



FlexPod Definition

FlexPod

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FlexPod Definition

FlexPod Express Technical Specifications

TR-4293: FlexPod Express Technical Specifications

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FlexPod Express is a predesigned, best practice architecture that is built on the Cisco Unified Computing System (Cisco UCS) and the Cisco Nexus family of switches, and the storage layer is built by using the NetApp FAS or the NetApp E-Series storage. FlexPod Express is a suitable platform for running various virtualization hypervisors and bare metal operating systems (OSs) 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. This document categorizes the FlexPod Express configurations based on the storage system used, FlexPod Express with NetApp FAS and FlexPod Express with E-Series.

FlexPod platforms

There are three FlexPod platforms:

- **FlexPod Datacenter.** This platform is a massively scalable virtual data center infrastructure suited for workload enterprise applications, virtualization, VDI, and public and private cloud. FlexPod Datacenter has its own specifications, which are documented in [TR-4036: FlexPod Datacenter Technical Specifications](#).
- **FlexPod Express.** This platform is a compact converged infrastructure that is targeted for remote office and edge use cases.

This document provides the technical specifications for the FlexPod Express platform.

FlexPod Rules

The FlexPod design allows a flexible infrastructure that encompasses many different components and software versions.

Use the rule sets as a guide for building or assembling a valid FlexPod configuration. The numbers and rules listed in this document are the minimum requirements for FlexPod; they can be expanded in the included product families as required for different environments and use cases.

Supported versus validated FlexPod configurations

The FlexPod architecture is defined by the set of rules described in this document. The hardware components and software configurations must be supported by the Cisco Hardware Compatibility List (HCL) and the [NetApp Interoperability Matrix Tool \(IMT\)](#).

Each Cisco Validated Design (CVD) or NetApp Verified Architecture (NVA) is a possible FlexPod configuration. Cisco and NetApp document these configuration combinations and validate them with extensive end-to-end testing. The FlexPod deployments that deviate from these configurations are fully supported if they follow the

guidelines in this document and all the components are listed as compatible in the Cisco HCL and NetApp [IMT](#).

For example, adding additional storage controllers or Cisco UCS servers and upgrading software to newer versions is fully supported if the software, hardware, and configurations meet the guidelines defined in this document.

Storage Software

FlexPod Express supports storage systems that run NetApp ONTAP or SANtricity operating systems.

NetApp ONTAP

The NetApp ONTAP software is the operating system that runs on AFF and FAS storage systems. ONTAP provides a highly scalable storage architecture that enables nondisruptive operations, nondisruptive upgrades, and an agile data infrastructure.

For more information about ONTAP, see the [ONTAP product page](#).

E-Series SANtricity software

E-Series SANtricity software is the operating system that runs on E-Series storage systems. SANtricity provides a highly flexible system that meets varying application needs and offers built-in high availability and a wide variety of data protection features.

For more information, see the [SANtricity product page](#).

Minimum hardware requirements

This section describes the minimum hardware requirements for the different versions of FlexPod Express.

FlexPod Express with NetApp FAS

The hardware requirements for FlexPod Express solutions that use NetApp FAS controllers for underlying storage include the configurations describe in this section.

CIMC-based configuration (standalone rack servers)

The Cisco Integrated Management Controller (CIMC) configuration includes the following hardware components:

- Two 10Gbps standard Ethernet switches in a redundant configuration (Cisco Nexus 31108 is recommended, with Cisco Nexus 3000 and 9000 models supported)
- Cisco UCS C-Series standalone rack servers
- Two AFF C190, AFF A250, FAS2600, or FAS 2700 series controllers in a high-availability (HA) pair configuration deployed as a two-node cluster

Cisco UCS-managed configuration

The Cisco UCS-managed confirmation includes the following hardware components:

- Two 10Gbps standard Ethernet switches in a redundant configuration (Cisco Nexus 3524 is recommended)
- One Cisco UCS 5108 alternating current (AC) blade server chassis
- Two Cisco UCS 6324 fabric interconnects
- Cisco UCS B-Series servers (at least four Cisco UCS B200 M5 blade servers)
- Two AFF C190, AFF A250, FAS2750, or FAS2720 controllers in an HA pair configuration (requires two available unified target adapter 2 [UTA2] ports per controller)

FlexPod Express with E-Series

The hardware requirements for the FlexPod Express with E-Series starter configuration include:

- Two Cisco UCS 6324 fabric interconnects
- One Cisco UCS Mini chassis 5108 AC2 or DC2 (the Cisco UCS 6324 fabric interconnects are only supported in the AC2 and DC2 chassis)
- Cisco UCS B-Series servers (at least two Cisco UCS B200 M4 blade servers)
- One HA pair configuration of an E-Series E2824 storage system loaded with minimum 12 disk drives
- Two 10Gbps standard Ethernet switches in a redundant configuration (existing switches in the data center can be used)

These hardware components are required to build a starter configuration of the solution; additional blade servers and disk drives can be added as needed. The E-Series E2824 storage system can be replaced with a higher platform and can also be run as an all-flash system.

Minimum Software Requirements

This section describes the minimum software requirements for the different versions of FlexPod Express.

Software requirements for FlexPod Express with NetApp AFF or FAS

The software requirements for the FlexPod Express with NetApp FAS include:

- ONTAP 9.1 or later
- Cisco NX-OS version 7.0(3)I6(1) or later
- In the Cisco UCS- managed configuration, Cisco UCS Manager UCS 4.0(1b)

All software must be listed and supported in the [NetApp IMT](#). Certain software features might require more recent versions of code than the minimums listed in previous architectures.

Software requirements for FlexPod Express with E-Series

The software requirements for the FlexPod Express with E-Series include:

- E-Series SANtricity software 11.30 or higher
- Cisco UCS Manager 4.0(1b).

All software must be listed and supported in the [NetApp IMT](#).

Connectivity requirements

This section describes the connectivity requirements for the different versions of FlexPod Express.

Connectivity requirements for FlexPod Express with NetApp FAS

The connectivity requirements for FlexPod Express with NetApp FAS include:

- NetApp FAS storage controllers must be directly connected to the Cisco Nexus switches, except in the Cisco UCS-managed configuration, where storage controllers are connected to the fabric interconnects.
- No additional equipment can be placed inline between the core FlexPod components.
- Virtual port channels (vPCs) are required to connect the Cisco Nexus 3000/9000 series switches to the NetApp storage controllers.
- Although it is not required, enabling jumbo frame support is recommended throughout the environment.

Connectivity requirements for FlexPod Express with NetApp E-Series

The connectivity requirements for FlexPod Express with E-Series include:

- The E-Series storage controllers must be directly connected to the fabric interconnects.
- No additional equipment should be placed inline between the core FlexPod components.
- vPCs are required between the fabric interconnects and the Ethernet switches.

Connectivity requirements for FlexPod Express with NetApp AFF

The connectivity requirements for FlexPod Express with NetApp AFF include:

- NetApp AFF storage controllers must be directly connected to the Cisco Nexus switches, except in the Cisco UCS-managed configuration, where storage controllers are connected to the fabric interconnects.
- No additional equipment can be placed inline between the core FlexPod components.
- Virtual port channels (vPCs) are required to connect the Cisco Nexus 3000/9000 series switches to the NetApp storage controllers.
- Although it is not required, enabling jumbo frame support is recommended throughout the environment.

Other requirements

Additional requirements for FlexPod Express include the following:

- Valid support contracts are required for all equipment, including:
 - SMARTnet support for Cisco equipment
 - SupportEdge Advisor or SupportEdge Premium support for NetApp equipment
- All software components must be listed and supported in the [NetApp IMT](#).
- All NetApp hardware components must be listed and supported on [NetApp Hardware Universe](#).
- All Cisco hardware components must be listed and supported on [Cisco HCL](#).

Optional Features

This section describes the optional features for FlexPod Express.

iSCSI boot option

The FlexPod Express architecture uses iSCSI boot. The minimum requirements for the iSCSI boot option include:

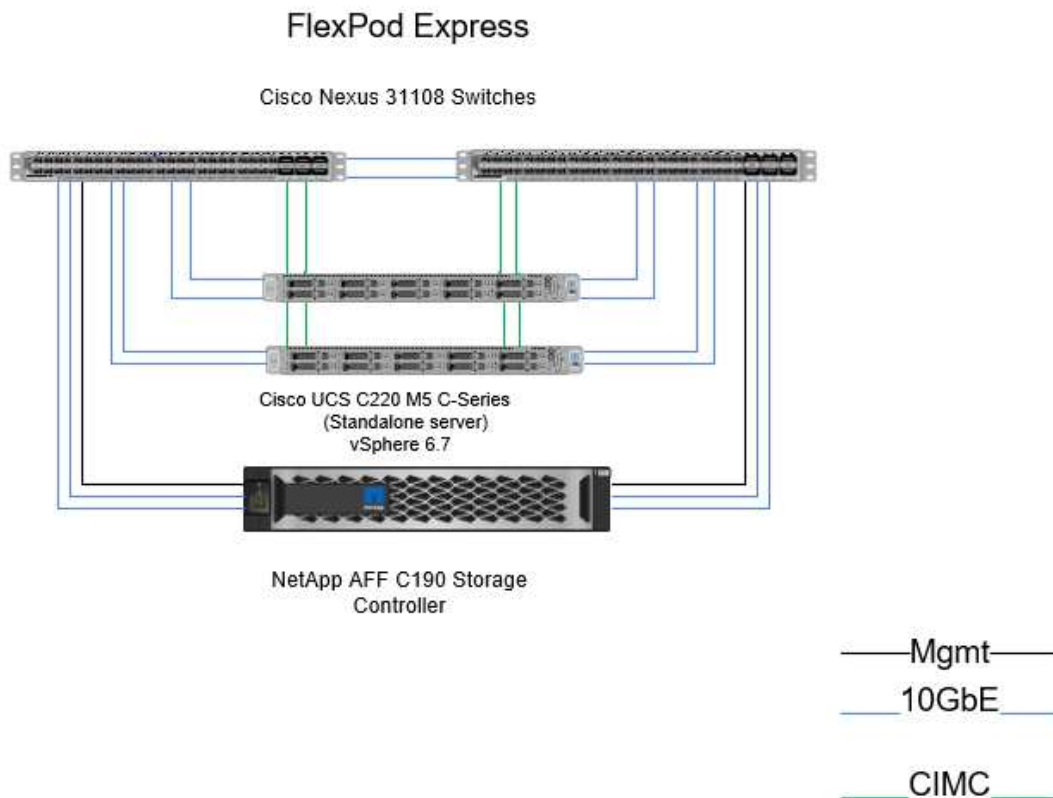
- An iSCSI license/feature activated on the NetApp storage controller
- A two-port 10Gbps Ethernet adapter on each node in the NetApp storage controller HA pair
- An adapter in the Cisco UCS server that is capable of iSCSI boot

Configuration options

This section provides more information about the configuration required and validated in the FlexPod Express architecture.

FlexPod Express with Cisco UCS C-Series and AFF C190 Series

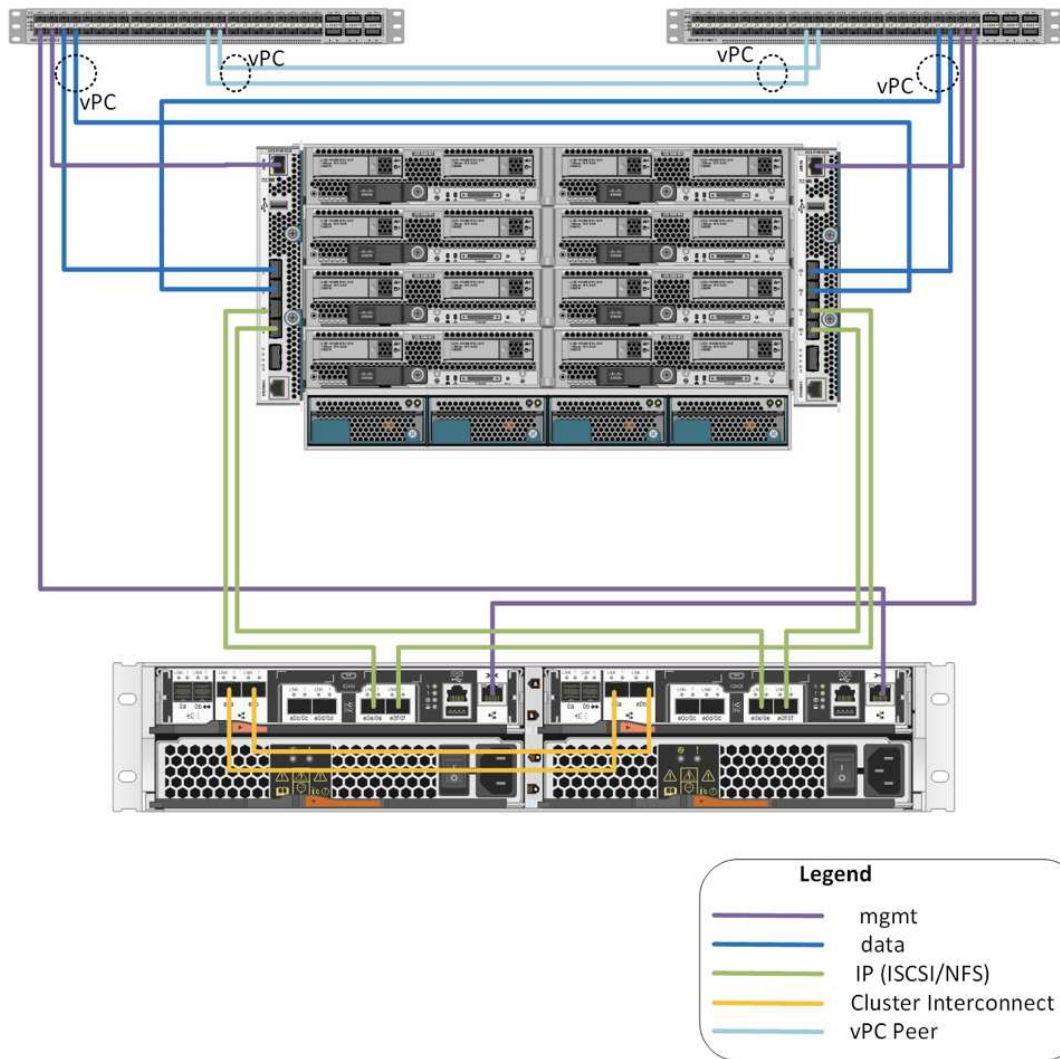
The following figure illustrates the FlexPod Express with Cisco UCS C-Series and AFF C190 series solution. This solution supports both 10GbE uplinks.



For more information about this configuration, see the FlexPod Express with VMware vSphere 6.7 and NetApp AFF C190 NVA Deployment Guide (in progress).

FlexPod Express with Cisco UCS Mini and AFF A220 and FAS 2750/2720

The following figure illustrates the FlexPod Express with Cisco UCS- managed configuration.



For more information about this configuration, see [FlexPod Express with VMware vSphere 6.7U1 and NetApp AFF A220 with Direct - Attached IP - Based Storage](#).

Cisco components

Cisco is a substantial contributor to the FlexPod Express design and architecture; it contributes the compute and networking layers of the solution. This section describes the Cisco UCS and Cisco Nexus components that are available for FlexPod Express.

Cisco UCS B-Series blade server options

Cisco UCS B-Series blades currently supported in the Cisco UCS Mini platform are B200 M5 and B420 M4. Other blades will be listed in the following table as they become supported in the Cisco UCS Mini platform.

Cisco UCS B-Series server	Part number	Technical specifications
Cisco UCS B200 M5	UCSB-B200-M5	https://www.cisco.com/c/en/us/support/servers-unified-computing/ucs-b200-m5-blade-server/model.html
Cisco UCS B200 M4	UCSB-B200-M4	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-b-series-blade-servers/b200m4-specsheet.pdf
Cisco UCS B420 M4	UCSB-B420-M4	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-b-series-blade-servers/b420m4-spec-sheet.pdf

Cisco UCS C-Series rack server options

Cisco UCS C-Series blades are available in one-rack and two-rack unit (RU) varieties, with various CPU, memory, and I/O options. The part numbers listed in the following table are for the base server; they do not include CPUs, memory, disk drives, PCIe cards, or the Cisco FEX. Multiple configuration options are available and supported in FlexPod.

Cisco UCS C-Series rack server	Part number	Technical specifications
Cisco UCS C220 M4	UCSC-C220-M4S	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/c220m4-sff-spec-sheet.pdf
Cisco UCS C240 M4	UCSC-C240-M4S	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/c240m4-sff-spec-sheet.pdf
Cisco UCS C460 M4	UCSC-C460-M4	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/c460m4_specsheets.pdf

Cisco Nexus switches

Redundant switches are required for all FlexPod Express architectures.

The FlexPod Express with NetApp AFF or FAS architecture is built with the Cisco Nexus 31108 switch. FlexPod Express with the Cisco UCS Mini (Cisco UCS- managed) architecture is validated by using the Cisco Nexus 3524 switch. This configuration can also be deployed with a standard switch.

The FlexPod Express with E-Series can be deployed with a standard switch.

The following table lists the part numbers for the Cisco Nexus series chassis; they do not include additional SFP or add-on modules.

Cisco Nexus Series switch	Part number	Technical specifications
Cisco Nexus 3048	N3K-C3048TP-1GE	http://www.cisco.com/c/en/us/products/collateral/switches/nexus-3000-series-switches/data_sheet_c78-685363.html
Cisco Nexus 31108	N3K-C31108PC-V	http://www.cisco.com/c/en/us/products/switches/nexus-31108pc-v-switch/index.html
Cisco Nexus 9396	N9K-C9396PX	http://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-729405.html
Cisco Nexus 3172	N3K-C3172	https://www.cisco.com/c/en/us/products/collateral/switches/nexus-3000-series-switches/data_sheet_c78-729483.html

Cisco Support licensing options

Valid SMARTnet support contracts are required on all Cisco equipment in the FlexPod Express architecture.



The licenses required and the part numbers for those licenses should be verified by your sales representative because they can differ for different products.

The following table lists the Cisco support licensing options.

Cisco Support licensing	License guide
SMARTnet 24x7x4	http://www.cisco.com/web/services/portfolio/product-technical-support/smartnet/index.html

NetApp components

NetApp storage controllers provide the storage foundation in the FlexPod Express architecture for both boot and application data storage. This section lists the different NetApp options in the FlexPod Express architecture.

NetApp storage controller options

NetApp FAS

Redundant AFF C190, AFF A220, or FAS2750 series controllers are required in the FlexPod Express architecture. The controllers run ONTAP software. When ordering the storage controllers, the preferred software version can be preloaded on the controllers. For ONTAP, the cluster can be deployed either with a pair of cluster interconnect switches or in a switchless cluster configuration.

The part numbers listed in the following table are for an empty controller. Different options and configurations are available based on the storage platform selected. Consult your sales representative for details about these additional components.

Storage controller	FAS part number	Technical specifications
FAS2750	Based on individual options chosen	https://www.netapp.com/us/products/storage-systems/hybrid-flash-array/fas2700.aspx
FAS2720	Based on individual options chosen	https://www.netapp.com/us/products/storage-systems/hybrid-flash-array/fas2700.aspx
AFF C190	Based on individual options chosen	https://www.netapp.com/us/products/entry-level-aff.aspx
AFF A220	Based on individual options chosen	https://www.netapp.com/us/documentation/all-flash-fas.aspx
FAS2620	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas2600/fas2600-tech-specs.aspx
FAS2650	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas2600/fas2600-tech-specs.aspx

E-Series storage

An HA pair of NetApp E2800 series controllers is required in the FlexPod Express architecture. The controllers run the SANtricity OS.

The part numbers listed in the following table are for an empty controller. Different options and configurations are available based on the storage platform selected. Consult your sales representative for details about these additional components.

Storage controller	Part number	Technical specifications
E2800	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/e2800/e2800-tech-specs.aspx

NetApp Ethernet expansion modules

NetApp FAS

The following table lists the NetApp FAS10GbE adapter options.

Component	Part number	Technical specifications
NetApp X1117A	X1117A-R6	https://library.netapp.com/ecm/ecm_download_file/ECMM1280307



The FAS2500 and 2600 series storage systems have onboard 10GbE ports.

The NetApp X1117A adapter is for FAS8020 storage systems.

E-Series storage

The following table lists the E-Series 10GbE adapter options.

Component	Part number
10GbE iSCSI/16Gb FC 4-port	X-56025-00-0E-C
10GbE iSCSI/16Gb FC 2-port	X-56024-00-0E-C



The E2824 series storage systems have onboard 10GbE ports.

The 10GbE iSCSI/16Gb FC 4-port host interface card (HIC) can be used for additional port density.

The onboard ports and the HIC can function as iSCSI adapters or FC adapters depending on the feature activated in SANtricity OS.

For more information about supported adapter options, see the Adapter section of [NetApp Hardware Universe](#).

NetApp disk shelves and disks

NetApp FAS

A minimum of one NetApp disk shelf is required for storage controllers. The NetApp shelf type selected determines which drive types are available within that shelf.

The FAS2700 and FAS2600 series of controllers are offered as a configuration that includes dual storage controllers plus disks housed within the same chassis. This configuration is offered with SATA or SAS drives; therefore, additional external disk shelves are not needed unless performance or capacity requirements dictate more spindles.



All disk shelf part numbers are for the empty shelf with two AC PSUs. Consult your sales representative for additional part numbers.

Disk drive part numbers vary according to the size and form factor of the disk you intend to purchase. Consult your sales representative for additional part numbers.

The following table lists the NetApp disk shelf options, along with the drives supported for each shelf type, which can be found on NetApp Hardware Universe. Follow the Hardware Universe link, select the version of ONTAP you are using, then select the shelf type. Under the shelf image, click Supported Drives to see the drives supported for specific versions of ONTAP and the disk shelves.

Disk shelf	Part number	Technical specifications
DS212C	DS212C-0-12	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe
DS224C	DS224C-0-24	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe

Disk shelf	Part number	Technical specifications
DS460C	DS460C-0-60	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe
DS2246	X559A-R6	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe
DS4246	X24M-R6	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe
DS4486	DS4486-144TB-R5-C	Disk Shelves and Storage Media Technical Specifications Supported Drives on NetApp Hardware Universe

E-Series storage

A minimum of one NetApp disk shelf is required for storage controllers that do not house any drives in their chassis. The NetApp shelf type selected determines which drive types are available within that shelf.

The E2800 series of controllers are offered as a configuration that includes dual storage controllers plus disks housed within a supported disk shelf. This configuration is offered with SSD or SAS drives.



Disk drive part numbers vary according to the size and form factor of the disk you intend to purchase. Consult your sales representative for additional part numbers.

The following table lists the NetApp disk shelf options and the drives supported for each shelf type, which can be found on NetApp Hardware Universe. Follow the Hardware Universe link, select the version of ONTAP you are using, then select the shelf type. Under the shelf image, click Supported Drives to see the drives supported for specific versions of ONTAP and the disk shelves.

Disk shelf	Part number	Technical specifications
DE460C	E-X5730A-DM-0E-C	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe
DE224C	E-X5721A-DM-0E-C	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe
DE212C	E-X5723A-DM-0E-C	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe

NetApp software licensing options

NetApp FAS

The following table lists the NetApp FAS software licensing options.

NetApp Software Licensing	Part Number	Technical Specifications
Base cluster license	Consult your NetApp sales team for more licensing information.	

E-Series storage

The following table lists the E-Series software licensing options.

NetApp software licensing	Part number	Technical specifications
Standard features	Consult your NetApp sales team for more licensing information.	
Premium features		

NetApp Support licensing options

SupportEdge Premium licenses are required, and the part numbers for those licenses vary based on the options selected in the FlexPod Express design.

NetApp FAS

The following table lists the NetApp support licensing options for NetApp FAS.

NetApp Support licensing	Part number	Technical specifications
SupportEdge Premium4 hours onsite; months: 36	CS-O2-4HR	https://www.netapp.com/pdf.html?item=/media/19784-ds-3873.pdf

E-Series storage

The following table lists the NetApp support licensing options for E-Series storage.

NetApp Support licensing	Part number	Technical specifications
Hardware support Premium 4 hours onsite; months: 36	SVC-O2-4HR-E	https://www.netapp.com/pdf.html?item=/media/19784-ds-3873.pdf
Software support	SW-SSP-O2-4HR-E	
Initial installation	SVC-INST-O2-4HR-E	

Power and cabling requirements

This section describes the power and minimum cabling requirements for a FlexPod Express design.

Power requirements

The power requirements are based on U.S. specifications and assume the use of AC power. Other countries might have different power requirements. Direct current (DC) power options are also available for most components. For additional data about the maximum power required as well as other detailed power

information, consult the detailed technical specifications for each hardware component.

For detailed Cisco UCS power data, see the [Cisco UCS Power Calculator](#).

The following table lists the power ports required per device.

Cisco Nexus switches	Power cables required
Cisco Nexus 3048	2x C13/C14 power cables for each Cisco Nexus 3000 series switch
Cisco Nexus 3524	2x C13/C14 power cables for each Cisco Nexus 3000 series switch
Cisco Nexus 9396	2x C13/C14 power cables for each Cisco Nexus 9000 series switch

Cisco UCS chassis	Power cables required
Cisco UCS 5108	2 CAB-US515P-C19-US/CAB-US520-C19-US for each Cisco UCS chassis

Cisco UCS B-Series servers	Power cables required
Cisco UCS B200 M4	N/A; blade server is powered by chassis
Cisco UCS B420 M4	N/A; blade server is powered by chassis
Cisco UCS B200 M5	N/A; blade server is powered by chassis
Cisco UCS B480 M5	N/A; blade server is powered by chassis

Cisco UCS C-Series servers	Power ports required
Cisco UCS C220 M4	2 x C13/C14 power cables for each Cisco UCS server
Cisco UCS C240 M4	
Cisco UCS C460 M4	
Cisco UCS C220 M5	
Cisco UCS C240 M5	
Cisco UCS C480 M5	

NetApp FAS controllers	Power ports required (per HA pair)
FAS2554	2 x C13/C14
FAS2552	2 x C13/C14
FAS2520	2 x C13/C14
FAS8020	2 x C13/C14

E-Series controllers	Power ports required (per HA pair)
E2824	2 x C14/C20

NetApp FAS disk shelves	Power ports required
DS212C	2 x C13/C14
DS224C	2 x C13/C14
DS460C	2 x C13/C14
DS2246	2 x C13/C14
DS4246	4 x C13/C14

E-Series disk shelves	Power ports required
DE460C	2 x C14/C20
DE224C	2 x C14/C20
DE212C	2 x C14/C20

Minimum cable requirements

This section describes the minimum cable requirements for a FlexPod Express design. Most FlexPod implementations require additional cables, but the number varies based on the deployment size and scope.

The following table lists the minimum number of cables required for each device.

Cisco Nexus 3000 Series switches	Cables required
Cisco Nexus 31108	At least two 10GbE fiber or Twinax cables per switch
Cisco Nexus 3172PQ	
Cisco Nexus 3048	
Cisco Nexus 3524	
Cisco Nexus 9396	
DS212C	Number of SAS cables depends on specific configuration of disk shelves
DS2246	
DS460C	
DS224C	
DS4246	
E2800	<ul style="list-style-type: none"> • At least one Gigabit Ethernet (1GbE) cable for management per controller • At least two 10GbE cables per controller (for iSCSI) or two FC cables matching speed requirements
DE460C	2 x mini-SAS HD cables per disk shelf
DE224C	2 x mini-SAS HD cables per disk shelf
DE212C	2 x mini-SAS HD cables per disk shelf

Technical Specifications and References

This section describes additional important technical specifications for each of the FlexPod Express components.

Cisco UCS B-Series blade servers

The following table lists the Cisco UCS B-Series blade server options.

Component	Cisco UCS B200 M4	Cisco UCS B420 M4	Cisco UCS B200 M5
Processor support	Intel Xeon E5-2600	Intel Xeon E5-4600	Intel Xeon Scalable processors
Maximum memory capacity	24 DIMMs for a maximum of 768GB	48 DIMMs for a maximum of 3TB	24 DIMMs for a maximum of 3072GB
Memory size and speed	32GB DDR4; 2133MHz	64GB DDR4; 2400MHz	16GB, 32GB, 64GB, and 128GB DDR4; 2666MHz
SAN boot support	Yes	Yes	Yes
Mezzanine I/O adapter slots	2	3	2, front and rear, including GPU support
I/O maximum throughput	80Gbps	160Gbps	80Gbps

Cisco UCS C-Series rack servers

The following table lists Cisco UCS C-Series rack server options.

Component	Cisco UCS C220 M4	Cisco UCS C240 M4	Cisco UCS C460 M4	Cisco UCS C220 M5
Processor support	1 or 2 Intel E5-2600 series	1 or 2 Intel Xeon E5-2600 series	2 or 4 Intel Xeon E7-4800/8800 series	Intel Xeon Scalable processors (1 or 2)
Maximum memory capacity	1.5GB	1.5TB	6TB	3072GB
PCIe slots	2	6	10	2
Form factor	1RU	2RU	4RU	1 RU

The following table lists the datasheets for the Cisco UCS C-Series rack server options.

Component	Cisco UCS datasheet
Cisco UCS C220 M4	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/c220m4-sff-spec-sheet.pdf
Cisco UCS C240 M4	http://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c240-m4-rack-server/datasheet-c78-732455.html

Component	Cisco UCS datasheet
Cisco UCS C460 M4	http://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c460-m4-rack-server/datasheet-c78-730907.html
Cisco UCS C220 M5	https://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/c220m5-sff-specsheet.pdf

Cisco Nexus 3000 Series switches

The following table lists the Cisco Nexus 3000 series switch options.

Component	Cisco Nexus 3048	Cisco Nexus 3524	Cisco Nexus 31108	Cisco Nexus 3172PQ
Form factor	1RU	1RU	1RU	1 RU
Maximum 1Gbps ports	48	24	48 (10/40/100Gbps)	72 1/10GbE ports, or 48 1/10GbE plus six 40GbE ports
Forwarding rate	132Mbps	360Mbps	1.2Bpps	1Bpps
Jumbo frame support	Yes	Yes	Yes	Yes

The following table lists the datasheets for the Cisco Nexus 3000 series switch options.

Component	Cisco Nexus Datasheet
Cisco Nexus 31108	http://www.cisco.com/c/en/us/products/switches/nexus-31108pc-v-switch/index.html
Cisco Nexus 3172PQ	https://www.cisco.com/c/en/us/products/switches/nexus-3172pq-switch/index.html
Cisco Nexus 3048	https://www.cisco.com/c/en/us/products/switches/nexus-3048-switch/index.html
Cisco Nexus 3172PQ-XL	https://www.cisco.com/c/en/us/products/switches/nexus-3172pq-switch/index.html
Cisco Nexus 3548 XL	https://www.cisco.com/c/en/us/products/switches/nexus-3548-x-switch/index.html
Cisco Nexus 3524 XL	https://www.cisco.com/c/en/us/products/switches/nexus-3524-x-switch/index.html
Cisco Nexus 3548	https://www.cisco.com/c/en/us/products/switches/nexus-3548-x-switch/index.html
Cisco Nexus 3524	https://www.cisco.com/c/en/us/products/switches/nexus-3524-x-switch/index.html

The following table lists the Cisco Nexus 9000 series switch options.

Component	Cisco Nexus 9396	Cisco Nexus 9372
Form factor	2RU	1RU
Maximum ports	60	54
10Gbps SFP+ uplink ports	48	48

The following table lists the Cisco Nexus 9000 series switch options datasheets.

Component	Cisco Nexus datasheet
Cisco Nexus 9396	http://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-736967.html
Cisco Nexus 9372	http://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-736967.html
Nexus 9396X	https://www.cisco.com/c/en/us/products/switches/nexus-9396px-switch/index.html?dtdid=ossdc000283

NetApp FAS storage controllers

The following table lists the current NetApp FAS storage controller options.

Current component	FAS2620	FAS2650
Configuration	2 controllers in a 2U chassis	2 controllers in a 4U chassis
Maximum raw capacity	1440TB	1243TB
Internal drives	12	24
Maximum number of drives (internal plus external)	144	144
Maximum volume size	100TB	
Maximum aggregate size	4TB	
Maximum number of LUNs	2,048 per controller	
Storage networking supported	iSCSI, FC, FCoE, NFS, and CIFS	
Maximum number of NetApp FlexVol volumes	1,000 per controller.	
Maximum number of NetApp Snapshot copies	255,000 per controller	
Maximum NetApp Flash Pool intelligent data caching	24TB	



For details about the FAS storage controller option, see the [FAS models](#) section of the Hardware Universe. For AFF, see [AFF models](#) section.

The following table lists the characteristics of a FAS8020 controller system.

Component	FAS8020
Configuration	2 controllers in a 3U chassis
Maximum raw capacity	2880TB
Maximum number of drives	480
Maximum volume size	70TB
Maximum aggregate size	324TB
Maximum number of LUNs	8,192 per controller
Storage networking supported	iSCSI, FC, NFS, and CIFS
Maximum number of FlexVol volumes	1,000 per controller
Maximum number of Snapshot copies	255,000 per controller
Maximum NetApp Flash Cache intelligent data caching	3TB
Maximum Flash Pool data caching	24TB

The following table lists the datasheets for NetApp storage controllers.

Component	Storage controller datasheet
FAS2600 series	http://www.netapp.com/us/products/storage-systems/fas2600/fas2600-tech-specs.aspx
FAS2500 series	http://www.netapp.com/us/products/storage-systems/fas2500/fas2500-tech-specs.aspx
FAS8000 series	http://www.netapp.com/us/products/storage-systems/fas8000/fas8000-tech-specs.aspx

NetApp FAS Ethernet adapters

The following table lists NetApp FAS 10GbE adapters.

Component	X1117A-R6
Port count	2
Adapter type	SFP+ with fibre

The X1117A-R6 SFP+ adapter is supported on FAS8000 series controllers.

The FAS2600 and FAS2500 series storage systems have onboard 10GbE ports. For more information, see the [NetApp 10GbE adapter datasheet](#).



For more adapter details based on the AFF or FAS model, see the [Adapter section](#) in the Hardware Universe.

NetApp FAS disk shelves

The following table lists the current NetApp FAS disk shelf options.

Component	DS460C	DS224C	DS212C	DS2246	DS4246
Form factor	4RU	2RU	2RU	2RU	4RU
Drives per enclosure	60	24	12	24	24
Drive form factor	3.5" large form factor	2.5" small form factor	3.5" large form factor	2.5" small form factor	3.5" large form factor
Shelf I/O modules	Dual IOM12 modules	Dual IOM12 modules	Dual IOM12 modules	Dual IOM6 modules	Dual IOM6 modules

For more information, see the [NetApp disk shelves datasheet](#).



For more information about the disk shelves, see the NetApp Hardware Universe [Disk Shelves section](#).

NetApp FAS disk drives

The technical specifications for the NetApp disks include form factor size, disk capacity, disk RPM, supporting controllers, and Data ONTAP version requirements and are located in the Drives section on [NetApp Hardware Universe](#).

E-Series storage controllers

The following table lists the current E-Series storage controller options.

Current Component	E2812	E2824	E2860
Configuration	2 controllers in a 2U chassis	2 controllers in a 2U chassis	2 controllers in a 4U chassis
Maximum raw capacity	1800TB	1756.8TB	1800TB
Internal drives	12	24	60
Maximum number of drives (internal plus external)	180		
Maximum SSD	120		
Maximum volume size for disk pool volume	1024TB		
Maximum disk pools	20		
Storage networking supported	iSCSI and FC		
Maximum number of volumes	512		

The following table lists the datasheets for the current E-Series storage controller.

Component	Storage controller datasheet
E2800	https://www.netapp.com/pdf.html?item=/media/7573-ds-3805.pdf

E-Series adapters

The following table lists the E-Series adapters.

Component	X-56023-00-0E-C	X-56025-00-0E-C	X-56027-00-0E-C	X-56024-00-0E-C	X-56026-00-0E-C
Port count	2	4	4	2	2
Adapter type	10Gb Base-T	16G FC and 10GbE iSCSI	SAS	16G FC and 10GbE iSCSI	SAS

E-Series disk shelves

The following table lists the E-Series disk shelf options.

Component	DE212C	DE224C	DE460C
Form factor	2RU	2RU	4RU
Drives per enclosure	12	24	60
Drive form factor	2.5" small form factor 3.5"	2.5"	2.5" small form factor 3.5"
Shelf I/O modules	IOM12	IOM12	IOM12

E-Series disk drives

The technical specifications for the NetApp disk drives include form factor size, disk capacity, disk RPM, supporting controllers, and SANtricity version requirements and are located in the Drives section on [NetApp Hardware Universe](#).

Previous architectures and equipment

FlexPod is a flexible solution allowing customers to use both existing and new equipment currently for sale by Cisco and NetApp. Occasionally, certain models of equipment from both Cisco and NetApp are designated end of life.

Even though these models of equipment are no longer available, customers who bought one of these models before the end-of-sale date can use that equipment in a FlexPod configuration.

Additionally, FlexPod Express architectures are periodically refreshed to introduce the latest hardware and software from Cisco and NetApp to the FlexPod Express solution. This section lists the previous FlexPod Express architectures and hardware used within them.

Previous FlexPod Express architectures

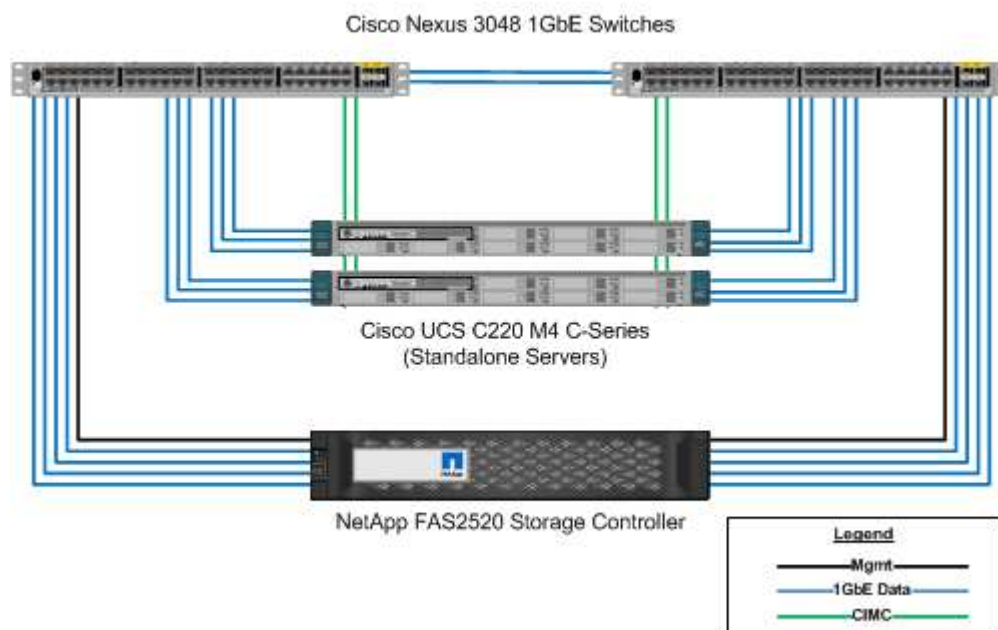
This section describes the previous FlexPod Express architectures.

FlexPod Express small and medium configurations

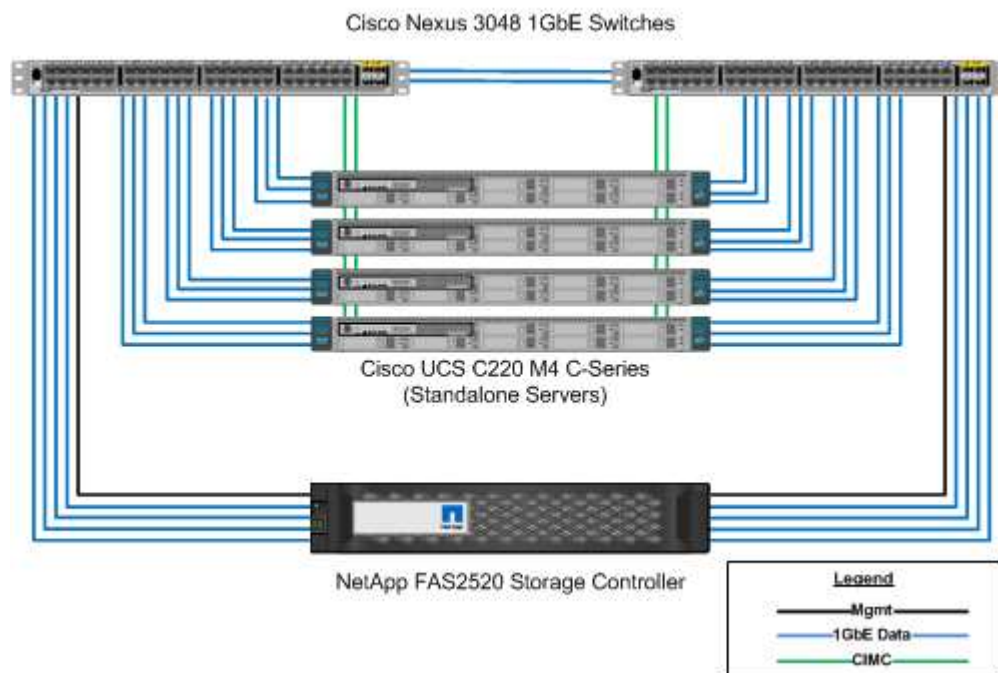
The FlexPod Express small and medium configurations include the following components:

- Two Cisco Nexus 3048 switches in a redundant configuration
- At least two Cisco UCS C-Series rack mount servers
- Two FAS2200 or FAS2500 series controllers in an HA pair configuration

The following figure illustrates the FlexPod Express small configuration.



The following figure illustrates the FlexPod Express medium configuration.

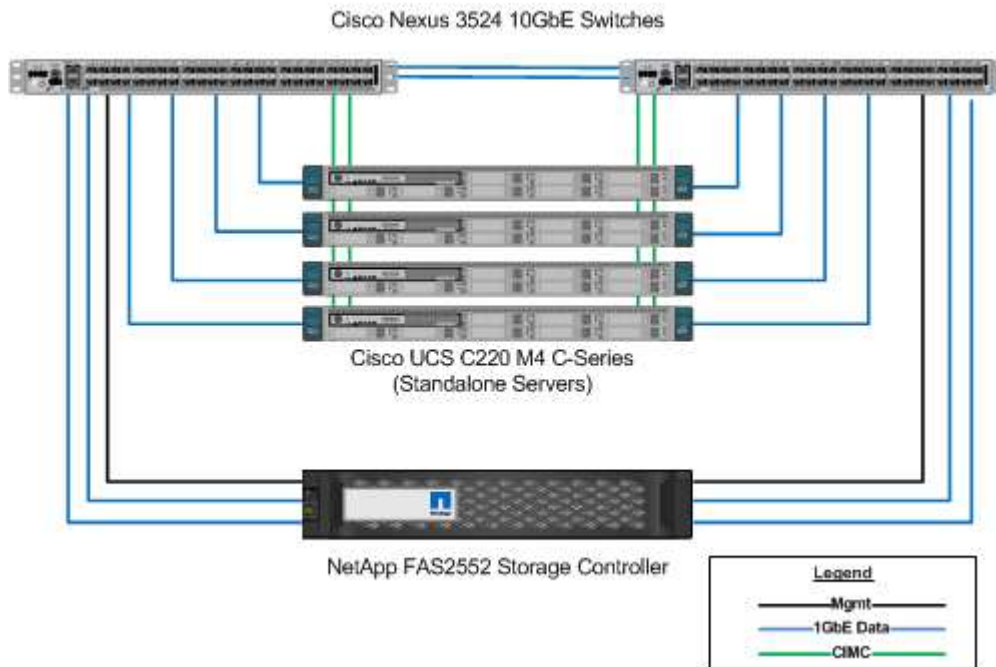


FlexPod Express large configuration

The FlexPod Express large configuration includes the following components:

- Two Cisco Nexus 3500 series or Cisco Nexus 9300 series switches in a redundant configuration
- At least two Cisco UCS C-Series rack mount servers
- Two FAS2552, FAS2554, or FAS8020 controllers in an HA pair configuration (requires two 10GbE ports per controller)
- One NetApp disk shelf with any supported disk type (when the FAS8020 is used)

The following figure illustrates the FlexPod Express large configuration.



Previous FlexPod Express verified architectures

Previous FlexPod Express verified architectures are still supported. The architecture and deployment documents include:

- [FlexPod Express with Cisco UCS C-Series and NetApp FAS2500 Series](#)
- [FlexPod Express with VMware vSphere 6.0: Small and Medium Configurations](#)
- [FlexPod Express with VMware vSphere 6.0: Large Configuration](#)
- [FlexPod Express with Microsoft Windows Server 2012 R2 Hyper-V: Small and Medium Configurations](#)
- [FlexPod Express with Microsoft Windows Server 2012 R2 Hyper-V: Large Configuration](#)

Previous hardware

The following table lists the hardware used in previous FlexPod Express architectures.

Hardware used in previous architectures	Technical specifications (if available)
Cisco UCS C220 M3	http://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c220-m3-rack-server/data_sheet_c78-700626.html
Cisco UCS C24 M3	http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/data_sheet_c78-706103.html
Cisco UCS C22 M3	http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/data_sheet_c78-706101.html
Cisco UCS C240 M3	http://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c240-m3-rack-server/data_sheet_c78-700629.html
Cisco UCS C260 M2	http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/c260m2_specsheets.pdf
Cisco UCS C420 M3	http://www.cisco.com/en/US/products/ps12770/index.html
Cisco UCS C460 M2	http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/ps11587/spec_sheet_c17-662220.pdf
Cisco UCS B200 M3	http://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-b200-m3-blade-server/data_sheet_c78-700625.html
Cisco UCS B420 M3	N/A
Cisco UCS B22 M3	http://www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-b-series-blade-servers/b22m3_specsheets.pdf
Cisco Nexus 3524	http://www.cisco.com/c/en/us/products/switches/nexus-3524-switch/index.html
FAS2240	
FAS2220	http://www.netapp.com/us/products/storage-systems/fas2200/fas2200-tech-specs.aspx
DS4243	N/A

Legacy equipment

The following table lists the NetApp legacy storage controller options.

Storage controller	FAS part number	Technical specifications
FAS2520	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas2500/fas2500-tech-specs.aspx
FAS2552	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas2500/fas2500-tech-specs.aspx

Storage controller	FAS part number	Technical specifications
FAS2554	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas2500/fas2500-tech-specs.aspx
FAS8020	Based on individual options chosen	http://www.netapp.com/us/products/storage-systems/fas8000/fas8000-tech-specs.aspx

The following table lists the NetApp legacy disk shelf options for NetApp FAS.

Disk shelf	Part number	Technical specifications
DE1600	E-X5682A-DM-0E-R6-C	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe
DE5600	E-X4041A-12-R6	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe
DE6600	X-48564-00-R6	Disk Shelves Technical Specifications Supported Drives on NetApp Hardware Universe

NetApp legacy FAS controllers

The following table lists the legacy NetApp FAS controller options.

Current component	FAS2554	FAS2552	FAS2520
Configuration	2 controllers in a 4U chassis	2 controllers in a 2U chassis	2 controllers in a 2U chassis
Maximum raw capacity	576TB	509TB	336TB
Internal drives	24	24	12
Maximum number of drives (internal plus external)	144	144	84
Maximum volume size	60TB		
Maximum aggregate size	120TB		
Maximum number of LUNs	2,048 per controller		
Storage networking supported	iSCSI, FC, FCoE, NFS, and CIFS		iSCSI, NFS, and CIFS
Maximum number of NetApp FlexVol volumes	1,000 per controller		
Maximum number of NetApp Snapshot copies	255,000 per controller		



For more NetApp FAS models, see the [FAS models section](#) in the Hardware Universe.

Additional Information

To learn more about the information that is described in this document, see the following documents and websites:

- AFF and FAS System Documentation Center

<https://docs.netapp.com/platstor/index.jsp>

- AFF Documentation Resources page

<https://www.netapp.com/us/documentation/all-flash-fas.aspx>

- FAS Storage Systems Documentation Resources page

<https://www.netapp.com/us/documentation/fas-storage-systems.aspx>

- FlexPod

<https://flexpod.com/>

- NetApp documentation

<https://docs.netapp.com>

FlexPod Datacenter Technical Specifications

TR-4036: FlexPod Datacenter Technical Specifications

Arvind Ramakrishnan, and Jyh-shing Chen, NetApp

The FlexPod platform is a predesigned, best practice data center architecture that is built on the Cisco Unified Computing System (Cisco UCS), the Cisco Nexus family of switches, and NetApp storage controllers (AFF, ASA, or FAS systems).

FlexPod is a suitable platform for running a variety of virtualization hypervisors as well as bare-metal operating systems and enterprise workloads. FlexPod delivers not only a baseline configuration, but also the flexibility to be sized and optimized to accommodate many different use cases and requirements.



Before you order a complete FlexPod configuration, see the [FlexPod Converged Infrastructure](#) page on netapp.com for the latest version of these technical specifications.

Next: [FlexPod platforms](#).

FlexPod platforms

There are two FlexPod platforms:

- **FlexPod Datacenter.** This platform is a massively scalable virtual data center infrastructure that is suited

for workload enterprise applications; virtualization; virtual desktop infrastructure (VDI); and public, private, and hybrid cloud workloads.

- **FlexPod Express.** This platform is a compact converged infrastructure that is targeted to remote office and edge use cases. FlexPod Express has its own specifications that are documented in the [FlexPod Express Technical Specifications](#).

This document provides the technical specifications for the FlexPod Datacenter platform.

FlexPod rules

The FlexPod design enables a flexible infrastructure that encompasses many different components and software versions.

Use the rule sets as a guide for building or assembling a valid FlexPod configuration. The numbers and rules that are listed in this document are the minimum requirements for a FlexPod configuration. They can be expanded in the included product families as required for different environments and use cases.

Supported versus validated FlexPod configurations

The FlexPod architecture is defined by the set of rules that are described in this document. The hardware components and software configurations must be supported by the [Cisco UCS Hardware and Software Compatibility List](#) and the [NetApp Interoperability Matrix Tool \(IMT\)](#).

Each Cisco Validated Design (CVD) or NetApp Verified Architecture (NVA) is a possible FlexPod configuration. Cisco and NetApp document these configuration combinations and validate them with extensive end-to-end testing. The FlexPod deployments that deviate from these configurations are fully supported if they follow the guidelines in this document and if all the components are listed as compatible in the Cisco UCS Hardware and Software Compatibility List and the NetApp [IMT](#).

For example, adding more storage controllers or Cisco UCS Servers and upgrading software to newer versions are fully supported if the software, hardware, and configurations meet the guidelines that are defined in this document.

NetApp ONTAP

NetApp ONTAP software is installed on all NetApp FAS, AFF, and AFF All SAN Array (ASA) systems. FlexPod is validated with ONTAP software, providing a highly scalable storage architecture that enables nondisruptive operations, nondisruptive upgrades, and an agile data infrastructure.

For more information about ONTAP, see the [ONTAP Data Management Software](#) product page.

Cisco Nexus switching modes of operation

A variety of Cisco Nexus products can be used as the switching component of a given FlexPod deployment. Most of these options leverage the traditional Cisco Nexus OS or NX-OS software. The Cisco Nexus family of switches offers varying capabilities within its product lines. These capabilities are detailed later in this document.

Cisco's offering in the software-defined networking space is called Application Centric Infrastructure (ACI). The Cisco Nexus product line that supports the ACI mode, also called fabric mode, is the Cisco Nexus 9300 series. These switches can also be deployed in NX-OS or standalone mode.

Cisco ACI is targeted at data center deployments that focus on the requirements of a specific application. Applications are instantiated through a series of profiles and contracts that allow connectivity from the host or virtual machine (VM) all the way through the network to the storage.

FlexPod is validated with both modes of operation of the Cisco Nexus switches. For more information about the ACI and the NX-OS modes, see the following Cisco pages:

- [Cisco Application Centric Infrastructure](#)
- [Cisco NX-OS Software](#)

Minimum hardware requirements

A FlexPod Datacenter configuration has minimum hardware requirements, including, but not limited to, switches, fabric interconnects, servers, and NetApp storage controllers.

You must use Cisco UCS Servers. Both C-Series and B-Series Servers have been used in the validated designs. Cisco Nexus Fabric Extenders (FEXs) are optional with C-Series Servers.

A FlexPod configuration has the following minimum hardware requirements:

- Two Cisco Nexus switches in a redundant configuration. This configuration can consist of two redundant switches from the Cisco Nexus 5000, 7000, or 9000 Series. The two switches should be of the same model and should be configured in the same mode of operation.

If you are deploying an ACI architecture, you must observe the following additional requirements:

- Deploy the Cisco Nexus 9000 Series Switches in a leaf-spine topology.
- Use three Cisco Application Policy Infrastructure Controllers (APICs).
- Two Cisco UCS 6200, 6300, or 6400 Series Fabric Interconnects in a redundant configuration.
- Cisco UCS Servers:
 - If the solution uses B-Series Servers, one Cisco UCS 5108 B-Series Blade Server Chassis plus two Cisco UCS B-Series Blade Servers plus two 2104, 2204/8, 2408, or 2304 I/O modules (IOMs).
 - If the solution uses C-Series Servers, two Cisco UCS C-Series Rack Servers.

For larger deployments of Cisco UCS C-Series Rack Servers, you can choose a pair of 2232PP FEX modules. However, the 2232PP is not a hardware requirement.

- Two NetApp storage controllers in a high-availability (HA) pair configuration:

This configuration can consist of any supported NetApp FAS, AFF, or ASA-series storage controllers. See the [NetApp Hardware Universe](#) application for a current list of supported FAS, AFF, and ASA controller models.

- The HA configuration requires two redundant interfaces per controller for data access; the interfaces can be FCoE, FC, or 10/25/100Gb Ethernet (GbE).
- If the solution uses NetApp ONTAP, a cluster interconnect topology that is approved by NetApp is required. For more information, see the [Switches](#) tab of the NetApp Hardware Universe.

- If the solution uses ONTAP, at least two additional 10/25/100GbE ports per controller are required for data access.
- For ONTAP clusters with two nodes, you can configure a two-node switchless cluster.
- For ONTAP clusters with more than two nodes, a pair of cluster interconnect switches are required.
- One NetApp disk shelf with any supported disk type. See the Shelves tab of the [NetApp Hardware Universe](#) for a current list of supported disk shelf models.

Minimum software requirements

A FlexPod configuration has the following minimum software requirements:

- NetApp ONTAP:
 - ONTAP software version requires ONTAP 9.1 or later
- Cisco UCS Manager releases:
 - Cisco UCS 6200 Series Fabric Interconnect—2.2(8a)
 - Cisco UCS 6300 Series Fabric Interconnect—3.1(1e)
 - Cisco UCS 6400 Series Fabric Interconnect—4.0(1)
- Cisco Intersight Managed Mode:
 - Cisco UCS 6400 Series Fabric Interconnect – 4.1(2)
- For Cisco Nexus 5000 Series Switches, Cisco NX-OS software release 5.0(3)N1(1c) or later, including NX-OS 5.1.x
- For Cisco Nexus 7000 Series Switches:
 - The 4-slot chassis requires Cisco NX-OS software release 6.1(2) or later
 - The 9-slot chassis requires Cisco NX-OS software release 5.2 or later
 - The 10-slot chassis requires Cisco NX-OS software release 4.0 or later
 - The 18-slot chassis requires Cisco NX-OS software release 4.1 or later
- For Cisco Nexus 9000 Series Switches, Cisco NX-OS software release 6.1(2) or later



The software that is used in a FlexPod configuration must be listed and supported in the NetApp [IMT](#). Some features might require more recent releases of the software than the ones that are listed.

Connectivity requirements

A FlexPod configuration has the following connectivity requirements:

- A separate 100Mbps Ethernet/1Gb Ethernet out-of-band management network is required for all components.
- NetApp recommends that you enable jumbo frame support throughout the environment, but it is not required.
- The Cisco UCS Fabric Interconnect appliance ports are recommended only for iSCSI and NAS connections.
- No additional equipment can be placed in line between the core FlexPod components.

Uplink connections:

- The ports on the NetApp storage controllers must be connected to the Cisco Nexus 5000, 7000, or 9000 Series Switches to enable support for virtual port channels (vPCs).
- vPCs are required from the Cisco Nexus 5000, 7000, or 9000 Series Switches to the NetApp storage controllers.
- vPCs are required from the Cisco Nexus 5000, 7000, or 9000 Series Switches to the fabric interconnects.
- A minimum two connections are required for a vPC. The number of connections within a vPC can be increased based on the application load and performance requirements.

Direct connections:

- NetApp storage controller ports that are directly connected to the fabric interconnects can be grouped to enable a port channel. vPC is not supported for this configuration.
- FCoE port channels are recommended for end-to-end FCoE designs.

SAN boot:

- FlexPod solutions are designed around a SAN-boot architecture using iSCSI, FC, or FCoE protocols. Using boot-from-SAN technologies provides the most flexible configuration for the data center infrastructure and enables the rich features available within each infrastructure component. Although booting from SAN is the most efficient configuration, booting from local server storage is a valid and supported configuration.
- SAN boot over FC-NVME is not supported.

Other requirements

A FlexPod architecture has the following additional interoperability and support-related requirements:

- All hardware and software components must be listed and supported on the NetApp [IMT](#), the [Cisco UCS Hardware and Software Compatibility List](#), and the Cisco UCS Hardware and Software Interoperability Matrix Tool.
- Valid support contracts are required for all equipment, including:
 - Smart Net Total Care (SmartNet) support for Cisco equipment
 - SupportEdge Advisor or SupportEdge Premium support for NetApp equipment

For more information, see the NetApp [IMT](#).

Optional features

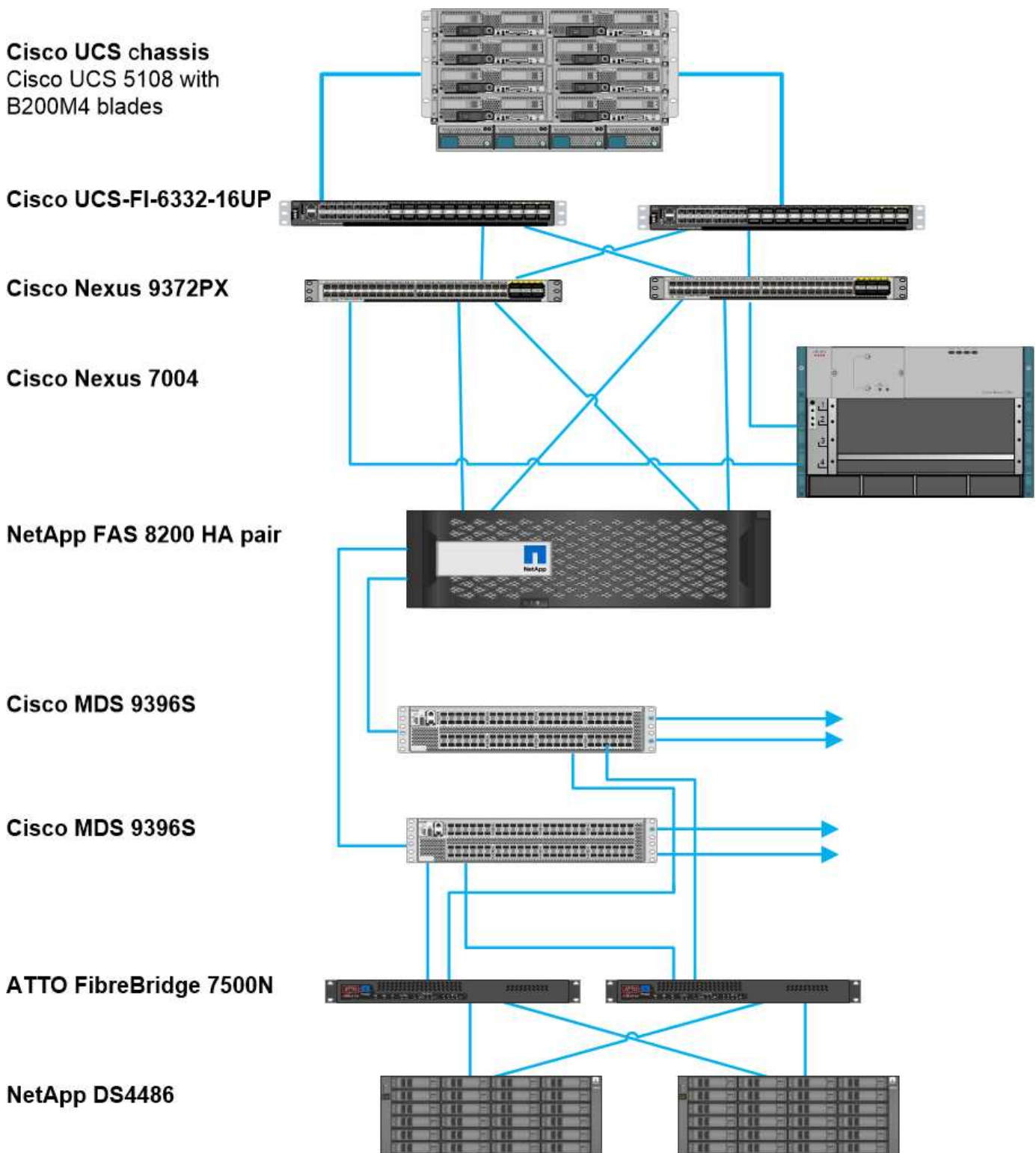
NetApp supports several optional components to further enhance FlexPod Datacenter architectures. Optional components are outlined in the following subsections.

MetroCluster

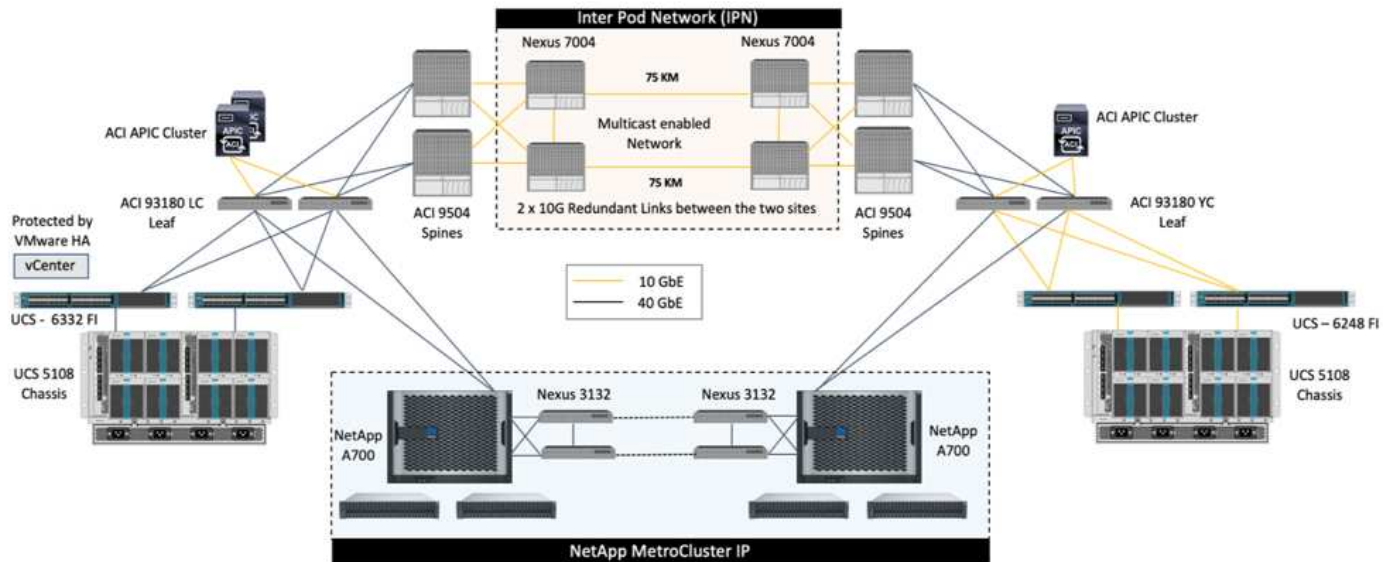
FlexPod supports both variants of the NetApp MetroCluster software for continuous availability, in either two- or four-node cluster configurations. MetroCluster provides synchronous replication for critical workloads. It requires a dual-site configuration that is connected with Cisco switching. The maximum supported distance between the sites is approximately 186 miles (300km) for MetroCluster FC and increases to approximately 435 miles (700km) for MetroCluster IP. The following figures illustrate a FlexPod Datacenter with NetApp

MetroCluster architecture and FlexPod Datacenter with NetApp MetroCluster IP architecture, respectively.

The following figure depicts FlexPod Datacenter with NetApp MetroCluster architecture.

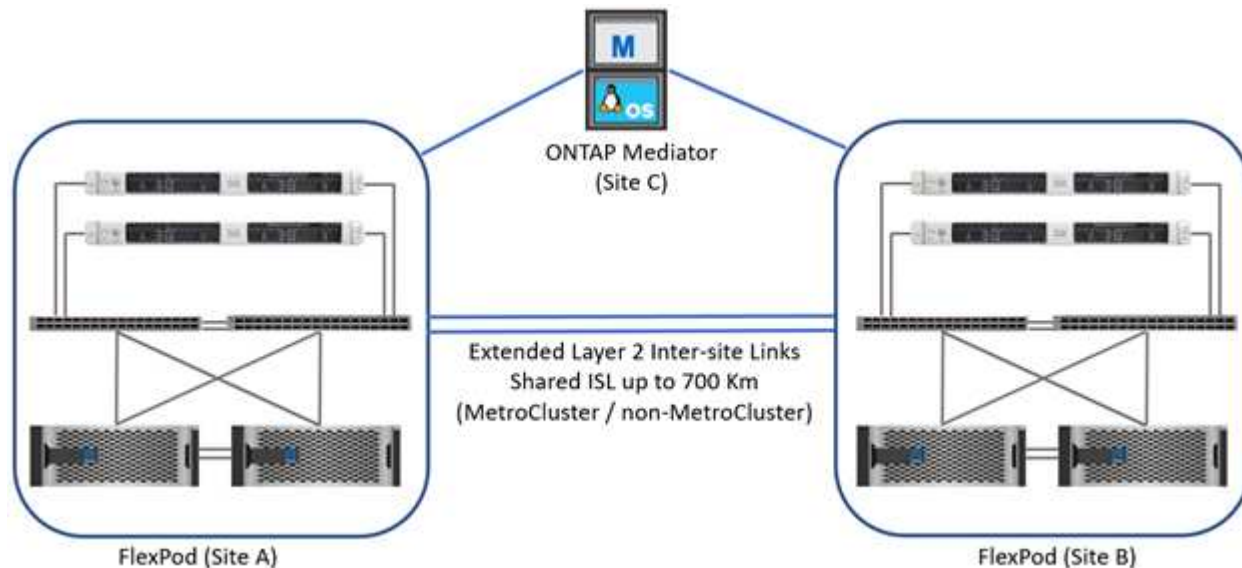


The following figure depicts the FlexPod Datacenter with NetApp MetroCluster IP architecture.



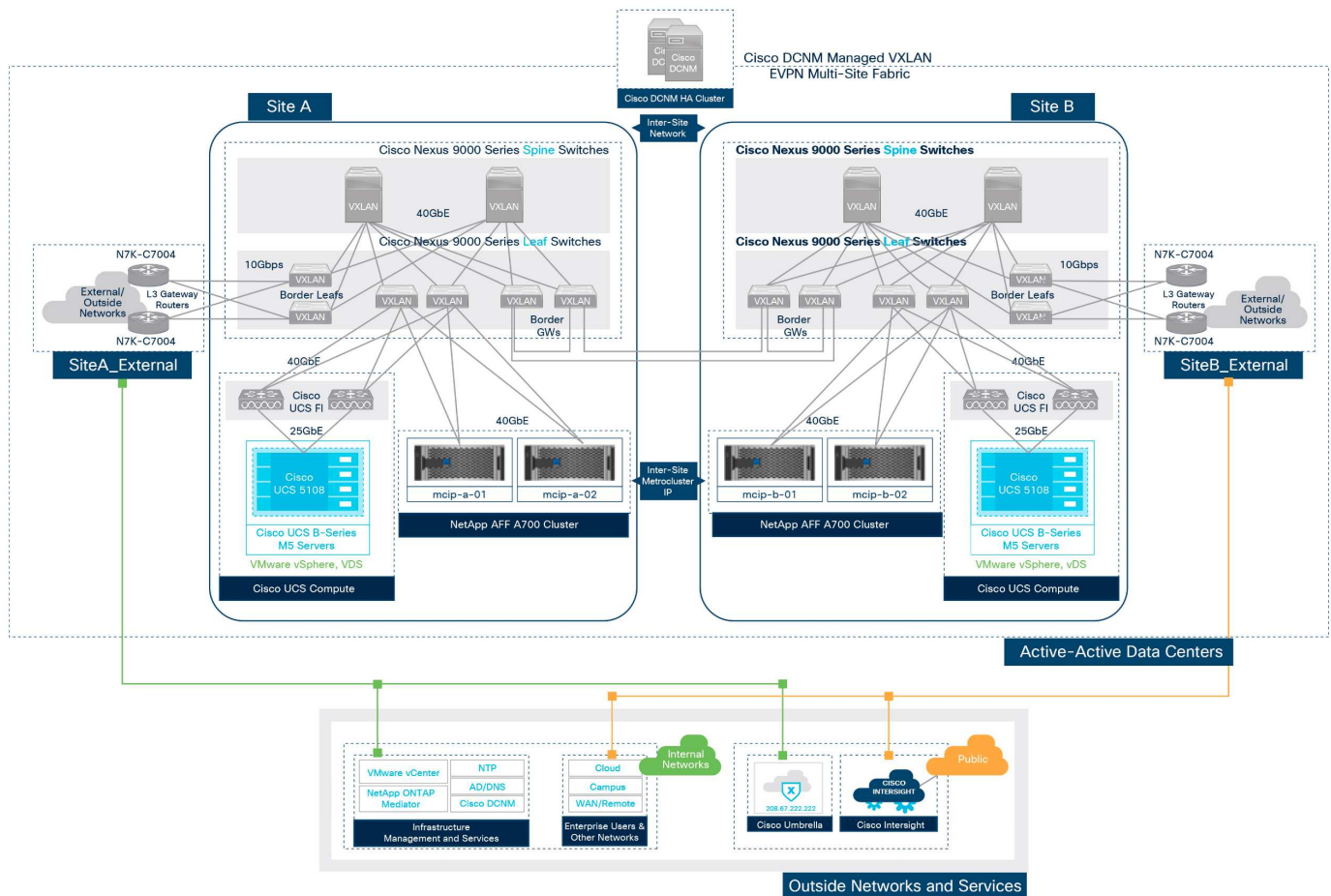
Starting with ONTAP 9.8, ONTAP Mediator can be deployed at a third site to monitor the MetroCluster IP solution and to facilitate automated unplanned switchover when a site disaster occurs.

For a FlexPod MetroCluster IP solution deployment with extended layer-2 site-to-site connectivity, you can achieve cost savings by sharing ISL and using FlexPod switches as compliant MetroCluster IP switches if the network bandwidth and switches meet the requirements as illustrated in the following figure, which depicts the FlexPod MetroCluster IP solution with ISL sharing and compliant switches.

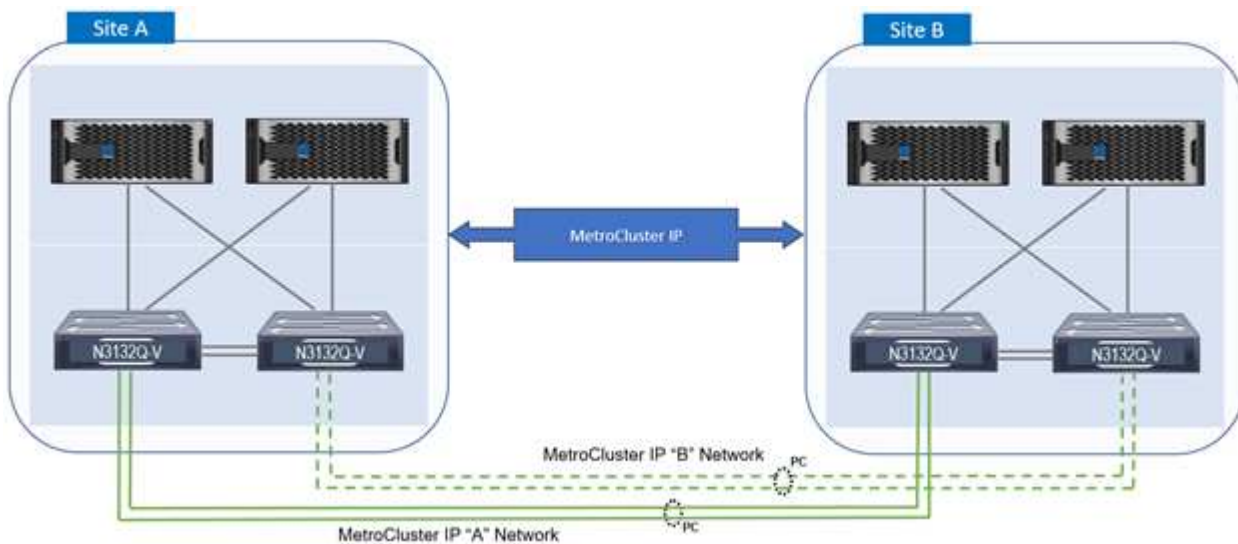


The following two figures depict the VXLAN Multi-Site fabric and the MetroCluster IP storage fabric for a FlexPod MetroCluster IP solution with VXLAN Multi-Site fabric deployment.

- VXLAN Multi-Site fabric for FlexPod MetroCluster IP solution



- MetroCluster IP storage fabric for FlexPod MetroCluster IP solution



End-to-end FC-NVMe

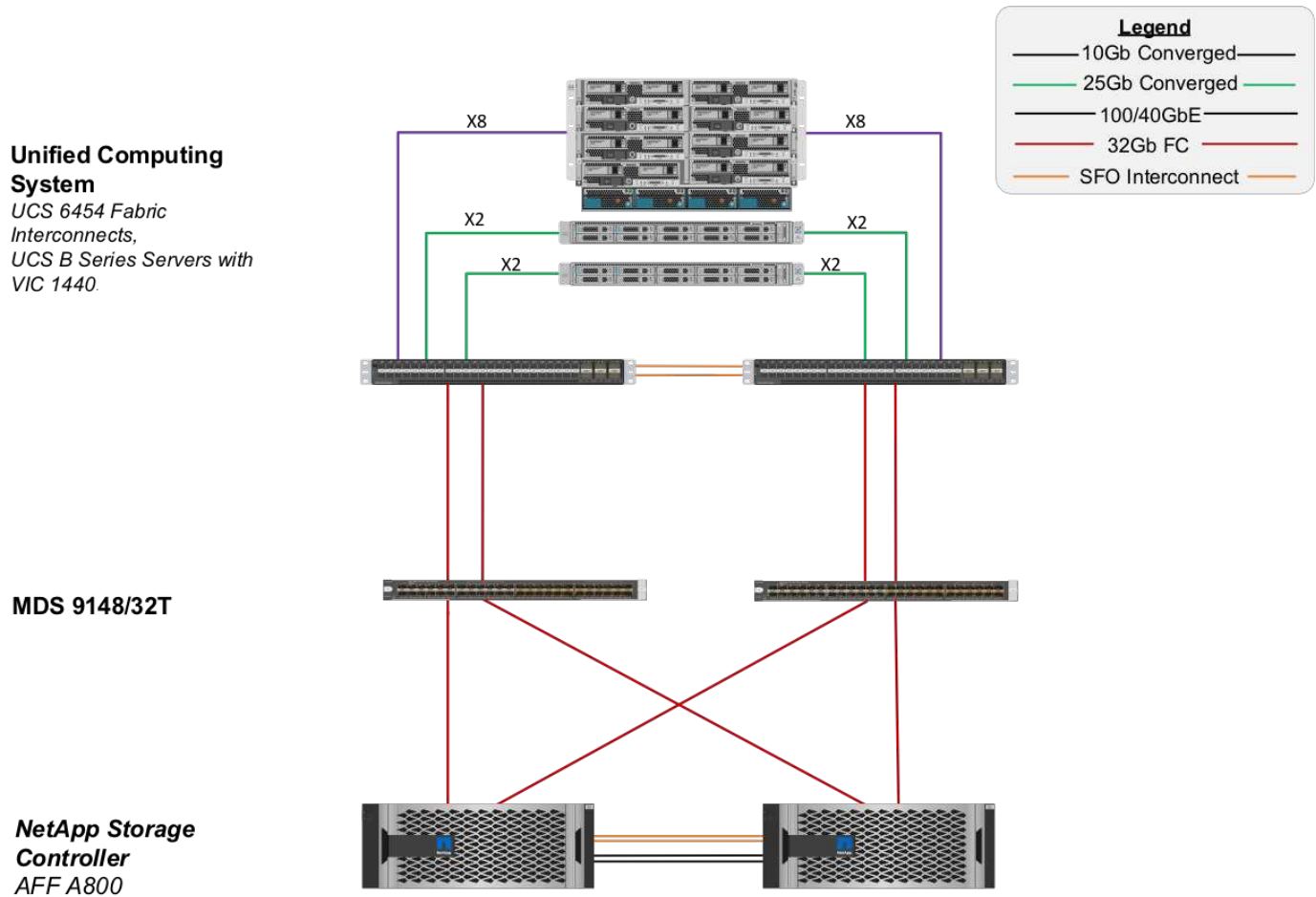
An end-to-end FC-NVMe seamlessly extends a customer's existing SAN infrastructure for real-time applications while simultaneously delivering improved IOPS and throughput with reduced latency.

An existing 32G FC SAN transport can be used to simultaneously transport both NVMe and SCSI workloads.

The following figure illustrates the Flexpod Datacenter for FC with Cisco MDS.

More details about the FlexPod configurations and performance benefits, see [Introducing End-to-End NVMe for FlexPod White Paper](#).

For more information about ONTAP implementation, see [TR-4684: Implementing and Configuring Modern SANs with NVMe](#).



FC SAN boot through Cisco MDS

To provide increased scalability by using a dedicated SAN network, FlexPod supports FC through Cisco MDS switches and Nexus switches with FC support such as Cisco Nexus 93108TC-FX. The FC SAN boot option through Cisco MDS has the following licensing and hardware requirements:

- A minimum of two FC ports per NetApp storage controller; one port for each SAN fabric
- An FC license on each NetApp storage controller
- Cisco MDS switches and firmware versions that are supported on the NetApp [IMT](#)

For more guidance on an MDS-based design, see the CVD [FlexPod Datacenter with VMware vSphere 6.7U1 Fibre Channel and iSCSI Deployment Guide](#).

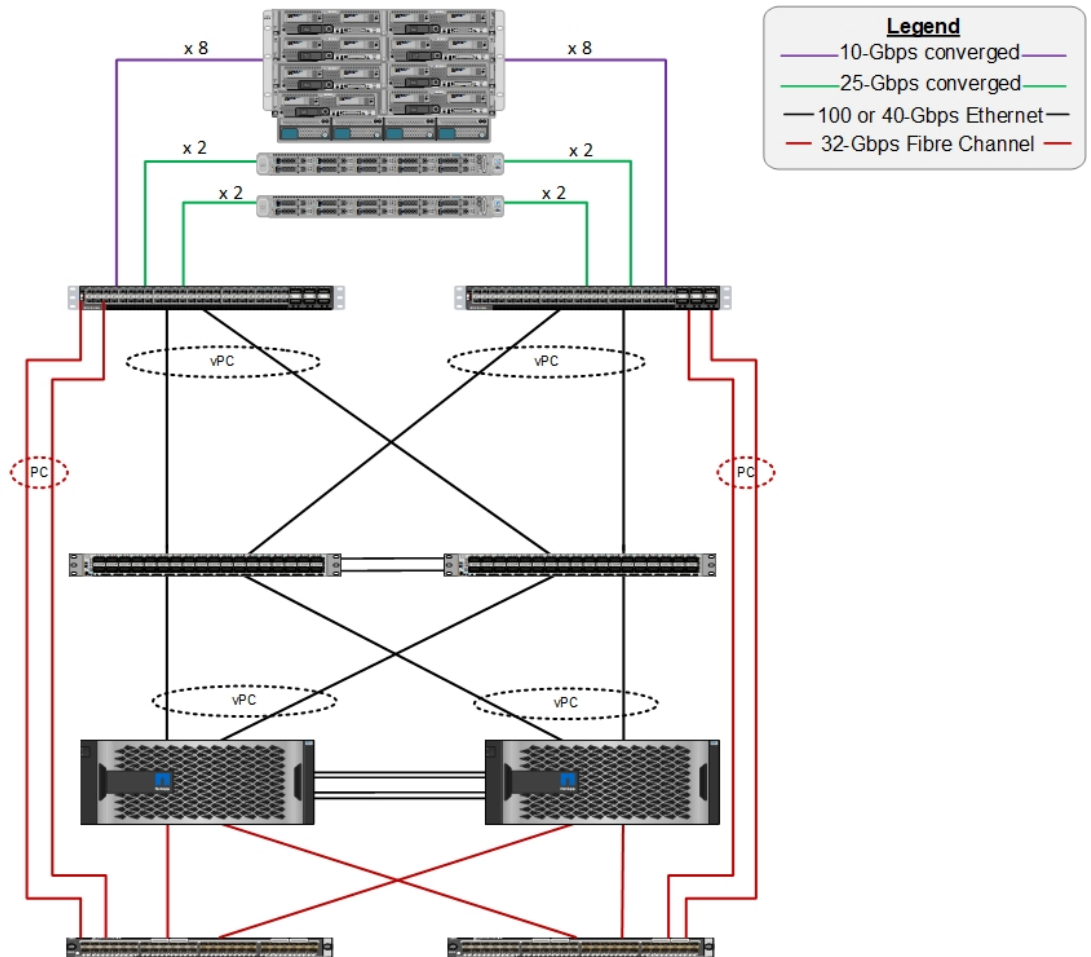
The following figures show an example of FlexPod Datacenter for FC with MDS connectivity and FlexPod Datacenter for FC with Cisco Nexus 93180YC-FX, respectively.

Cisco Unified Computing System
 Cisco UCS 6454 Fabric Interconnects,
 UCS B-Series Blade Servers with UCS VIC 1440, and
 UCS C-Series Rack Servers with UCS VIC 1457

Cisco Nexus 9336C-FX2

NetApp storage controllers AFF-A800

Cisco MDS 9148T or 9132T switch

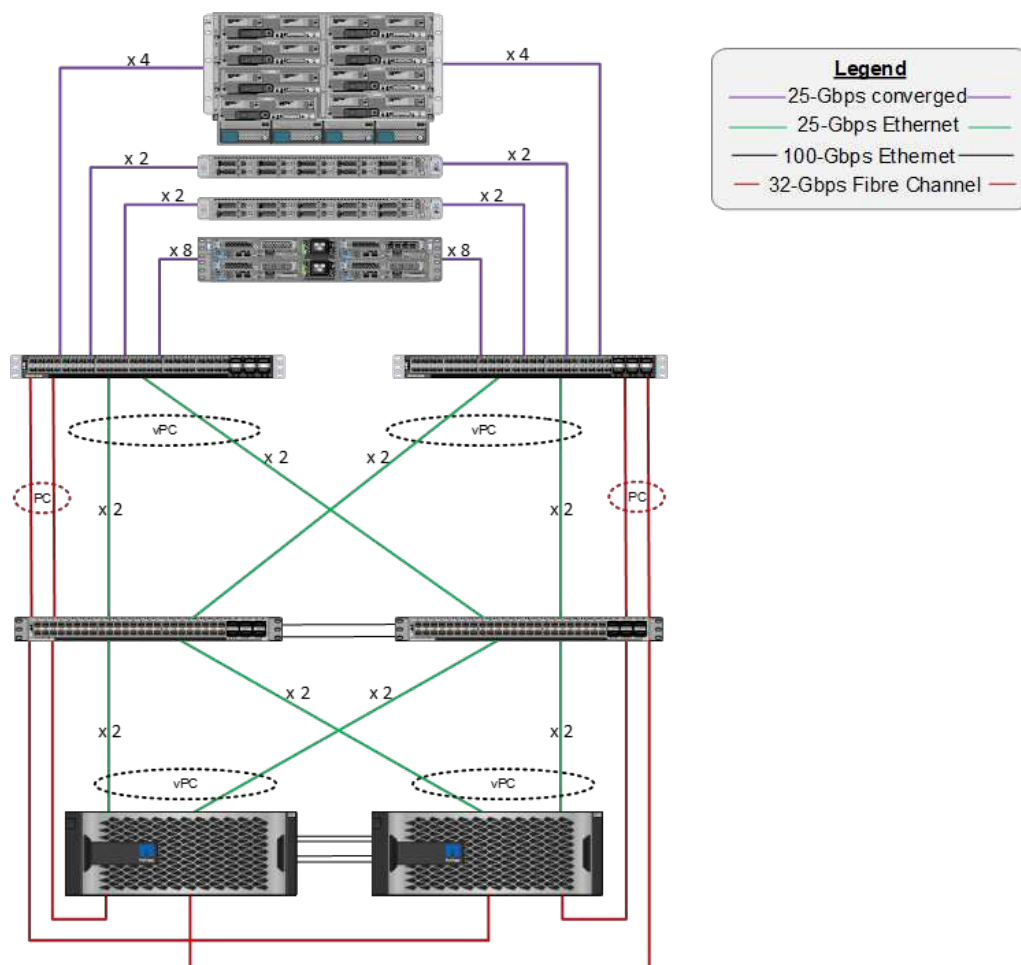


Cisco Unified Computing System

Cisco UCS 6454 Fabric Interconnects, UCS 2408 Fabric Extenders, UCS B-Series Blade Servers with UCS VIC 1440, UCS C-Series Rack Servers with UCS VIC 1457, UCS C4200 Chassis, and UCS C125 Servers with UCS VIC 1455

Cisco Nexus 93180YC-FX

NetApp storage controllers AFF-A400



FC SAN boot with Cisco Nexus

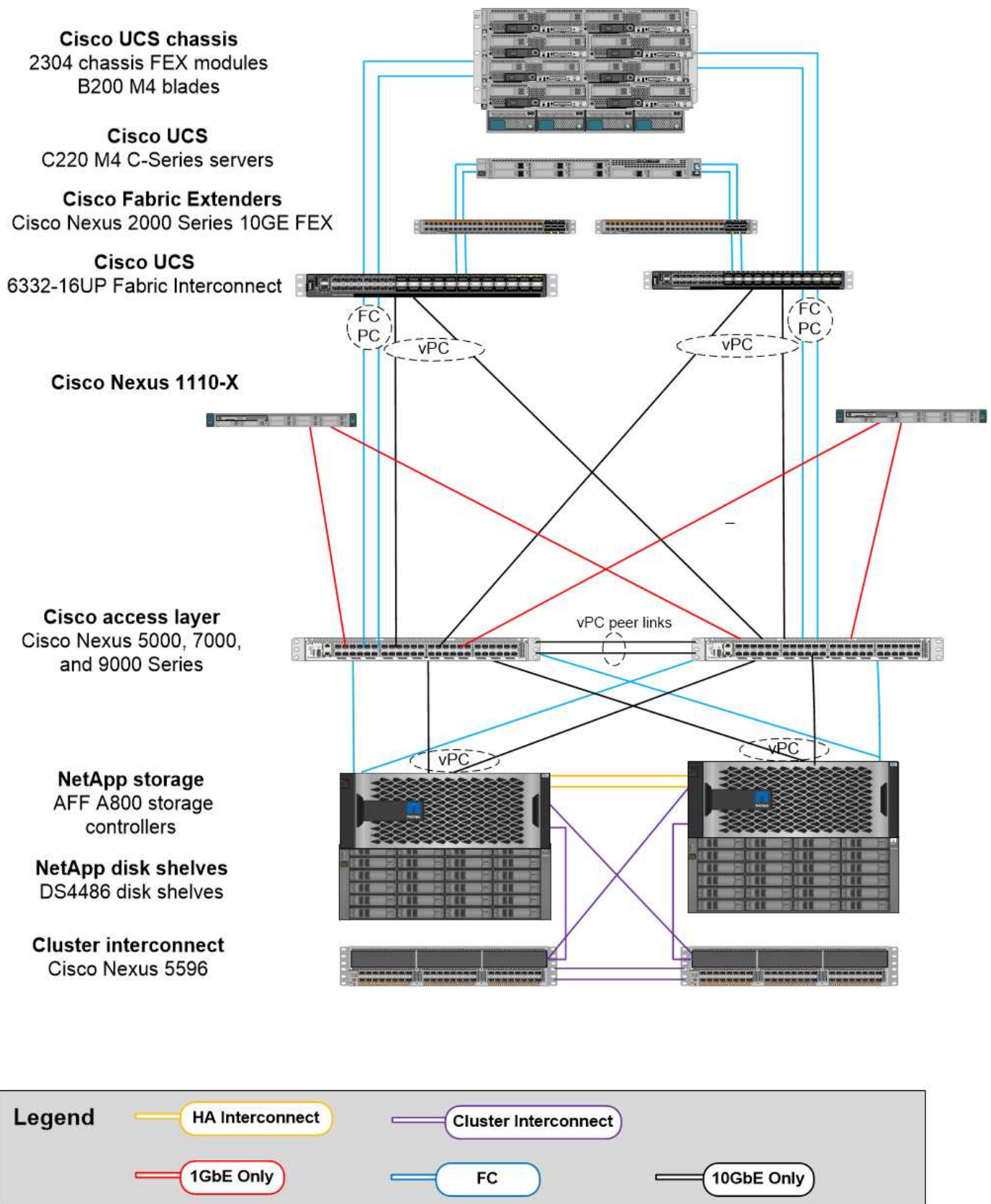
The classic FC SAN boot option has the following licensing and hardware requirements:

- When FC zoning is performed in the Cisco Nexus 5000 Series Switch, a Storage Protocols Service Package license for the Cisco Nexus 5000 Series Switches (FC_FEATURES_PKG) is required.
- When FC zoning is performed in the Cisco Nexus 5000 Series Switch, SAN links are required between the fabric interconnect and the Cisco Nexus 5000 Series Switch. For additional redundancy, SAN port channels are recommended between the links.
- The Cisco Nexus 5010, 5020, and 5548P Switches require a separate FC or universal port (UP) module for connectivity into the Cisco UCS Fabric Interconnect and into the NetApp storage controller.
- The Cisco Nexus 93180YC-FX requires an FC feature license for capabilities to enable FC.
- Each NetApp storage controller requires a minimum of two 8/16/32Gb FC ports for connectivity.
- An FC license on the NetApp storage controller is required.



The use of the Cisco Nexus 7000 or 9000 family of switches precludes the use of traditional FC unless FC zoning is performed in the fabric interconnect. In that case, SAN uplinks to the switch are not supported.

The following figure shows an FC connectivity configuration.



FCoE SAN boot option

The FCoE SAN boot option has the following licensing and hardware requirements:

- When FC zoning is performed in the switch, a Storage Protocols Service Package license for the Cisco

Nexus 5000 or 7000 Series Switches (FC_FEATURES_PKG) is required.

- When FC zoning is performed in the switch, FCoE uplinks are required between the fabric interconnect and the Cisco Nexus 5000 or 7000 Series Switches. For additional redundancy, FCoE port channels are also recommended between the links.
- Each NetApp storage controller requires at least one dual-port unified target adapter (UTA) add-on card for FCoE connectivity unless onboard unified target adapter 2 (UTA2) ports are present.
- This option requires an FC license on the NetApp storage controller.
- If you use the Cisco Nexus 7000 Series Switches and FC zoning is performed in the switch, a line card that is capable of supporting FCoE is required.



The use of the Cisco Nexus 9000 Series Switches precludes the use of FCoE unless FC zoning is performed in the fabric interconnect and storage is connected to the fabric interconnects with appliance ports. In that case, FCoE uplinks to the switch are not supported.

The following figure shows an FCoE boot scenario.

Cisco UCS chassis
2304 chassis FEX modules
B200 M4 blades

Cisco UCS
C220 M4 C-Series servers

Cisco Fabric Extenders
Cisco Nexus 2000 Series 10GE FEX

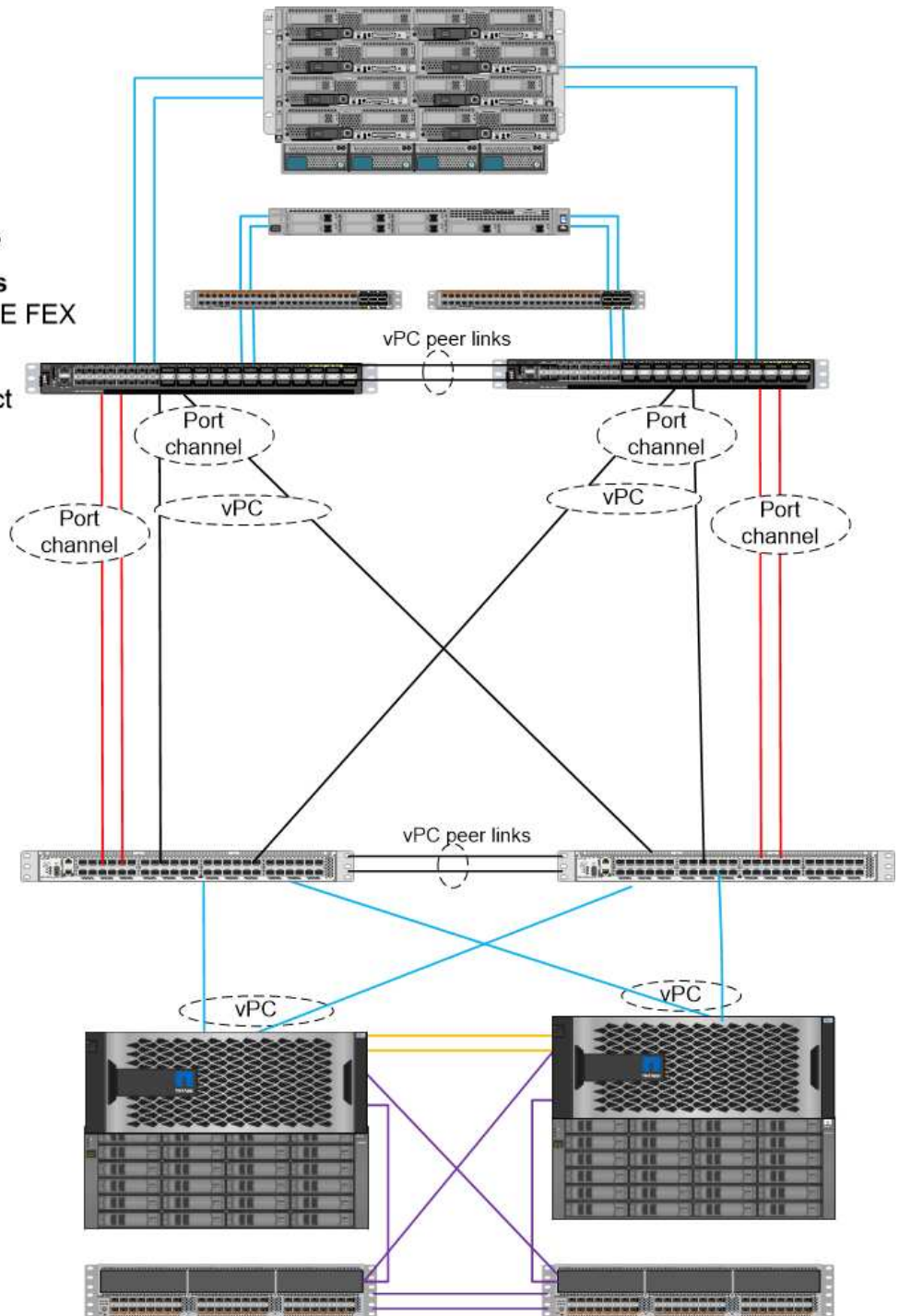
Cisco UCS
6332-16UP Fabric Interconnect

Cisco access layer
Cisco Nexus 5000, 7000,
and 9000 Series

NetApp storage
AFF A800 storage
controllers

NetApp disk shelves
DS4486 disk shelves

Cluster interconnect
Cisco Nexus 5596



Legend

HA Interconnect

Cluster Interconnect

FCoE Only

FCoE and 10GbE

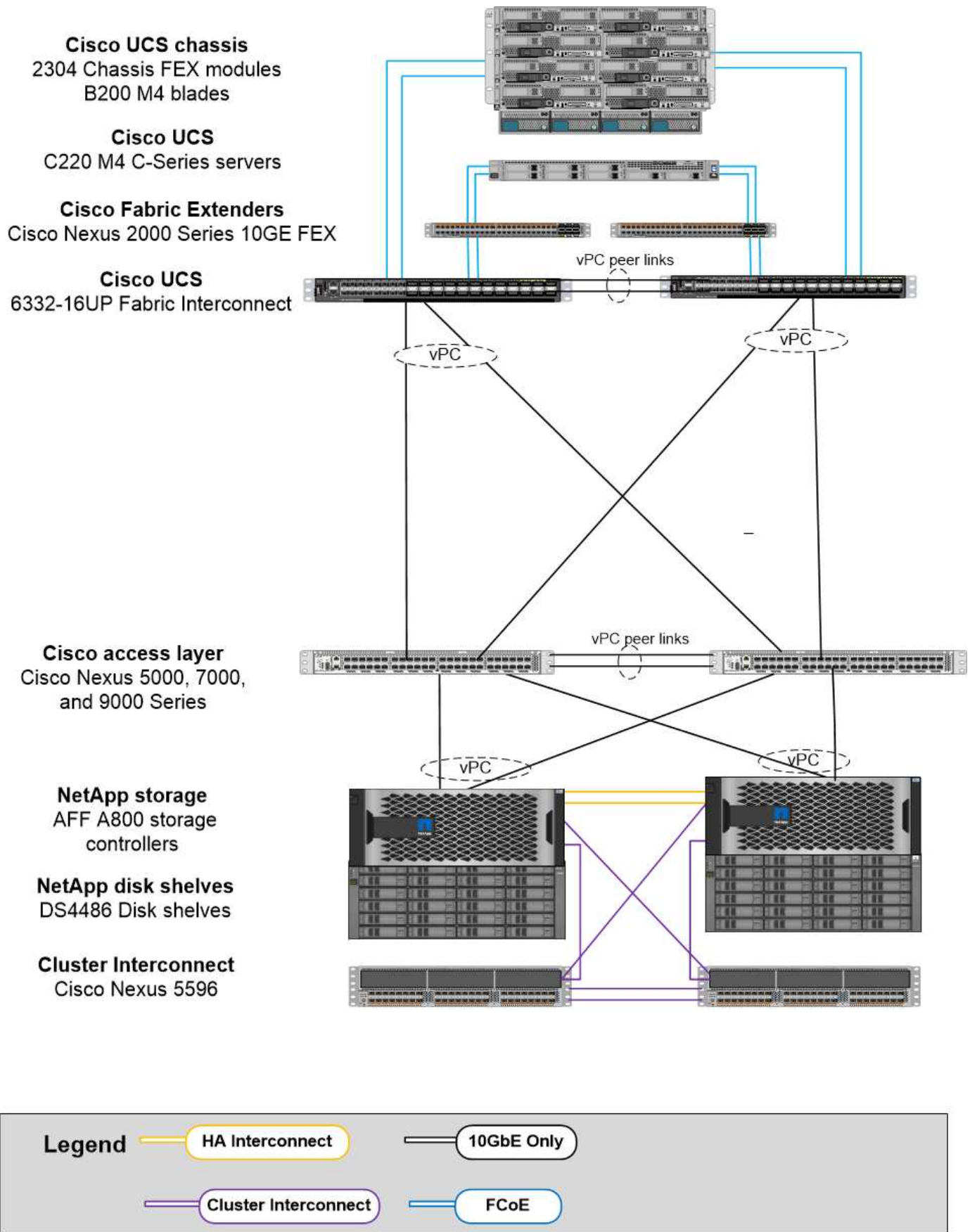
10GbE Only

iSCSI boot option

The iSCSI boot option has the following licensing and hardware requirements:

- An iSCSI license on the NetApp storage controller is required.
- An adapter in the Cisco UCS Server that is capable of iSCSI boot is required.
- A two-port 10Gbps Ethernet adapter on the NetApp storage controller is required.

The following figure shows an Ethernet-only configuration that is booted by using iSCSI.



Cisco UCS direct connect with NetApp storage

NetApp AFF and FAS controllers can be directly connected to the Cisco UCS fabric interconnects without any upstream SAN switch.

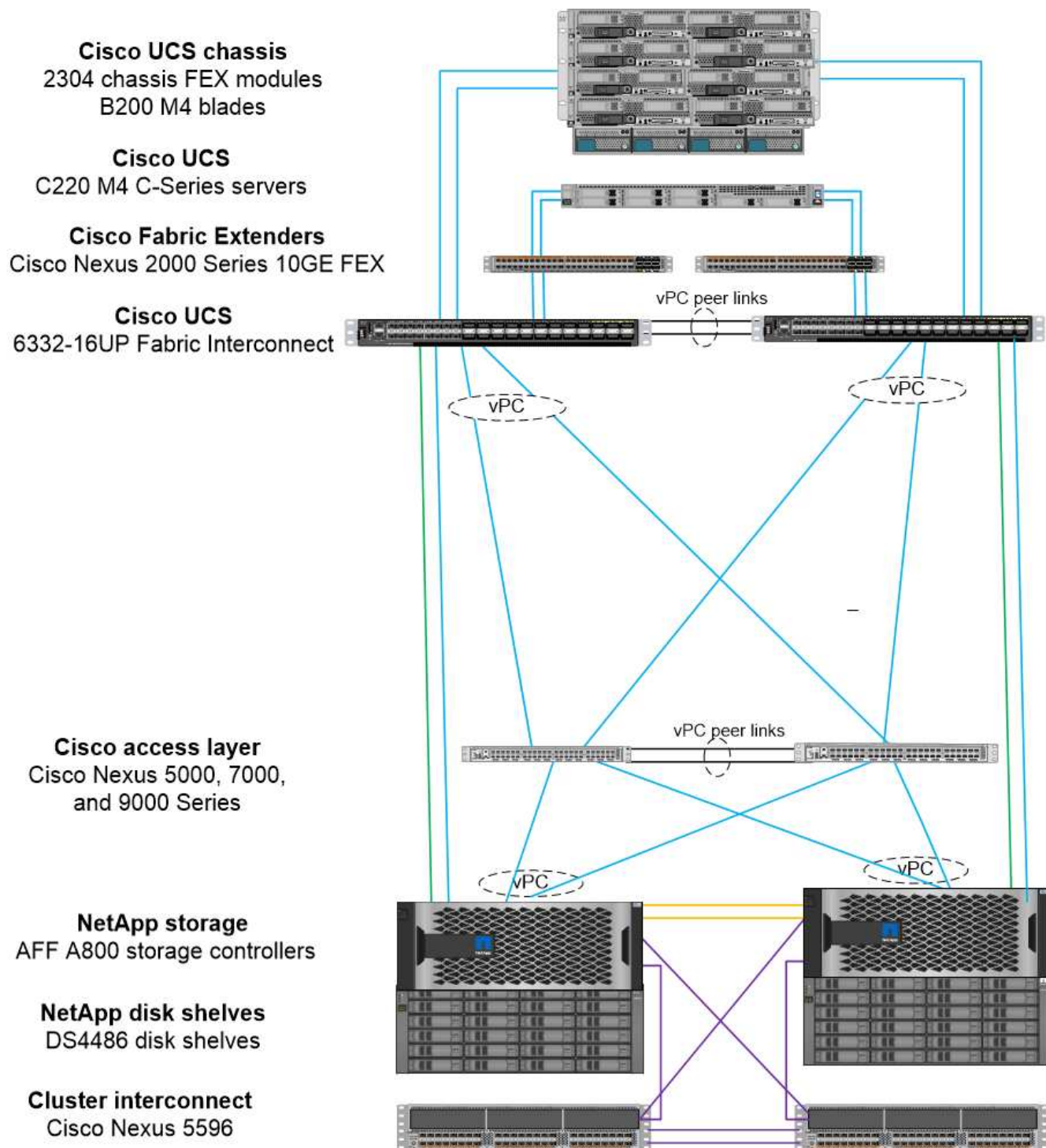
Four Cisco UCS port types can be used to directly connect to NetApp storage:

- **Storage FC port.** Directly connect this port to an FC port on NetApp storage.
- **Storage FCoE port.** Directly connect this port to an FCoE port on NetApp storage.
- **Appliance port.** Directly connect this port to a 10GbE port on NetApp storage.
- **Unified storage port.** Directly connect this port to a NetApp UTA.

The licensing and hardware requirements are as follows:

- A protocol license on the NetApp storage controller is required.
- A Cisco UCS adapter (initiator) is required on the server. For a list of supported Cisco UCS adapters, see the NetApp [IMT](#).
- A target adapter on the NetApp storage controller is required.

The following figure shows an FC direct-connect configuration.



Legend

HA Interconnect

Cluster Interconnect

FC

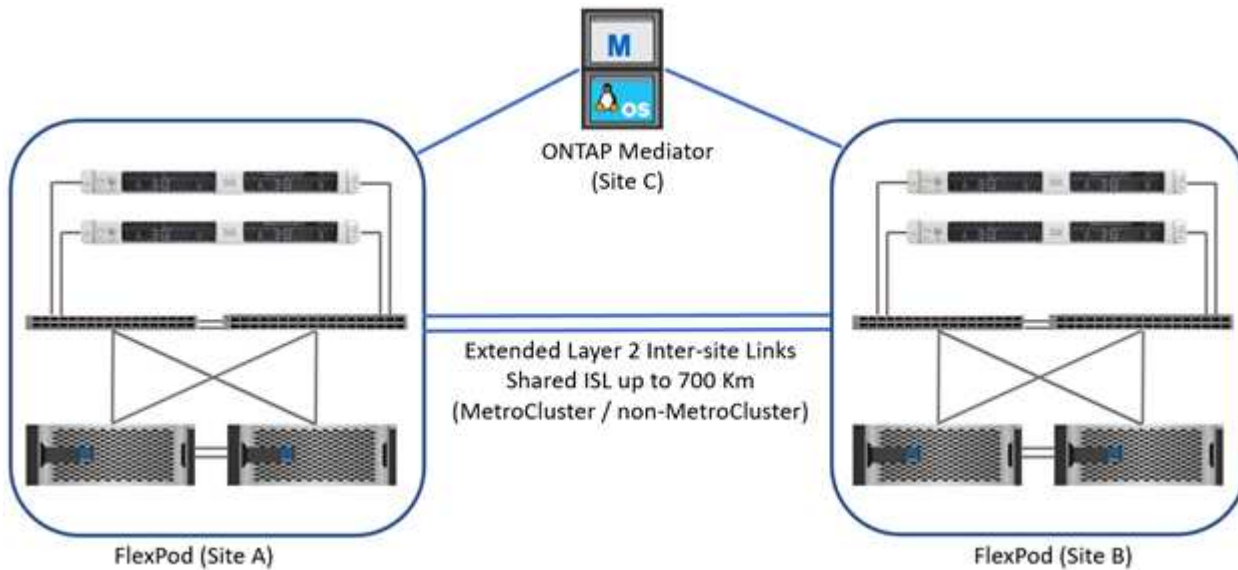
FCoE

10GbE Only

Notes:

- Cisco UCS is configured in FC switching mode.
- FCoE ports from the target to fabric interconnects are configured as FCoE storage ports.
- FC ports from the target to fabric interconnects are configured as FC storage ports.

The following figure shows an iSCSI/Unified IP direct-connect configuration.



Notes:

- Cisco UCS is configured in Ethernet switching mode.
- iSCSI ports from the target to fabric interconnects are configured as Ethernet storage ports for iSCSI data.
- Ethernet ports from the target to fabric interconnects are configured as Ethernet storage ports for CIFS/NFS data.

Cisco components

Cisco has contributed substantially to the FlexPod design and architecture, covering both the compute and networking layers of the solution. This section describes the Cisco UCS and Cisco Nexus options that are available for FlexPod. FlexPod supports both Cisco UCS B-Series and C-Series servers.

Cisco UCS fabric interconnect options

Redundant fabric interconnects are required in the FlexPod architecture. When you add multiple Cisco UCS chassis to a pair of fabric interconnects, remember that the maximum number of chassis in an environment is determined by both an architectural and a port limit.

The part numbers that are shown in the following table are for the base fabric interconnects. They do not include the power supply unit (PSU) or SFP+, QSFP+, or expansion modules. Additional fabric interconnects are supported; see the [NetApp IMT](#) for a complete list.

Cisco UCS fabric interconnect	Part number	Technical specifications
Cisco UCS 6332UP	UCS-FI-6332-UP	Cisco UCS 6332 Fabric Interconnect

Cisco UCS fabric interconnect	Part number	Technical specifications
Cisco UCS 6454	UCS-FI-6454-U	Cisco UCS 6454 Fabric Interconnect

Cisco UCS 6454

The Cisco UCS 6454 Series offers line-rate, low-latency, lossless 10/25/40/100GbE Ethernet and FCoE connectivity, as well as unified ports that are capable of either Ethernet or FC operation. The 44 10/25Gbps ports can operate as 10Gbps or 25Gbps converged Ethernet, of which eight are unified ports capable of operating at 8/16/32Gbps for FC. Four ports operate at 1/10/25Gbps for legacy connectivity, and six QSFP ports serve as 40/100Gbps uplink ports or breakout ports. You can establish 100Gbps end-to-end network connectivity with NetApp storage controllers that support 100Gbps adapters. For adapters and platform support, see the [NetApp Hardware Universe](#).

For details about ports, see the [Cisco UCS 6454 Fabric Interconnect Datasheet](#).

For technical specifications about the 100Gb QSFP data modules, see the [Cisco 100GBASE QSFP Modules Datasheet](#).

Cisco UCS B-Series chassis option

To use Cisco UCS B-Series blades, you must have a Cisco UCS B-Series chassis. The table below describes the Cisco UCS B-Series chassis option.

Cisco UCS B-Series chassis	Part number	Technical specifications
Cisco UCS 5108	N20-C6508	Cisco UCS 5100 Series Blade Server Chassis

Each Cisco UCS 5108 blade chassis must have two Cisco UCS 2200/2300/2400 Series IOMs to provide redundant connectivity to the fabric interconnects.

Cisco UCS B-Series blade server options

Cisco UCS B-Series Blade Servers are available in half-width and full-width varieties, with various CPU, memory, and I/O options. The part numbers that are listed in the following table are for the base server. They do not include the CPU, memory, drives, or mezzanine adapter cards. Multiple configuration options are available and are supported in the FlexPod architecture.

Cisco UCS B-Series blade	Part number	Technical specifications
Cisco UCS B200 M6	UCSB-B200-M6	Cisco UCS B200 M6 Blade Server

Previous generations of Cisco UCS B-Series blades can be used in the FlexPod architecture, if they are supported on the [Cisco UCS Hardware and Software Compatibility List](#). The Cisco UCS B-Series Blade Servers must also have a valid SmartNet support contract.

Cisco UCS X-Series chassis option

To use Cisco UCS X-Series compute nodes, you must have a Cisco UCS X-Series chassis. The following table describes the Cisco UCS X-Series chassis option.

Cisco UCS X-Series blade	Part number	Technical specifications
Cisco UCS 9508 M6	UCSX-9508	Cisco UCX9508 X-Series Chassis

Each Cisco UCS 9508 chassis must have two Cisco UCS 9108 Intelligent Fabric Modules (IFMs) to provide redundant connectivity to the fabric interconnects.

Cisco UCS X-Series device options

Cisco UCS X-Series compute nodes are available with various CPU, memory, and I/O options. The part numbers listed in the following table are for the base node. They do not include the CPU, memory, drives, or mezzanine adapter cards. Multiple configuration options are available and are supported in the FlexPod architecture.

Cisco UCS X-Series compute nodes	Part number	Technical specifications
Cisco UCS X210c M6	UCSX-210C-M6	Cisco UCS X210c M6 Compute Node

Cisco UCS C-Series rack server options

Cisco UCS C-Series Rack Servers are available in one and two rack-unit (RU) varieties, with various CPU, memory, and I/O options. The part numbers that are listed in the second table below are for the base server. They do not include CPUs, memory, drives, Peripheral Component Interconnect Express (PCIe) cards, or the Cisco Fabric Extender. Multiple configuration options are available and are supported in the FlexPod architecture.

The following table lists the Cisco UCS C-Series Rack Server options.

Cisco UCS C-Series rack server	Part number	Technical specifications
Cisco UCS C220 M6	UCSC-C220-M6	Cisco UCS C220 M6 Rack Server
Cisco UCS C225 M6	UCSC-C225-M6	Cisco UCS C225 M6 Rack Server
Cisco UCS C240 M6	UCSC-C240-M6	Cisco UCS C240 M6 Rack Server
Cisco UCS C245 M6	UCSC-C245-M6	Cisco UCS C245 M6 Rack Server

Previous generations of Cisco UCS C-Series servers can be used in the FlexPod architecture, if they are supported on the [Cisco UCS Hardware and Software Compatibility List](#). The Cisco UCS C-Series servers must also have a valid SmartNet support contract.

Cisco Nexus 5000 Series switch options

Redundant Cisco Nexus 5000, 7000, or 9000 Series Switches are required in the FlexPod architecture. The part numbers that are listed in the table below are for the Cisco Nexus 5000 Series chassis; they do not include SFP modules, add-on FC, or Ethernet modules.

Cisco Nexus 5000 Series switch	Part number	Technical specifications
Cisco Nexus 56128P	N5K-C56128P	Cisco Nexus 5600 Platform Switches
Cisco Nexus 5672UP-16G	N5K-C5672UP-16G	

Cisco Nexus 5000 Series switch	Part number	Technical specifications
Cisco Nexus 5596UP	N5K-C5596UP-FA	Cisco Nexus 5548 and 5596 Switches
Cisco Nexus 5548UP	N5K-C5548UP-FA	

Cisco Nexus 7000 series switch options

Redundant Cisco Nexus 5000, 7000, or 9000 Series Switches are required in the FlexPod architecture. The part numbers that are listed in the table below are for the Cisco Nexus 7000 Series chassis; they do not include SFP modules, line cards, or power supplies, but they do include fan trays.

Cisco Nexus 7000 Series Switch	Part number	Technical specifications
Cisco Nexus 7004	N7K-C7004	Cisco Nexus 7000 4-Slot Switch
Cisco Nexus 7009	N7K-C7009	Cisco Nexus 7000 9-Slot Switch
Cisco Nexus 7702	N7K-C7702	Cisco Nexus 7700 2-Slot Switch
Cisco Nexus 7706	N77-C7706	Cisco Nexus 7700 6-Slot Switch

Cisco Nexus 9000 series switch options

Redundant Cisco Nexus 5000, 7000, or 9000 Series Switches are required in the FlexPod architecture. The part numbers that are listed in the table below are for the Cisco Nexus 9000 Series chassis; they do not include SFP modules or Ethernet modules.

Cisco Nexus 9000 Series Switch	Part Number	Technical Specifications
Cisco Nexus 93180YC-FX	N9K-C93180YC-FX	Cisco Nexus 9300 Series Switches
Cisco Nexus 93180YC-EX	N9K-93180YC-EX	
Cisco Nexus 9336PQ ACI Spine	N9K-C9336PQ	
Cisco Nexus 9332PQ	N9K-C9332PQ	
Cisco Nexus 9336C-FX2	N9K-C9336C-FX2	
Cisco Nexus 92304QC	N9K-C92304QC	Cisco Nexus 9200 Series Switches
Cisco Nexus 9236C	N9K-9236C	



Some Cisco Nexus 9000 Series Switches have additional variants. These variants are supported as part of the FlexPod solution. For the complete list of Cisco Nexus 9000 Series Switches, see [Cisco Nexus 9000 Series Switches](#) on the Cisco website.

Cisco APIC options

When deploying Cisco ACI, you must configure the three Cisco APICs in addition to the items in the section [Cisco Nexus 9000 Series Switches](#). For more information about the Cisco APIC sizes, see the [Cisco Application Centric Infrastructure Datasheet](#).

For more information about APIC product specifications refer to Table 1 through Table 3 on the [Cisco Application Policy Infrastructure Controller Datasheet](#).

Cisco Nexus fabric extender options

Redundant Cisco Nexus 2000 Series rack-mount FEXs are recommended for large FlexPod architectures that use C-Series servers. The table below describes a few Cisco Nexus FEX options. Alternate FEX models are also supported. For more information, see the [Cisco UCS Hardware and Software Compatibility List](#).

Cisco Nexus rack-mount FEX	Part number	Technical specifications
Cisco Nexus 2232PP	N2K-C2232PP	Cisco Nexus 2000 Series Fabric Extenders
Cisco Nexus 2232TM-E	N2K-C2232TM-E	
Cisco Nexus 2348UPQ	N2K-C2348UPQ	Cisco Nexus 2300 Platform Fabric Extenders
Cisco Nexus 2348TQCisco Nexus 2348TQ-E	N2K-C2348TQN2K-C2348TQ-E	

Cisco MDS options

Cisco MDS switches are an optional component in the FlexPod architecture. Redundant SAN switch fabrics are required when you implement the Cisco MDS switch for FC SAN. The table below lists the part numbers and details for a subset of the supported Cisco MDS switches. See the [NetApp IMT](#) and [Cisco Hardware and Software Compatibility List](#) for a complete list of supported SAN switches.

Cisco MDS 9000 series switch	Part number	Description
Cisco MDS 9148T	DS-C9148T-24IK	Cisco MDS 9100 Series Switches
Cisco MDS 9132T	DS-C9132T-MEK9	
Cisco MDS 9396S	DS-C9396S-K9	Cisco MDS 9300 Series Switches

Cisco software licensing options

Licenses are required to enable storage protocols on the Cisco Nexus switches. The Cisco Nexus 5000 and 7000 Series of switches all require a storage services license to enable the FC or FCoE protocol for SAN boot implementations. The Cisco Nexus 9000 Series Switches currently do not support FC or FCoE.

The required licenses and the part numbers for those licenses vary depending on the options that you select for each component of the FlexPod solution. For example, software license part numbers vary depending on the number of ports and which Cisco Nexus 5000 or 7000 Series Switches you choose. Consult your sales representative for the exact part numbers. The table below lists the Cisco software licensing options.

Cisco software licensing	Part number	License information
Cisco Nexus 5500 Storage License, 8-, 48-, and 96-port	N55-8P-SSK9/N55-48P-SSK9/N55-96P-SSK9	Licensing Cisco NX-OS Software Features
Cisco Nexus 5010/5020 Storage Protocols License	N5010-SSK9/N5020-SSK9	
Cisco Nexus 5600 Storage Protocols License	N56-16p-SSK9/N5672-72P-SSK9/N56128-128P-SSK9	
Cisco Nexus 7000 Storage Enterprise License	N7K-SAN1K9	
Cisco Nexus 9000 Enterprise Services License	N95-LAN1K9/N93-LAN1K9	

Cisco support licensing options

Valid SmartNet support contracts are required on all Cisco equipment in the FlexPod architecture.

The required licenses and the part numbers for those licenses must be verified by your sales representative because they can vary for different products. The table below lists the Cisco support licensing options.

Cisco Support licensing	License guide
Smart Net Total Care Onsite Premium	Cisco Smart Net Total Care Service

NetApp components

NetApp storage controllers provide the storage foundation in the FlexPod architecture for both boot and application data storage. NetApp components include storage controllers, cluster interconnect switches, drives and disk shelves, and licensing options.

NetApp storage controller options

Redundant NetApp FAS, AFF, or AFF ASA controllers are required in the FlexPod architecture. The controllers run ONTAP software. When the storage controllers are ordered, the preferred software version can be preloaded on the controllers. For ONTAP, a complete cluster is ordered. A complete cluster includes a pair of storage controllers and a cluster interconnect (switch or switchless).

Different options and configurations are available, depending on the selected storage platform. Consult your sales representative for details about these additional components.

The controller families that are listed in the table below are appropriate for use in a FlexPod Datacenter solution because their connection to the Cisco Nexus switches is seamless. See the [NetApp Hardware Universe](#) for specific compatibility details on each controller model.

Storage controller family	Technical specifications
AFF A-Series	AFF A-Series Documentation
AFF ASAA-Series	AFF ASAA-Series Documentation
FAS Series	FAS Series Documentation

Cluster interconnect switch options

The following table lists the Nexus cluster interconnect switches that are available for FlexPod architectures. In addition, FlexPod supports all ONTAP supported cluster switches including non-Cisco switches, provided they are compatible with the version of ONTAP being deployed. See the [NetApp Hardware Universe](#) for additional compatibility details for specific switch models.

Cluster interconnect switch	Technical specifications
Cisco Nexus 3132Q-V	NetApp Documentation: Cisco Nexus 3132Q-V switches
Cisco Nexus 9336C-FX2	NetApp Documentation: Cisco Nexus 9336C-FX2 switches

NetApp disk shelf and drive options

A minimum of one NetApp disk shelf is required for all storage controllers.

The selected NetApp shelf type determines which drive types are available within that shelf.



For all disk shelves and disk part numbers, consult your sales representative.

For more information about the supported drives, click the NetApp Hardware Universe link in the following table and then select Supported Drives.

Disk shelf	Technical specifications
DS224C	Disk Shelves and Storage Media Supported Drives on NetApp Hardware Universe
DS212C	
DS460C	
NS224	

NetApp software licensing options

The following table lists the NetApp software licensing options that are available for the FlexPod Datacenter architecture. NetApp software is licensed at the FAS and AFF controller level.

NetApp software licensing	Part number	Technical specifications
SW, Complete BNDL (Controller), -C	SW-8XXX-COMP-BNDL-C	Product Library A–Z
SW, ONTAP Essentials (Controller), -C	SW-8XXX-ONTAP9-C	

NetApp support licensing options

NetApp SupportEdge Premium licenses are required for the FlexPod architecture, but the part numbers for those licenses vary based on the options that you select in the FlexPod design. For example, software license part numbers are different depending on which FAS controller you choose. Consult your sales representative for information about the exact part numbers for individual support licenses. The table below shows an example of a SupportEdge license.

NetApp support licensing	Part number	Technical specifications
SupportEdge Premium 4 hours on site—months: 36	CS-O2-4HR	NetApp SupportEdge Premium

Power and cabling requirements

A FlexPod design has minimum requirements for power and cabling.

Power requirements

Power requirements for FlexPod Datacenter differ based on the location where the FlexPod Datacenter configuration is installed.

For more data about the maximum power that is required and for other detailed power information, consult the technical specifications for each hardware component listed in the section [Technical Specifications and References: Hardware Components](#).

For detailed Cisco UCS power data, see the [Cisco UCS power calculator](#).

For NetApp storage controller power data, see the [NetApp Hardware Universe](#). Under Platforms, select the storage platform that you want to use in the configuration (FAS/V-Series or AFF). Select the ONTAP version and storage controller, and then click the Show Results button.

Minimum cable requirements

The number and type of cables and adapters that are required vary per FlexPod Datacenter deployment. The cable type, transceiver type, and number are determined during the design process based on your requirements. The table below lists the minimum number of cables required.

Hardware	Model number	Cables required
Cisco UCS chassis	Cisco UCS 5108	At least two twinaxial cables per Cisco UCS 2104XP, 2204XP, or 2208XP module

Hardware	Model number	Cables required
Cisco UCS Fabric Interconnects	Cisco UCS 6248UP	<ul style="list-style-type: none"> Two Cat5e cables for management ports
	Cisco UCS 6296UP	<ul style="list-style-type: none"> Two Cat5e cables for the L1, L2 interconnects, per pair of fabric interconnects
	Cisco UCS 6332-16UP	<ul style="list-style-type: none"> At least four twinaxial cables per fabric interconnect
	Cisco UCS 6454	<ul style="list-style-type: none"> At least four FC cables per fabric interconnect
	Cisco UCS 6332	<ul style="list-style-type: none"> Two Cat5e cables for management ports Two Cat5e cables for the L1, L2 interconnects, per pair of fabric interconnects At least four twinaxial cables per fabric interconnect
	Cisco UCS 6324	<ul style="list-style-type: none"> Two 10/100/1000Mbps management ports At least two twinaxial cables per fabric interconnect
Cisco Nexus 5000 and 7000 Series Switches	Cisco Nexus 5000 Series	<ul style="list-style-type: none"> At least two 10GbE fiber or twinaxial cables per switch At least two FC cables per switch (if FC/FCoE connectivity is required)
	Cisco Nexus 7000 Series	
Cisco Nexus 9000 Series Switches	Cisco Nexus 9000 Series	At least two 10GbE cables per switch
NetApp FAS controllers	AFF A-Series	<ul style="list-style-type: none"> A pair of SAS or SATA cables per storage controller At least two FC cables per controller, if using legacy FC At least two 10GbE cables per controller
	FAS Series	<ul style="list-style-type: none"> At least one GbE cable for management per controller For ONTAP, eight short twinaxial cables are required per pair of cluster interconnect switches

Hardware	Model number	Cables required
NetApp disk shelves	DS212C	Two SAS, SATA, or FC cables per disk shelf
	DS224C	
	DS460C	
	NS224	Two 100Gbps copper cables per disk shelf

Technical specifications and references

Technical specifications provide details about the hardware components in a FlexPod solution, such as chassis, FEXs, servers, switches, and storage controllers.

Cisco UCS B-Series blade server chassis

The technical specifications for Cisco UCS B-Series Blade Server chassis, as shown in the table below, include the following components:

- Number of rack units
- Maximum number of blades
- Unified Fabric capability
- Midplane I/O bandwidth per server
- Number of I/O bays for FEXs

Component	Cisco UCS 5100 Series blade server chassis
Rack units	6
Maximum full-width blades	4
Maximum half-width blades	8
Capable of Unified Fabric	Yes
Midplane I/O	Up to 80Gbps of I/O bandwidth per server
I/O bays for FEXs	Two bays for Cisco UCS 2104XP, 2204/8XP, 2408XP, and 2304 FEXs

For more information, see the [Cisco UCS 5100 Series Blade Server Chassis Datasheet](#).

Cisco UCS B-Series blade servers

The technical specifications for Cisco UCS B-Series Blade Servers, as shown in the table below, include the following components:

- Number of processor sockets
- Processor support
- Memory capacity
- Size and speed

- SAN boot support
- Number of mezzanine adapter slots
- I/O maximum throughput
- Form factor
- Maximum number of servers per chassis

Component	Cisco UCS datasheet
Cisco UCS B200 M6	Cisco UCS B200 M6 Blade Server

Cisco UCS C-Series rack servers

The technical specifications for the Cisco UCS C-Series rack servers include processor support, maximum memory capacity, the number of PCIe slots, and the size of the form factor. For additional details on compatible UCS server models, see the [Cisco Hardware Compatibility](#) list. The following tables illustrate the C-Series Rack Server datasheets and Cisco UCS C-Series chassis option, respectively.

Component	Cisco UCS datasheet
Cisco UCS C220 M6	Cisco UCS C220 M6 Rack Server
Cisco UCS C225 M6	Cisco UCS C225 M6 Rack Server
Cisco UCS C240 M6	Cisco UCS C240 M6 Rack Server
Cisco UCS C245 M6	Cisco UCS C245 M6 Rack Server

Cisco UCS X-Series chassis

The technical specifications for Cisco UCS X-Series chassis, as shown in the table below, include the following components:

- Number of rack units
- Maximum number of nodes
- Unified Fabric capability
- Number of I/O bays for IFMs

Component	Cisco UCS 9508 X-Series compute node chassis
Rack units	7
Maximum number of nodes	8
Capable of Unified Fabric	Yes
I/O bays for IFMs	Two bays for Cisco UCS 9108 Intelligent Fabric Modules (IFMs)

For more information, see the [Cisco UCS X9508 X-Series Chassis Datasheet](#).

Cisco UCS X-Series compute node

The technical specifications for Cisco UCS X-Series compute node, as shown in the following table below,

include the following components:

- Number of processor sockets
- Processor support
- Memory capacity
- Size and speed
- SAN boot support
- Number of mezzanine adapter slots
- I/O maximum throughput
- Form factor
- Maximum number of compute nodes per chassis

Component	Cisco UCS datasheet
Cisco UCS X210c M6	Cisco UCS X210c M6 Compute Node

GPU recommendation for FlexPod AI, ML, and DL

The Cisco UCS C-Series Rack Servers listed in the table below can be used in a FlexPod architecture for hosting AI, ML, and DL workloads. The Cisco UCS C480 ML M5 Servers are purpose built for AI, ML, and DL workloads and use NVIDIA's SXM2- based GPUs while the other servers use PCIe- based GPUs.

The table below also lists the recommended GPUs that can be used with these servers.

Server	GPUs
Cisco UCS C220 M6	NVIDIA T4
Cisco UCS C225 M6	NVIDIA T4
Cisco UCS C240 M6	NVIDIA TESLA A10, A100
Cisco UCS C245 M6	NVIDIA TESLA A10, A100

Cisco UCS VIC adapters for Cisco UCS B-Series blade servers

The technical specifications for Cisco UCS Virtual Interface Card (VIC) adapters for Cisco UCS B-Series Blade Servers include the following components:

- Number of uplink ports
- Performance per port (IOPS)
- Power
- Number of blade ports
- Hardware offload
- Single root input/output virtualization (SR-IOV) support

All currently validated FlexPod architectures use a Cisco UCS VIC. Other adapters are supported if they are listed on the NetApp [IMT](#) and are compatible with your deployment of FlexPod, but they might not deliver all the features that are outlined in corresponding reference architectures. The following table illustrates the Cisco UCS VIC adapter datasheets.

Component	Cisco UCS datasheet
Cisco UCS Virtual Interface Adapters	Cisco UCS VIC Datasheets

Cisco UCS fabric interconnects

The technical specifications for Cisco UCS fabric interconnects include form factor size, the total number of ports and expansion slots, and throughput capacity. The following table illustrates the Cisco UCS fabric interconnect datasheets.

Component	Cisco UCS datasheet
Cisco UCS 6248UP	Cisco UCS 6200 Series Fabric Interconnects
Cisco UCS 6296UP	
Cisco UCS 6324	Cisco UCS 6324 Fabric Interconnect
Cisco UCS 6300	Cisco UCS 6300 Series Fabric Interconnects
Cisco UCS 6454	Cisco UCS 6400 Series Fabric Interconnects

Cisco Nexus 5000 Series switches

The technical specifications for Cisco Nexus 5000 Series Switches, including the form factor size, the total number of ports, and layer- 3 module and daughter card support, are contained in the datasheet for each model family. These datasheets can be found in the following table.

Component	Cisco Nexus datasheet
Cisco Nexus 5548UP	Cisco Nexus 5548UP Switch
Cisco Nexus 5596UP (2U)	Cisco Nexus 5596UP Switch
Cisco Nexus 56128P	Cisco Nexus 56128P Switch
Cisco Nexus 5672UP	Cisco Nexus 5672UP Switch

Cisco Nexus 7000 Series switches

The technical specifications for Cisco Nexus 7000 Series Switches, including the form factor size and the maximum number of ports, are contained in the datasheet for each model family. These datasheets can be found in the following table.

Component	Cisco Nexus datasheet
Cisco Nexus 7004	Cisco Nexus 7000 Series Switches
Cisco Nexus 7009	
Cisco Nexus 7010	
Cisco Nexus 7018	

Component	Cisco Nexus datasheet
Cisco Nexus 7702	Cisco Nexus 7700 Series Switches
Cisco Nexus 7706	
Cisco Nexus 7710	
Cisco Nexus 7718	

Cisco Nexus 9000 Series switches

The technical specifications for Cisco Nexus 9000 Series Switches are contained in the datasheet for each model. Specifications include the form factor size; the number of supervisors, fabric module, and line card slots; and the maximum number of ports. These datasheets can be found in the following table.

Component	Cisco Nexus datasheet
Cisco Nexus 9000 Series	Cisco Nexus 9000 Series Switches
Cisco Nexus 9500 Series	Cisco Nexus 9500 Series Switches
Cisco Nexus 9300 Series	Cisco Nexus 9300 Series Switches
Cisco Nexus 9336PQ ACI Spine Switch	Cisco Nexus 9336PQ ACI Spine Switch
Cisco Nexus 9200 Series	Cisco Nexus 9200 Platform Switches

Cisco Application Policy Infrastructure controller

When you deploy Cisco ACI, in addition to the items in the section [Cisco Nexus 9000 Series Switches](#), you must configure three Cisco APICs. The following table lists the Cisco APIC datasheet.

Component	Cisco Application Policy Infrastructure datasheet
Cisco Application Policy Infrastructure Controller	Cisco APIC Datasheet

Cisco Nexus fabric extender details

The technical specifications for the Cisco Nexus FEX include speed, the number of fixed ports and links, and form factor size.

The following table lists the Cisco Nexus 2000 Series FEX datasheet.

Component	Cisco Nexus fabric extender datasheet
Cisco Nexus 2000 Series Fabric Extenders	Nexus 2000 Series FEX Datasheet

SFP modules

For information about the SFP modules, review the following resources:

- For information about the Cisco 10Gb SFP, see [Cisco 10 Gigabit Modules](#).
- For information about the Cisco 25Gb SFP, see [Cisco 25 Gigabit Modules](#).
- For information about the Cisco QSFP module, see the [Cisco 40GBASE QSFP Modules datasheet](#).

- For information about the Cisco 100Gb SFP, see [Cisco 100 Gigabit Modules](#).
- For information about the Cisco FC SFP module, see the [Cisco MDS 9000 Family Pluggable Transceivers datasheet](#).
- For information about all supported Cisco SFP and transceiver modules, see [Cisco SFP and SFP+ Transceiver Module Installation Notes](#) and [Cisco Transceiver Modules](#).

NetApp storage controllers

The technical specifications for NetApp storage controllers include the following components:

- Chassis configuration
- Number of rack units
- Amount of memory
- NetApp FlashCache caching
- Aggregate size
- Volume size
- Number of LUNs
- Supported network storage
- Maximum number of NetApp FlexVol volumes
- Maximum number of supported SAN hosts
- Maximum number of Snapshot copies

FAS Series

All available models of FAS storage controllers are supported for use in a FlexPod Datacenter. Detailed specifications for all FAS series storage controllers are available in the [NetApp Hardware Universe](#). See the platform-specific documentation listed in the following table for detailed information about a specific FAS model.

Component	FAS Series controller platform documentation
FAS9000 Series	FAS9000 Series Datasheet
FAS8700 Series	FAS8700 Series Datasheet
FAS8300 Series	FAS8300 Series Datasheet
FAS500f Series	FAS500f Series Datasheet
FAS2700 Series	FAS2700 Series Datasheet

AFF A-Series

All current models of NetApp AFF A-Series storage controllers are supported for use in FlexPod. Additional information can be found in the [AFF Technical Specifications](#) datasheet and in the [NetApp Hardware Universe](#). See the platform-specific documentation listed in the following table for detailed information about a specific AFF Model.

Component	AFF A-Series controller platform documentation
NetApp AFF A800	AFF A800 Platform Documentation
NetApp AFF A700	AFF A700 Platform Documentation
NetApp AFF A700s	AFF A700s Platform Documentation
NetApp AFF A400	AFF A400 Platform Documentation
NetApp AFF A250	AFF A250 Platform Documentation

AFF ASA A-Series

All current models of NetApp AFF ASA A-Series storage controllers are supported for use in FlexPod. Additional information can be found in the All SAN Array documentation resources, ONTAP AFF All SAN Array System technical report, and in the NetApp Hardware Universe. See the platform-specific documentation listed in the following table for detailed information about a specific AFF Model.

Component	AFF A-Series controller platform documentation
NetApp AFF ASA A800	AFF ASA A800 Platform Documentation
NetApp AFF ASA A700	AFF ASA A700 Platform Documentation
NetApp AFF ASA A400	AFF ASA A400 Platform Documentation
NetApp AFF ASA A250	AFF ASA A250 Platform Documentation
NetApp AFF ASA A220	AFF ASA A220 Platform Documentation

NetApp disk shelves

The technical specifications for NetApp disk shelves include the form factor size, the number of drives per enclosure, and the shelf I/O modules; this documentation can be found in the following table. For more information, see the [NetApp Disk Shelves and Storage Media Technical Specifications](#) and the [NetApp Hardware Universe](#).

Component	NetApp FAS/AFF disk shelf documentation
NetApp DS212C Disk Shelf	DS212C Disk Shelf Documentation
NetApp DS224C Disk Shelf	DS224C Disk Shelf Documentation
NetApp DS460C Disk Shelf	DS460C Disk Shelf Documentation
NetApp NS224 NVMe-SSD Disk Shelf	NS224 Disk Shelf Documentation

NetApp drives

The technical specifications for NetApp drives include the form factor size, disk capacity, disk RPM, supporting controllers, and ONTAP version requirements. These specifications can be found in the Drives section of the [NetApp Hardware Universe](#).

Legacy equipment

FlexPod is a flexible solution that enables you to use your existing equipment and new equipment that is currently for sale by Cisco and NetApp. Occasionally, certain models of

equipment from both Cisco and NetApp are designated as end of life (EOL).

Even though these equipment models are no longer available, if you purchased one of these models before the end-of-availability (EOA) date, you can use that equipment in a FlexPod configuration. A complete list of the legacy equipment models that are supported in FlexPod that are no longer for sale can be referenced on the [NetApp Service and Support Product Programs End of Availability Index](#).

For more information on legacy Cisco equipment, see the Cisco EOL and EOA notices for [Cisco UCS C-Series Rack Servers](#), [Cisco UCS B-Series Blade Servers](#), and [Nexus switches](#).

Legacy FC Fabric support includes the following:

- 2Gb Fabric
- 4Gb Fabric

Legacy software includes the following:

- NetApp Data ONTAP operating in 7-Mode, 7.3.5 and later
- ONTAP 8.1.x through 9.0.x
- Cisco UCS Manager 1.3 and later
- Cisco UCS Manager 2.1 through 2.2.7

Where to find additional Information

To learn more about the information that is described in this document, review the following documents and websites:

- NetApp Product Documentation
<https://docs.netapp.com/>
- NetApp Support Communications
<https://mysupport.netapp.com/info/communications/index.html>
- NetApp Interoperability Matrix Tool (IMT)
<https://mysupport.netapp.com/matrix/#welcome>
- NetApp Hardware Universe
<https://hwu.netapp.com/>
- NetApp Support
<https://mysupport.netapp.com/>

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