and exporting either the whole VM or only the VM storage. On NetApp arrays, ODX works across protocols and between file and block storage, which enables a mix of storage options for Windows 2012 Hyper-V VM storage.
- The NetApp SMI-S agent provides a unified storage management interface that you can use to discover, monitor, and manage NetApp storage systems. The interface also provides seamless integration of NetApp storage into Windows Server 2012 R2 and Microsoft System Center Virtual Machine Manager.
- NetApp SnapManager® software for Hyper-V with remote VSS capabilities protects VM resources running on block-level attached LUNs and CSVs and on remote SMB 3.0 file shares. The solution uses NetApp Snapshot® technology to offload the backup process from the Hyper-V host to the NetApp storage system. It can apply NetApp SnapMirror® technologies to off-site backups at remote locations. This tool has an easy-to-use management interface along with a set of PowerShell cmdlets for robust automation.
- Thin provisioning is a part of the storage-efficiency technologies that, along with deduplication, reduce both the allocated disk space and the overall cost of storage.

3.4 FlexPod Express Distinct Uplink Design

Figures 7 through 10 detail the distinct uplink design of FlexPod Express small/medium and large configurations with a clustered Data ONTAP logical model for VMware and Windows, respectively. The role of each component within the model is described in the sections that follow.

Figure 7) FlexPod Express 1G distinct uplink design with clustered Data ONTAP (VMware).

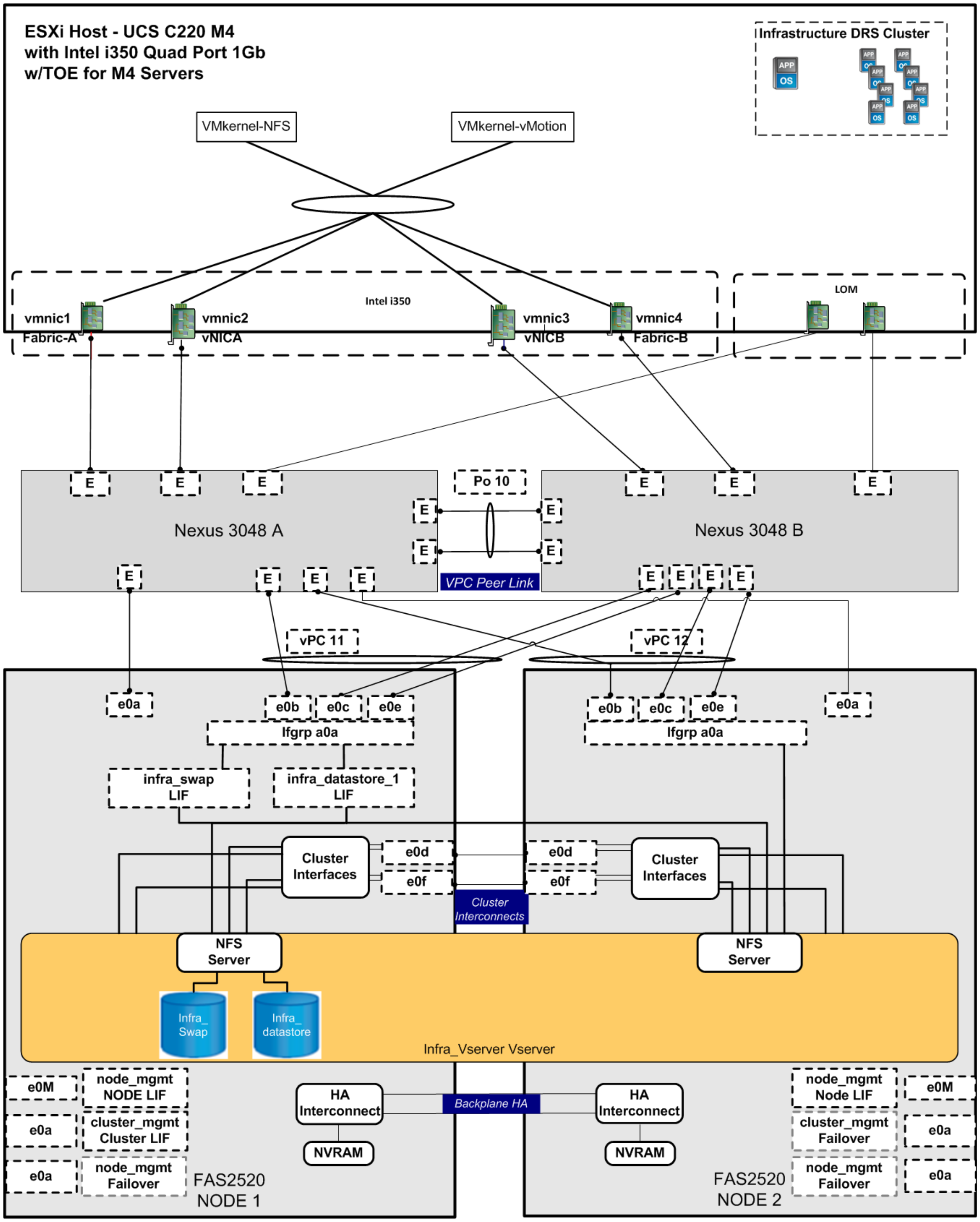


Figure 8) FlexPod Express 10G distinct uplink design with clustered Data ONTAP (VMware).

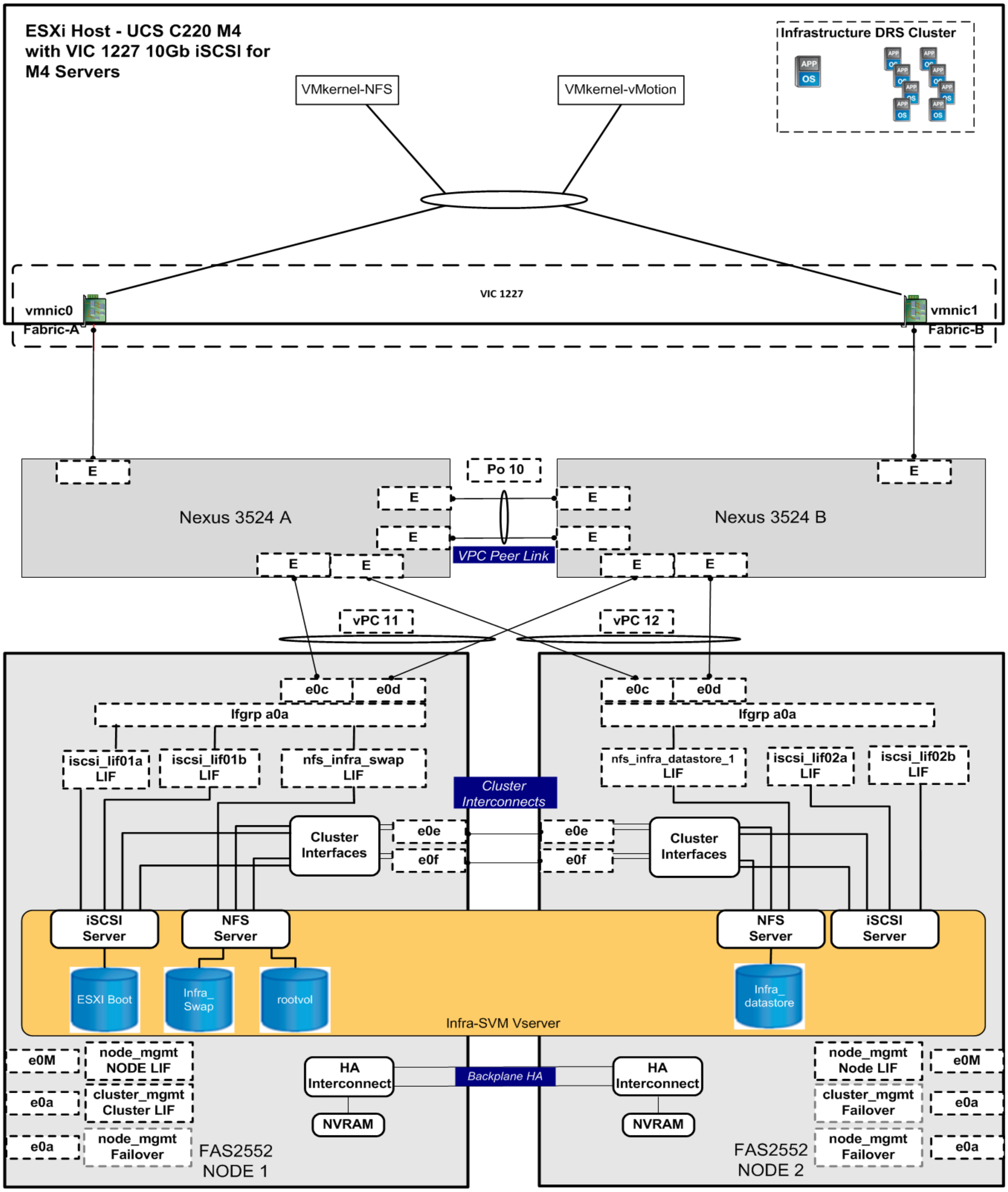


Figure 9) FlexPod Express 1G distinct uplink design with clustered Data ONTAP (Hyper-V).

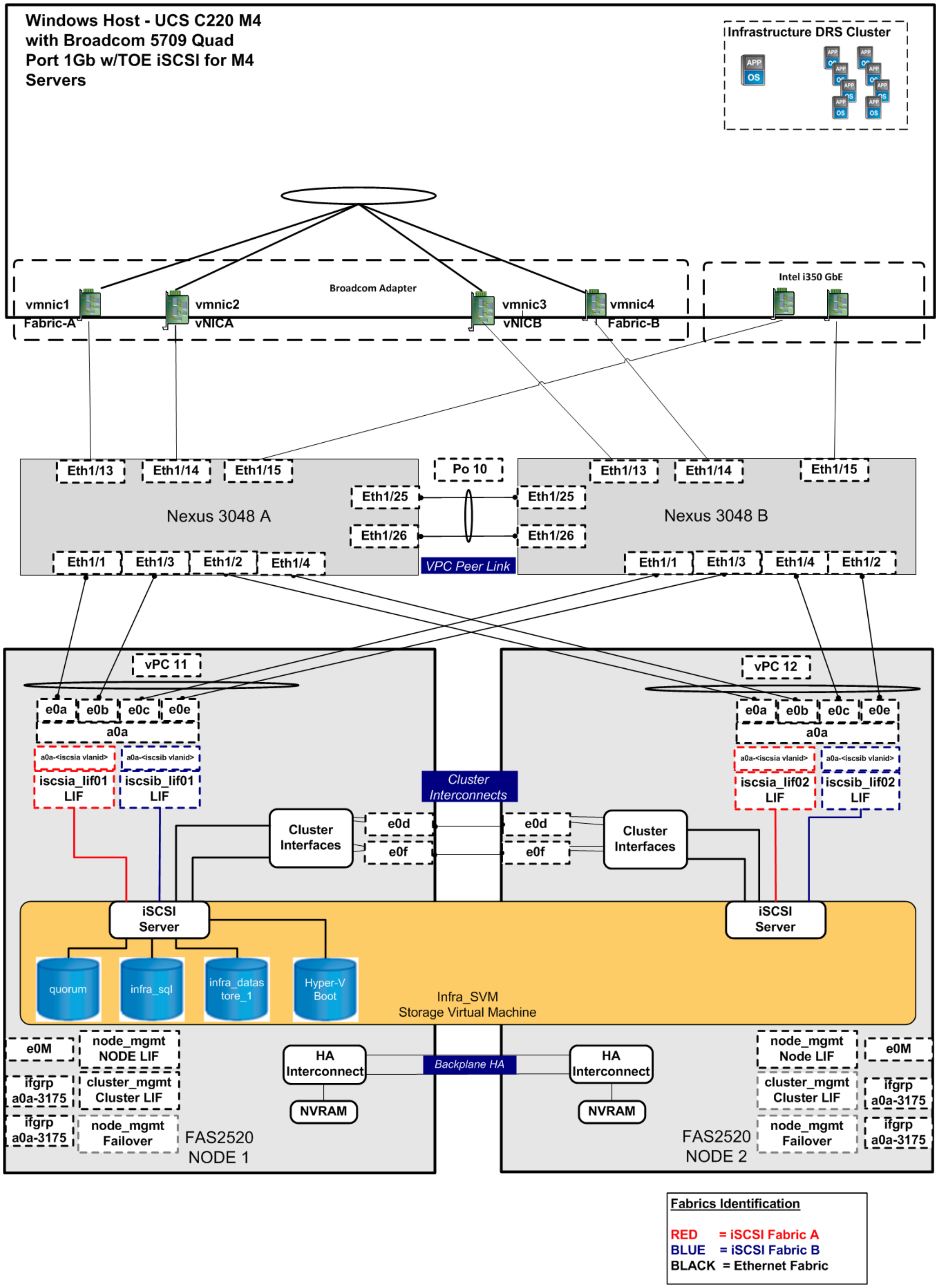
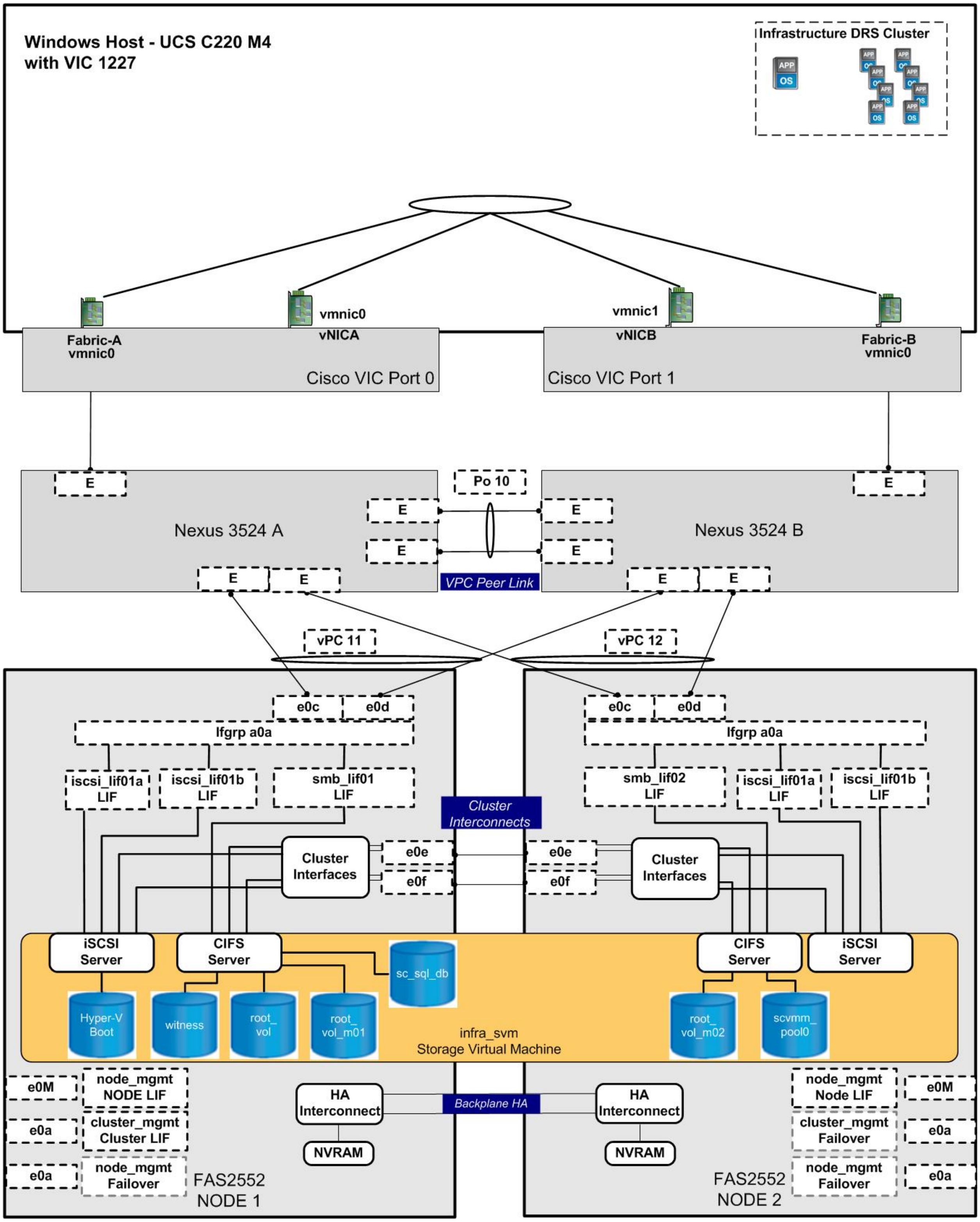


Figure 10) FlexPod Express 10G distinct uplink design with clustered Data ONTAP (Hyper-V).



3.5 Use Case Summary

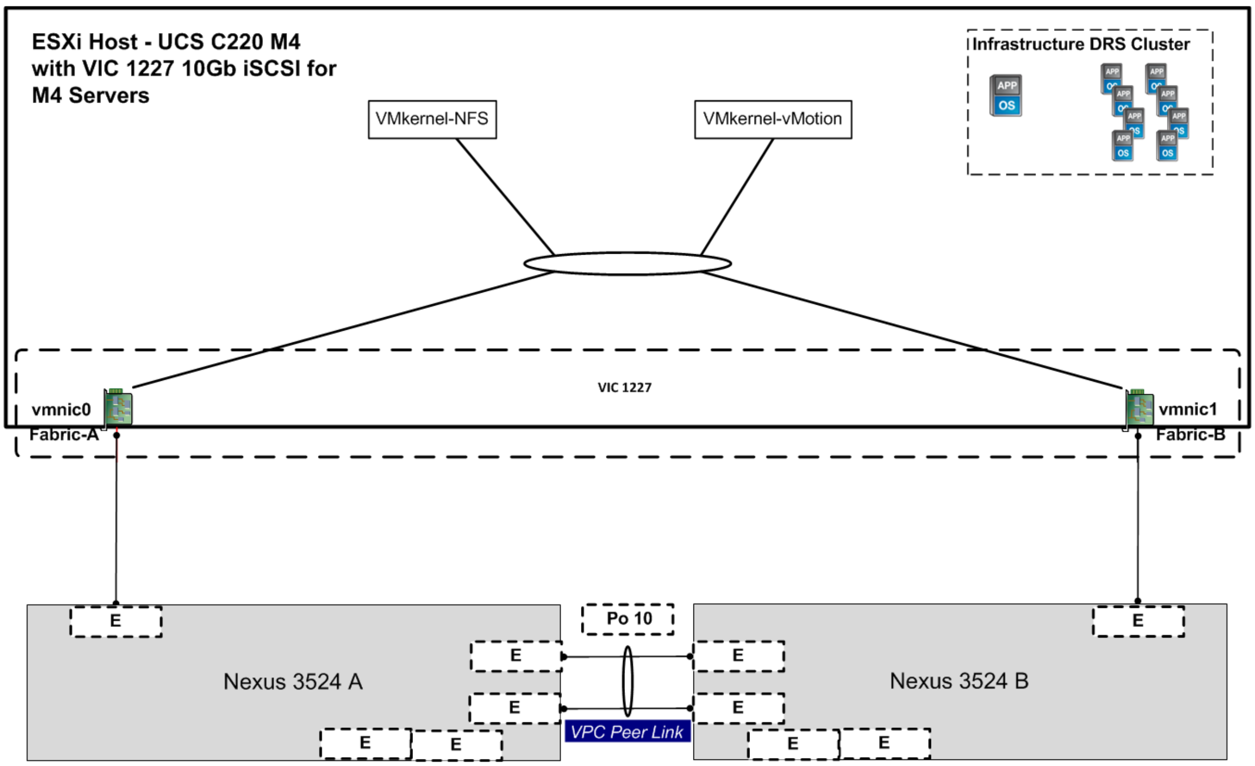
This solution applies to the following use cases:

- Customers requiring a remote office-branch office (ROBO) solution
- Customers requiring a cost-effective solution.

Cisco Unified Computing System C-Series Server Design

Cisco UCS supports the virtual server environment by providing a robust, highly available, and extremely manageable compute resource. As illustrated in Figure 11, the components of Cisco UCS offer physical redundancy and a set of logical structures to deliver a resilient FlexPod compute domain. The ESXi nodes include the Cisco UCS C220-M4 series blades with Cisco 1227 VIC adapters. These nodes were allocated to a VMware DRS and HA-enabled cluster supporting infrastructure services such as vSphere Virtual Center, Microsoft Active Directory, and database services.

Figure 11) FlexPod Express 1G distinct uplink design: Cisco UCS C-Series and Cisco Nexus 3048 focus.



NetApp Storage Controllers

Figure 12 details the logical configuration of the clustered Data ONTAP environment used during validation. The physical cluster consists of two NetApp storage controllers (nodes) configured as an HA pair in switchless cluster configuration; disks and shelves are not shown in this example. As illustrated, the storage controllers use multiple constructs to abstract the physical resources. These elements include:

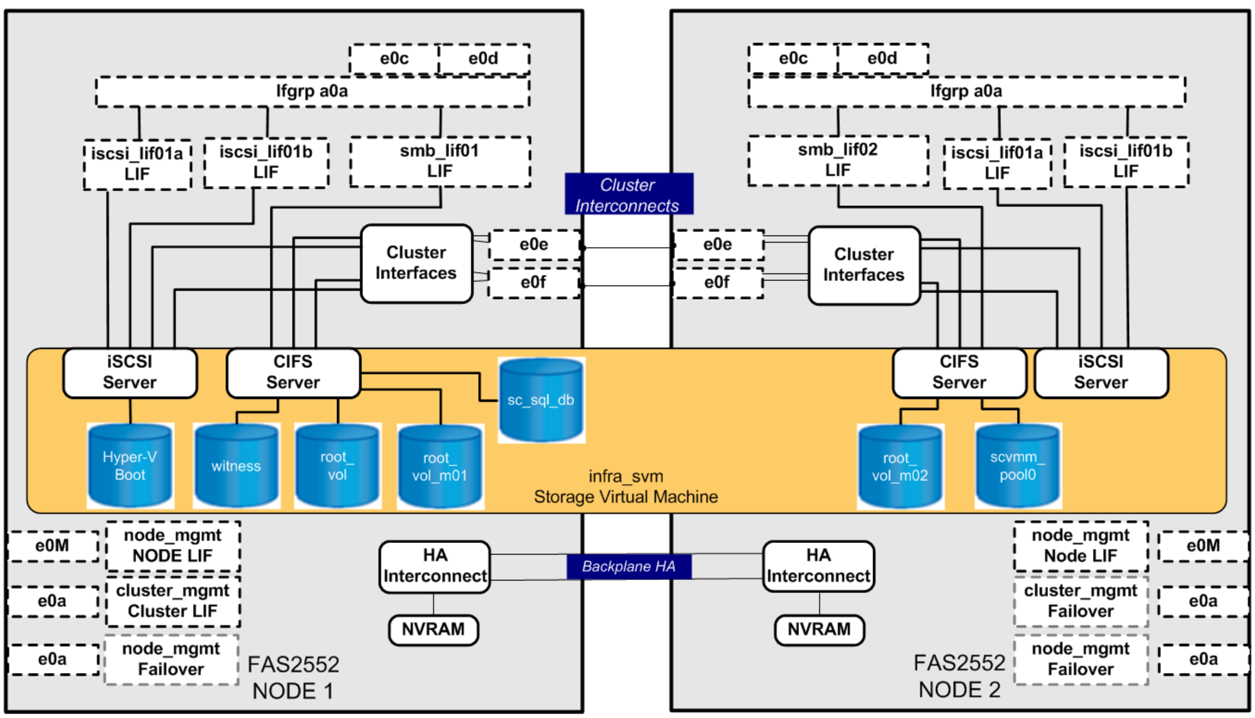
- **Ports.** A physical port such as e0a or e0e or a logical port such as a virtual LAN (VLAN) or an interface group (ifgrp).
- **Ifgrps**. A collection of physical ports to create one logical port constitutes an interface group. NetApp's interface group is a link aggregation technology and can be deployed in single (active-passive), multiple (“always-on"), or dynamic (active LACP) mode. However, NetApp recommends

using only dynamic interface groups to take advantage of LACP-based load distribution and link failure detection.

- **LIF**. A logical interface that is associated to a physical port, interface group, or VLAN interface. More than one LIF can be associated to a physical port at the same time. There are four types of LIFs:
  - NFS LIF
  - CIFS LIF
  - iSCSI LIF
  - FC LIF

  LIFs are logical network entities that have the same characteristics as physical network devices but are not tied to physical objects. LIFs used for Ethernet traffic are assigned specific Ethernet-based details such as IP addresses and iSCSI qualified names and then are associated with a specific physical port capable of supporting Ethernet. LIFs used for FC-based traffic are assigned specific FC-based details such as worldwide port names and then are associated with a specific physical port capable of supporting FC or FCoE. NAS LIFs can be nondisruptively migrated to any other physical network port throughout the entire cluster at any time, either manually or automatically (by using policies). However, SAN LIFs rely on MPIO and asymmetric logical unit access to notify clients of any change in the network topology.
- **Storage virtual machine (SVM, formerly called Vserver).** An SVM is a secure virtual storage server that contains data volumes and one or more LIFs through which it serves data to the clients. An SVM securely isolates the shared virtualized data storage and network and appears as a single dedicated server to its clients. Each SVM has a separate administrator authentication domain and can be managed independently by an SVM administrator.

Figure 12) FlexPod Express 10G distinct uplink design: NetApp storage controller focus (Hyper-V).



Nodes 1 and 2 form a two-node storage failover pair through the HA interconnect direct connection. The FlexPod Express design uses the following port and interface assignments:

- Ports 0c and 0d on each node support iSCSI data traffic that is accessible through an iSCSI LIF assigned to SAN A or B (red or blue fabric).

- Ethernet ports e0c and e0d on each node are members of a multimode LACP interface group for Ethernet data. This interface group has a LIF associated with it to support NFS traffic.
- Ports e0M are on each node and support a LIF dedicated to node management. Port e0a is defined as a failover port supporting the `node_mgmt` role.
- Ports e0a support cluster management data traffic through the cluster management LIF. This port and LIF enable administration of the cluster from the failover port and LIF if necessary.
- Ports e0e and e0f are cluster interconnect ports for cluster traffic. These ports connect to each node to create a switchless cluster.

4 Technology Requirements

This section covers the technology components for the FlexPod Express solution.

4.1 Hardware Requirements

Although Cisco UCS Mini is supported in FlexPod Express, the solution validation described in this document uses Cisco UCS C-Series servers.

Table 3 lists the hardware components required to implement the small and medium configuration for the FlexPod Express with VMware and Hyper-V solution.

Table 3) Hardware requirements for small and medium configuration.

Hardware	Quantity
NetApp FAS2520	1 HA pair
Cisco Nexus 3048 switch	2
Cisco C220 M4 servers with 2133Mhz processor, 8 x 16GB DIMM memory	2
Broadcom 5709 quad-port 1Gb	1
Embedded dual-port Intel i350 Gigabit Ethernet controller	1

Table 4 lists the hardware components required to implement the large configuration for the FlexPod Express with VMware and Hyper-V solution.

Table 4) Hardware requirements for large configuration.

Hardware	Quantity
NetApp FAS2552 and FAS2554	1 HA pair
Cisco Nexus 3524/9396PX switch	2
Cisco C220 M4 servers with 2133Mhz processor, 8 x 16GB DIMM memory	2
Cisco UCS VIC 1225/1227	2

Note: The 1Gb management connection to the Cisco Nexus 3524 requires GLC-Ts.

4.2 Software Requirements

Table 5 lists the software components required to implement the FlexPod Express solution. The software components used in any particular implementation of the solution might vary based on customer requirements.

Table 5) Software requirements.

Software	Version
Compute	
Cisco CIMC	2.0(3)
Network	
Cisco NX-OS	6.0(2)U6(1)—Cisco Nexus 3048 6.0(2)A6(1)—Cisco Nexus 3524
Storage	
NetApp Data ONTAP	8.3
NetApp Virtual Storage Console	6.0
Hypervisor	
VMware vSphere	6.0
VMware vCenter	6.0
Microsoft Windows Hyper-V	2012 R2
Microsoft System Center	2012 R2

5 Solution Verification

Cisco and NetApp designed and built FlexPod Express as their premiere shared infrastructure platform. Customers can trust that the FlexPod Express infrastructure was fully tested and validated to the highest standards to save them time and money as well as to mitigate risk. In keeping with this precedent, the architecture listed in this document was thoroughly tested by Cisco and NetApp data center architects and engineers. From redundancy and availability to each individual feature, the entire FlexPod Express architecture is validated to instill confidence in our customers and to build trust in the design.

6 Conclusion

FlexPod Express is the optimal shared infrastructure foundation on which to deploy a variety of IT workloads. Cisco and NetApp created a platform that is both flexible and scalable for various use cases and applications. One common use case is to deploy VMware vSphere or Windows Hyper-V as the virtualization solution, as described in this document. FlexPod Express can efficiently and effectively support business-critical applications running simultaneously from the same shared infrastructure. The flexibility and scalability of FlexPod Express also enable customers to start out with a right-sized infrastructure that can ultimately grow with and adapt to their evolving business requirements.

7 References

This report refers to the following documents and resources:

- NetApp FAS25XX series storage controllers:
  http://www.netapp.com/in/products/storage-systems/fas2500/
- Cisco UCS C-Series servers:
  http://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.html
- Cisco Nexus 3000 switches:
  http://www.cisco.com/c/en/us/products/switches/nexus-3000-series-switches/index.html

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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