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Data Center Design Overview

SMART BUSINESS ARCHITECTURE

February 2013 Series

Preface

Who Should Read This Guide

This Cisco® Smart Business Architecture (SBA) guide is for people who fill a variety of roles:

- Systems engineers who need standard procedures for implementing solutions
- Project managers who create statements of work for Cisco SBA implementations
- Sales partners who sell new technology or who create implementation documentation
- Trainers who need material for classroom instruction or on-the-job training

In general, you can also use Cisco SBA guides to improve consistency among engineers and deployments, as well as to improve scoping and costing of deployment jobs.

Release Series

Cisco strives to update and enhance SBA guides on a regular basis. As we develop a series of SBA guides, we test them together, as a complete system. To ensure the mutual compatibility of designs in Cisco SBA guides, you should use guides that belong to the same series.

The Release Notes for a series provides a summary of additions and changes made in the series.

All Cisco SBA guides include the series name on the cover and at the bottom left of each page. We name the series for the month and year that we release them, as follows:

month year Series

For example, the series of guides that we released in February 2013 is the "February Series".

You can find the most recent series of SBA guides at the following sites:

Customer access: http://www.cisco.com/go/sba

Partner access: http://www.cisco.com/go/sbachannel

Comments and Questions

If you would like to comment on a guide or ask questions, please use the SBA feedback form.

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What's In This SBA Guide

Cisco SBA Data Center

Cisco SBA helps you design and quickly deploy a full-service business network. A Cisco SBA deployment is prescriptive, out-of-the-box, scalable, and flexible.

Cisco SBA incorporates LAN, WAN, wireless, security, data center, application optimization, and unified communication technologies—tested together as a complete system. This component-level approach simplifies system integration of multiple technologies, allowing you to select solutions that solve your organization's problems—without worrying about the technical complexity.

Cisco SBA Data Center is a comprehensive design that scales from a server room to a data center for networks with up to 10,000 connected users. This design incorporates compute resources, security, application resiliency, and virtualization.

Route to Success

To ensure your success when implementing the designs in this guide, you should first read any guides that this guide depends upon—shown to the left of this guide on the route below. As you read this guide, specific prerequisites are cited where they are applicable.

About This Guide

This *design overview* provides the following information:

- An introduction to a Cisco SBA design
- An explanation of the requirements that shaped the design
- A description of the benefits that the design will provide your organization

You can find the most recent series of Cisco SBA guides at the following sites:

Customer access: http://www.cisco.com/go/sba

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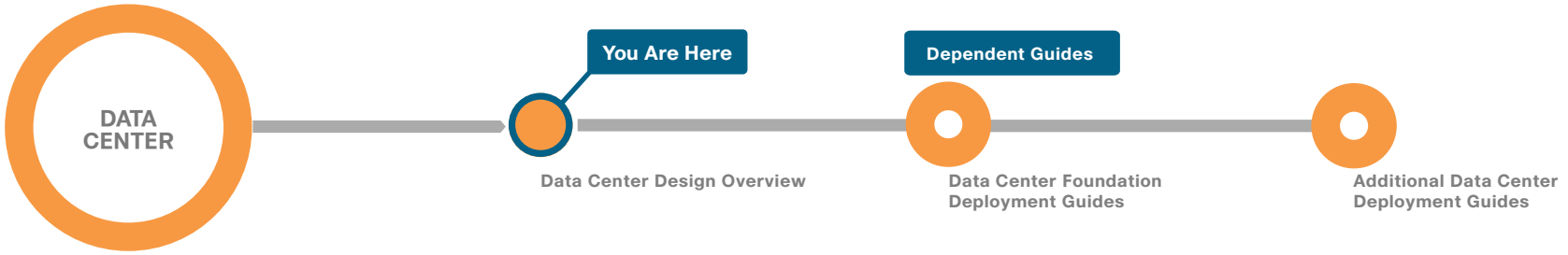


Introduction

The Cisco Smart Business Architecture (SBA) data center is a comprehensive architecture to accommodate your organization's IT needs from a server room to a data center for organizations with up to 300 server ports. This out-of-the-box approach is simple, easy to use, affordable, scalable, and flexible. The Cisco SBA data center architecture provides the ability for growing organizations to migrate from your server room deployment to a scalable data center design.

The Cisco SBA data center architecture incorporates Ethernet and storage network, computing resources, security, application resiliency, and virtualization tested together as a solution. This solution-level approach to building out an architecture simplifies the system integration normally associated with multiple technologies, allowing you to select the modules that meet your organization's requirements rather than worrying about matching components and interoperability.

Cisco has designed, built, and tested this architecture to meet the following goals:

- **Ease of deployment**—A top requirement was to develop a design according to best-practice methodology that provides a fast and resilient deployment.
- **Cost-effective**—A requirement in the selection of products for the Cisco SBA server room and data center architecture was to meet the budget guidelines for a growing organization to scale from a server room with up to 25 servers, to a data center with up to 300 server ports supporting a mix of physical and virtual servers.
- **Flexibility and scalability**—As the company grows, so too must its infrastructure. Products selected need to have the ability to grow the network foundation and services in a modular manner.
- **Resiliency and security**—The data center foundation is designed with redundant devices and links to enhance reliability. Network services are layered on to protect critical data center resources from attacks or unplanned outages.
- **Ease of management**—Deployment and configuration guidance includes configuration examples of management by unique element managers or by a network management system.

Related Reading

The *Cisco SBA—Data Center Deployment Guide* focuses on the processes and procedures necessary to deploy your data center foundation Ethernet and storage transport. The data center foundation is designed to support the flexibility and scalability of the Cisco Unified Computing System (UCS) and provides details for the integration of functionality between the server and the network for Cisco and non-Cisco servers. Data center services like security with firewall and intrusion prevention, and application resiliency with advanced server load balancing techniques, are included. This guide also discusses the considerations and options for data center power and cooling. The supplemental *Cisco SBA—Data Center Configuration Files Guide* provides snapshots of the actual platform configurations used in the design.

The *Cisco SBA—Data Center Unified Computing System Deployment Guide* provides the processes and procedures necessary to deploy a Cisco UCS using both the Cisco B-Series Blade Server system and the Cisco C-Series Rack-Mount servers so that they are ready to deploy an operating system or hypervisor software.

The *Cisco SBA—Data Center Server Room Deployment Guide* provides processes and procedures for building out a server room that provides resilient Ethernet and security services for up to 25 servers. This deployment is ideal for centralizing servers at a regional site or smaller headquarters location.

The supplemental *Cisco SBA—Data Center Virtualization with Cisco UCS, Nexus 1000V, and VMware Deployment Guide* builds on the foundation computing deployment guide to enable virtualization in your data center design. Finally, the supplemental *Cisco SBA—Data Center NetApp Storage Deployment Guide* provides a concise yet detailed process of deploying a NetApp storage array in your data center to complete the design.

Business Overview

As organizations grow they face many challenges related to information-processing capacity and the ability to keep up with the demands of their internal and external users. New organizations begin with a small group of servers to house basic resources like email, file sharing, database applications, and web services. Over time, the size of the applications and the number of applications drives increased processing and storage requirements and results in a growth explosion commonly referred to as "server sprawl." Small organizations can use many of the same data center technologies that larger organizations use to manage growth and control operational and capital expenses. The challenge for organizations is determining how to absorb and deploy new technology with their existing IT staff and ensure that the design grows with the organization.

Organizations must address the following challenges as they look to grow their data center infrastructure:

- **Supporting rapid application growth**—IT organizations must reduce the time necessary to expand existing applications or deploy new applications, often from months or days to hours.
- **Managing growing data storage requirements**—Application growth is driving the need to centralize data storage to control costs and improve the ability to back up critical information.
- **Optimizing the investment in server processing resources**—Reduce the cost of maintaining, operating, and deploying servers by improving utilization and combining applications on a smaller number of physical servers.
- **Reliably accessing information**—Application availability drives user productivity and requires a high availability foundation design.
- **Securing the organization's critical data**—The central repository of the organization's most critical data must be protected from attacks and snooping.
- **Controlling the cost of deploying a new data center**—Avoid designing and building everything from scratch by using tested reference designs.

Architecture Rationale

As a building is erected, the construction relies on a set of plans to organize the timing and interdependencies of different activities to complete a structure that is sound, reliable, and useful for the end user. The lack of a planned architecture can result in delays, compromised reliability, and increased costs. As your organization grows, you require a plan for how to grow the IT infrastructure to support user access to applications that support the business. Workforce productivity enhancements are built on the expectation of nonstop access to applications and resources that enable a user to do their job. Depending on the location of a user, many factors can influence the successful connectivity to an application that resides in the data center. However, the availability of the data center itself is core to overall reliability.

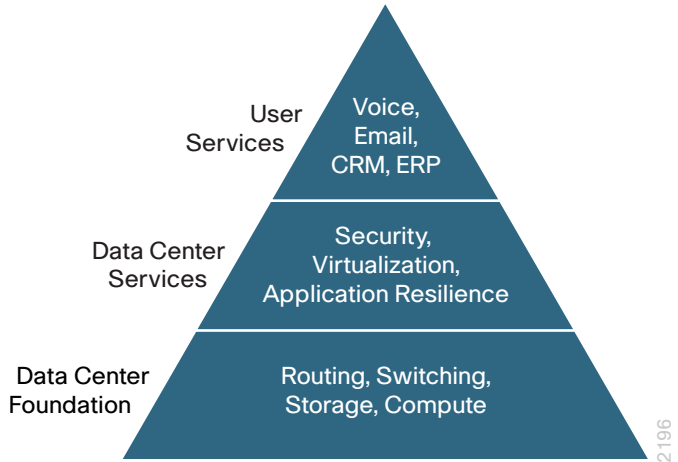
Planning, testing, and implementing various components and services in the data center on your own can pose a large challenge for organizations. By using the Cisco SBA data center design that tests and validates the foundation infrastructure, security, application resilience, computing, and virtualization, you can reduce costs, risks, and operational issues, and increase deployment speed.

Architecture Overview

In the context of building design, architecture means the art and science of designing and constructing buildings. In the context of a computer design, architecture refers to the design, structure, and behavior of the computer system—how the various components interact to communicate and process information for an application. These definitions support the broader definition of the process used to create the Cisco SBA data center design.

The Cisco SBA program follows a consistent design process of building a network based on layers of services. The Cisco SBA data center architecture consists of three primary modular layers with hierarchical interdependencies: data center foundation, data center services, and user services. Figure 1 illustrates the Cisco SBA data center architecture layered services.

Figure 1 - Cisco SBA data center pyramid of service layers



The ultimate goal of the layers of the architecture is to support the user services that drive the organization's success.

Data Center Foundation

Similar to the foundation of a building, the primary building block of the data center is the foundation layer upon which all other services rely. Whether it's a server room Ethernet LAN or a formal data center, the foundation must be resilient, scalable, and flexible to support data center services that add value, performance, and reliability. The data center foundation provides the computing necessary to support the applications that process information and the seamless transport between servers, storage, and the end users who access the applications.

To the applications and users, the network foundation works transparently when implemented correctly. The intelligent infrastructure of Ethernet and storage switches tied to servers and storage arrays make this all possible.

Data Center Services

Data center services are the next layer in the hierarchy. Like the customizable aspects of a building plan, they complement and customize the environment for the intended purpose. You may require large open spaces for a manufacturing floor, or high solid walls with controlled access for a secure environment. The consideration of these customizable services makes the structure more usable. Data center services allow you to customize the environment to a greater degree and enhance operation.

Cisco data center services include firewalls and intrusion prevention to enhance the security of the applications and access to critical data, and application services like load balancing and service monitoring to enhance resilience. Virtual switching extends the network control in a seamless manner from the foundation network into the hypervisor systems on servers to increase control and lower operational costs.

User Services

User services sit at the top of the pyramid and rely on the data center foundation and services to work. User services are those applications that allow a person to do their job and ultimately drive productivity for the organization. In the context of a building, this may be the elevator that takes you to your office floor, the lights in the office, or the message button on the

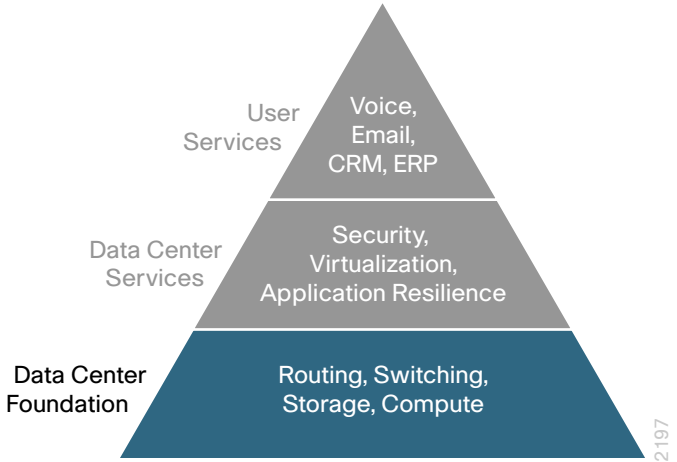
phone that allows you to check messages. User services in the data center include email, order processing, and file sharing. Other applications in the data center that rely on the data center foundation and services like data base applications, modeling, and transaction processing, also sit at the top of the pyramid of services.

Notes

Data Center Foundation

There is a tendency to discount the foundation of the network as simple plumbing, and to think that all you need to do is consider the feeds and speeds and ignore the rest. Just as the electrical system in a building has to be designed for the scale, distribution, and peak loads of a building, the data center foundation needs similar consideration. The data center foundation includes the switching of packets to and from computers or servers located in the data center, as well as the interaction of the network with the server and storage to accommodate a dynamic or virtualized environment.

Figure 2 - Foundation layer of the Cisco SBA data center pyramid



Ethernet Infrastructure

There are two design models for the Ethernet LAN infrastructure in the Cisco SBA data center architecture. The Cisco SBA server room is designed to provide a resilient Ethernet LAN for smaller server densities. The Cisco SBA data center is designed to scale up to 300 server ports and provide a more robust environment for virtual servers and data center services. The design model you choose is based on density, services, and scalability.

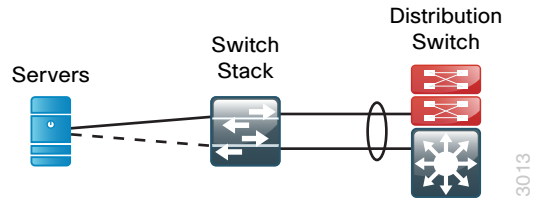
The Cisco SBA Server Room

As organizations grow at a location, they often have to deal with centralizing servers that are under a desk, stacked in a utility closet, or sharing a non-environmentally controlled wiring closet. The location may be a smaller organization's headquarters, or a larger organization's regional site. Regardless of the function of the location, as the organization's dependence on the services and applications hosted on the servers grows, they require a more robust and controlled environment.

The Cisco SBA server room lays the foundation for a resilient Layer 2 Ethernet using a pair of Cisco Catalyst 3750-X switches configured as a switch stack for server and network appliance connectivity up to Gigabit speeds. Cisco StackWise provides proven control-plane and data-plane resilience for Ethernet traffic, and Cisco StackPower provides an efficient and reliable power source for the switch stack. By using the same Catalyst 3750-X switches in the server room that your organization uses in the Cisco SBA LAN access layer, you can simplify sparing.

The Cisco SBA server room Catalyst 3750-X connects to the Cisco SBA LAN distribution layer switch for Layer 3 services and access to the rest of the network with 1 Gigabit or 10 Gigabit EtherChannel links for resilience and bandwidth scalability, as shown in Figure 3.

Figure 3 - Cisco SBA server room connected to the Cisco SBA LAN distribution layer



The Cisco SBA Data Center

As your organization or location grows, you outgrow the capacity of the server-room Ethernet switching stack deployed in the *Cisco SBA—Data Center Server Room Deployment Guide*. It is important to be prepared for the ongoing transition of available server hardware from 1-Gigabit Ethernet attachment to 10-Gigabit. Multi-tier applications often divide browser-based client services, business logic, and database layers into multiple servers, which increases the amount of server-to-server traffic and drives performance requirements higher. As the physical environment that houses the organization's servers grows to multiple racks, it also becomes more challenging to elegantly manage the cabling required to attach servers to the network. Ten-Gigabit Ethernet connections are now more common on servers and help to improve overall network performance, while also reducing the number of physical links required to provide the necessary bandwidth. The Cisco SBA data center is designed to make this transition easier by scaling the Ethernet foundation with a consistent set of deployment steps, features, and functionality.

The foundation of the Ethernet network in the Cisco SBA data center is a resilient pair of Cisco Nexus 5500 Series switches. These switches offer the ideal platform for building a scalable, high-performance data center for growing organizations supporting both 10-Gigabit and 1-Gigabit Ethernet attached servers. The Cisco Nexus 5500 switch core is designed with the Layer 3 switching module to provide a Layer 2 and Layer 3 data center core for high speed switching of data within the data center and to the rest of the network. The Cisco Nexus 5500 Series provides the scalability required for data centers with up to 300 server ports supporting a mix of physical and virtual servers:

- The Layer 3 routing table can accommodate up to 8000 IPv4 routes.
- The Layer 3 engine supports up to 8000 adjacencies or MAC addresses for the Layer 2 domain.
- The solution provides for up to 1000 IP Multicast groups when operating in the recommended virtual port channel (vPC) mode.

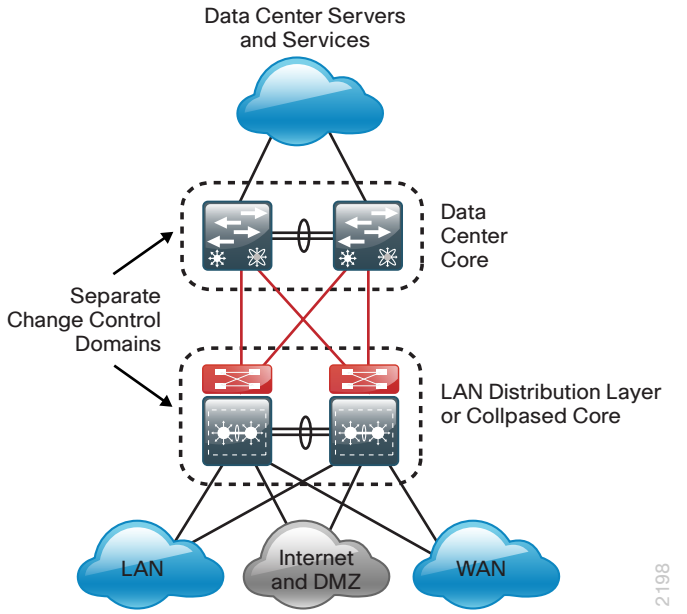
A second generation of the Layer 3 engine for the Cisco Nexus 5548 and 5596 switches is now available. This second generation hardware version of the Layer 3 module doubles the routing and adjacency scalability when you are running Cisco Nexus Operating System (NX-OS) software release 5.2(1) N1(1) or later.

Reader Tip

For more specific scalability design numbers for the Cisco Nexus 5500 Series, see the documentation here: http://www.cisco.com/en/US/docs/switches/datacenter/nexus5000/sw/configuration_limits/limits_521/nexus_5000_config_limits_521.html#wp327738

The Layer 3 data center core connects to the Layer 3 LAN core designed in the *Cisco SBA—Borderless Networks LAN Deployment Guide*, as shown in Figure 4.

Figure 4 - Data center core to LAN core connectivity



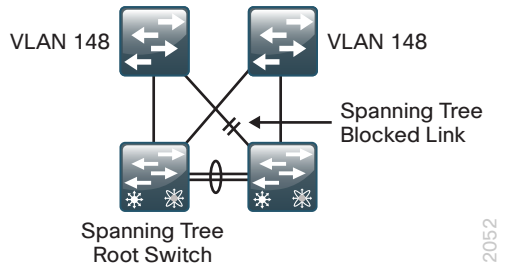
The results of using Layer 3 to interconnect the two core layers are:

- A resilient Layer 3 interconnect with rapid failover.
- A logical separation of change control for the two core networks.
- The LAN core provides a scalable interconnect for LAN, WAN, and Internet Edge.
- The data center core provides interconnect for all data center servers and services.
- Intra-data center Layer 2 and Layer 3 traffic flows between servers and appliances are switched locally on the data center core.
- The data center has a logical separation point for moving to an offsite location while still providing core services without redesign.

Resilient Data Center Core

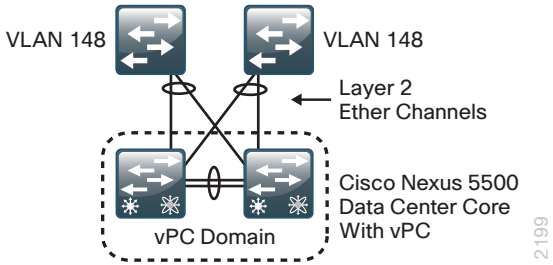
The data center needs to provide a topology where any data center VLAN can be extended to any server in the environment to accommodate new installs without disruption, and the ability to move a server load to any other physical server in the data center. Traditional Layer 2 designs with LAN switches rely on Spanning Tree Protocol in order to detect and block loops created when a VLAN is extended to multiple access layer switches. Spanning Tree Protocol blocks links to prevent looping, as shown in Figure 5.

Figure 5 - Traditional design with spanning tree blocked links



The Cisco Nexus 5500 Series switch pair, which provides the central Ethernet switching fabric for the Cisco SBA data center design, is enhanced by using the Cisco vPC technology. vPC allows links that are physically connected to two different Cisco Nexus switches to appear to a third downstream device to be coming from a single device and as part of a single Ethernet Port Channel. The third device can be a server, switch, or any other device or appliance that supports IEEE 802.3ad Port Channels. This capability allows the two data center core switches to build resilient, loop-free Layer 2 topologies that forward on all connected links instead of requiring Spanning Tree Protocol blocking for loop prevention. From a resiliency point of view, vPC allows the Ethernet PortChannel to span two switches, which act as a single logical peer, as shown in Figure 6, and which is known as multichassis EtherChannel (MCEC).

Figure 6 - Data center core with Cisco vPC



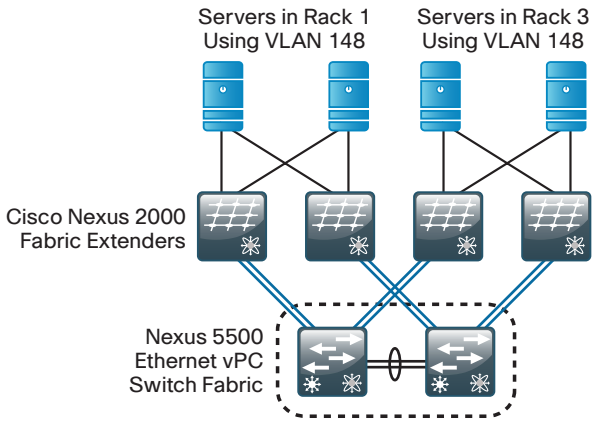
MCEC links from a device connected to the data center core using vPC provide spanning tree loop-free topologies, which allow VLANs to be extended across the data center while maintaining a resilient architecture.

Fabric Extension

The Cisco Nexus 5500 Series support the Cisco Nexus 2000 Series Fabric Extenders (FEX). Fabric extenders allow the switching fabric of the resilient switching pair to be physically extended to provide port aggregation in the top of multiple racks, reducing cable management issues as the server environment expands. The Cisco Nexus FEX also scale the port density of the data center with 48-port Gigabit Ethernet and 32-port 10-Gigabit Ethernet densities that aggregate server traffic to the data center core Cisco Nexus 5500 Series switches. The fabric extenders are all managed centrally from the Cisco Nexus 5500 Series switch pair, where they appear as “remote line cards” to the primary data center switches. All programming, operation, and packet transport is done by the Cisco Nexus 5500 switches. This centralized management provides easy port provisioning and reduces operational costs because there are fewer devices to manage for the growing organization.

The Cisco FEX design also allows you to deploy servers and appliances in VLANs, which span multiple racks for virtualization or mobility, by using top of rack Cisco FEX connectivity without creating large spanning tree loops, as shown in Figure 7.

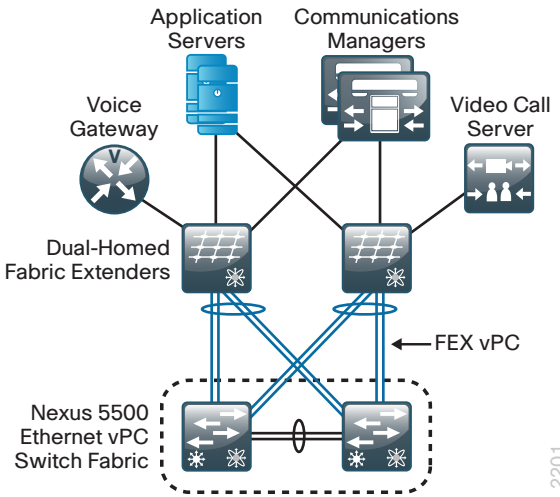
Figure 7 - Cisco Nexus 2000 Series FEX topology



The Cisco Nexus FEX is able to carry both Ethernet and FCoE traffic when using 10-Gigabit Ethernet fiber optic or twinax connections, further reducing cabling requirements and the rack space required for separate platforms. The same fabric extender technology is integrated into the Cisco UCS to provide a flexible and modular data center design.

You can provide network additional resiliency by dual-homing servers into two separate fabric extenders, each of which is single homed to one member of the Cisco Nexus 5500 Series switch pair. To provide high availability for both single-homed servers and dual-homed servers, the Cisco FEX may instead be dual homed into the two members of the central switch pair. The dual-homed Cisco FEX provides a spanning-tree loop free topology for all connected servers using vPC. Because the Cisco FEX is connected to both of the data center core Cisco Nexus 5500s, they now provide enhanced resiliency to the connected servers and appliances.

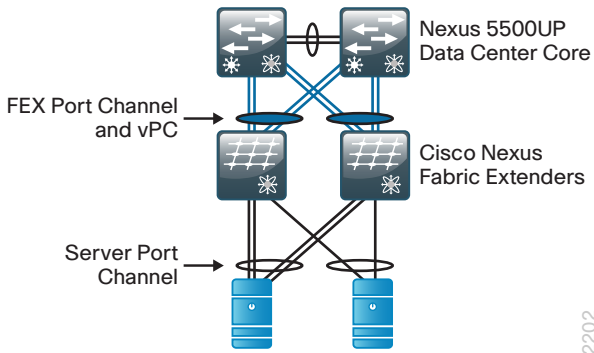
Figure 8 - Cisco Nexus 2000 Series FEX resilient dual-homed topology



In earlier Cisco Nexus 5500 Series and Cisco Nexus 2000 Series designs, the dual-homed Cisco FEX connection was unable to support a server that was connected to two dual-homed Cisco FEXs with a single EtherChannel connected server. This condition meant that you may need to have a mix of single-homed Cisco FEX and dual-homed FEXs in the data center to support different server connectivity requirements.

As of Cisco NX-OS release 5.1(3)N1(1) for the Cisco Nexus 5500 Series switches, a Cisco Nexus 5500 Series switch can support a port channel connected to two dual-homed Cisco FEXs, as shown in Figure 9. This capability is referred to as *Enhanced vPC*. The Cisco Nexus 5500 Series switches are the only Nexus 5000 Series switch models that support Enhanced vPC.

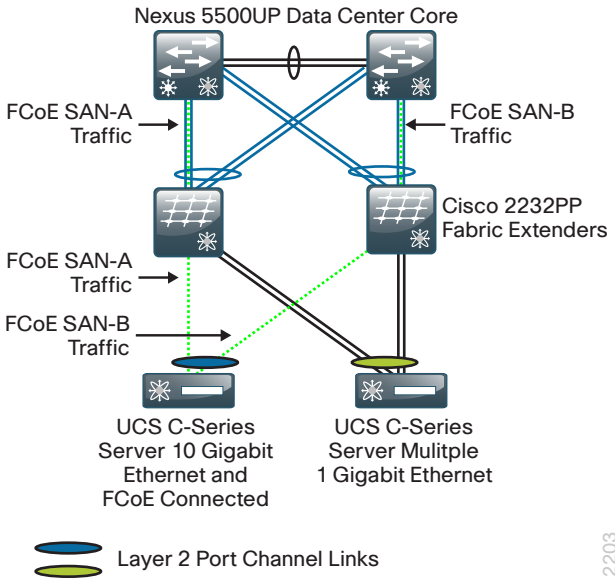
Figure 9 - Enhanced vPC



With Enhanced vPC, the dual-homed Cisco FEX uplinks are programmed with a port channel and vPC that connects it to both data core switches. Additionally, the Ethernet interfaces on the Cisco FEX connected to the server interfaces are programmed with a different port channel for the server port channel. The Cisco Nexus 5500 switches then automatically create a vPC to enable the server port channel that is connected the dual-homed Cisco FEX pair. The result is a more resilient and simplified Cisco FEX deployment in the data center that can support single and dual-homed servers with or without EtherChannel from the server.

Enhanced vPC also supports a dual-homed server with EtherChannel running FCoE. However, this may not be suitable for a high-bandwidth FCoE environment, as the FCoE traffic can only use a subset of the Cisco FEX uplinks to the data center core, as shown in Figure 10. The FCoE traffic can use only the Cisco FEX to Nexus 5500 uplinks on the left-side or right-side respectively, as SAN traffic must maintain SAN-A and SAN-B isolation, and therefore cannot connect to both data center core switches. Non-FCoE Ethernet traffic, such as IP connectivity, from the dual-homed Cisco FEX can utilize all Cisco FEX to data center core uplinks, which maximizes traffic load balancing and bandwidth.

Figure 10 - Enhanced vPC with FCoE traffic

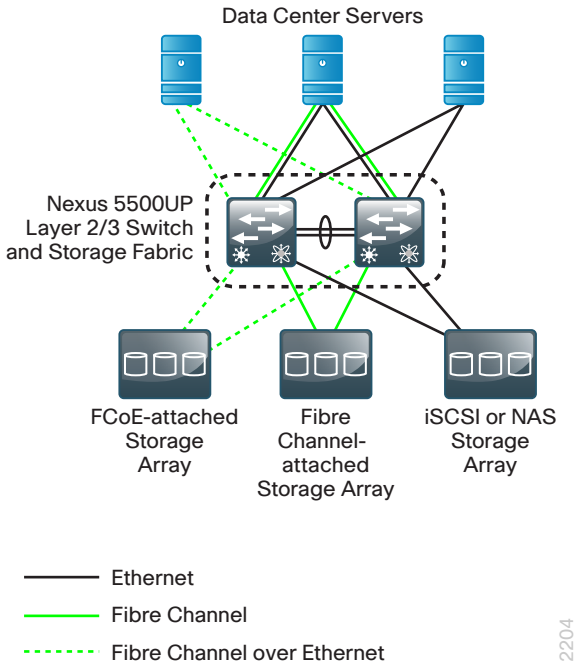


Storage Infrastructure

There is a constant demand for more storage. Storage for servers can be physically attached to the server or connected over a network. Direct attached storage (DAS) is physically attached to a single server and is difficult to use efficiently because it can only be used by the host attached to it. SANs allow multiple servers to share a pool of storage over a Fibre Channel (FC) or Ethernet network. This capability allows storage administrators to easily expand capacity for servers supporting data-intensive applications. The Cisco SBA data center design allows you to choose to deploy Ethernet-based storage access, FC-based storage access, or both.

Most organizations have applications for multiple storage access technologies, such as FC for the high performance database, and production servers and network attached storage (NAS) for desktop storage access. The data center core Cisco Nexus 5500UP switches that are used as the foundation of the network feature universal ports, which allow a port to transport 10 Gigabit Ethernet and Fibre Channel over Ethernet (FCoE) on a port, or native FC.

Figure 11 - Cisco Nexus 5500 with universal port

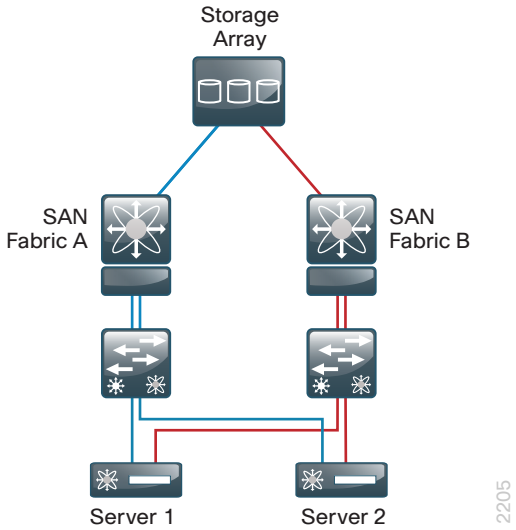


This universal port capability provides the flexibility to support multiple SAN technologies on a single platform, thus reducing costs and operational complexity.

Fibre Channel Storage

FC allows servers to connect to storage across a fiber-optic network, across a data center, or even over a WAN. Multiple servers can share a single storage array. In a SAN, a fabric consists of servers and storage connected to FC switches, as shown in Figure 12. It is standard practice in SANs to create two completely separate physical fabrics, providing two distinct paths to the storage. FC fabric services operate independently on each fabric so when a server needs resilient connections to a storage array, it connects to two separate fabrics. This design prevents failures or misconfigurations in one fabric from affecting the other fabric. This Cisco SBA data center design uses two Cisco Nexus 5500UP switches for the data center core FC connectivity. The universal port capability of the Cisco Nexus 5500UP switch allows a data center core switch port to support Ethernet and FCoE or native FC. For larger FC SAN environments, the design includes Cisco MDS Series 9100 Multi-layer fabric switches. The family of Cisco MDS Series switches can also provide FC solutions for fabrics like long distance SAN extension using Fibre Channel over IP (FCoIP), hardware accelerated encryption, and I/O acceleration.

Figure 12 - Dual-fabric SAN with a single disk array



Each server or host on a SAN connects to the FC switch with a multi-mode fiber cable connected to a host bus adapter (HBA). For resilient connectivity, each host connects one port to each of the fabrics. This allows critical applications to tolerate a loss of any single HBA, fiber optic link, or even one of the fabric switches.

IP-based Storage Options

Many storage systems provide the option for access using IP over the Ethernet network. This approach allows a growing organization to gain the advantages of centralized storage when they don't require the performance and isolation of a FC network. Options for IP-based storage connectivity include Internet Small Computer System Interface (iSCSI) and NAS.

iSCSI is a protocol that enables servers to connect to storage over an IP connection and is a lower-cost alternative to FC. iSCSI services on the server must contend for CPU and bandwidth, along with other network applications, so you need to ensure that the processing requirements and performance are suitable for a specific application. iSCSI has become a storage technology that is supported by most server, storage, and application vendors. iSCSI provides block-level storage access to raw disk resources, similar to FC. Network interface cards (NICs) also can provide support to offload iSCSI to a separate processor to increase performance.

NAS is a general term used to refer to a group of common file access protocols, the most common implementations use common Internet file system (CIFS) or network file system (NFS). CIFS originated in the Microsoft network environment and is a common desktop file sharing protocol. NFS is a multi-platform protocol that originated in the UNIX environment and is a protocol that can be used for shared hypervisor storage. Both NAS protocols provide file-level access to shared storage resources.

The data center core Ethernet network built on the Cisco Nexus 5500UP Series switches can support the FC, iSCSI, and NAS requirements of your organization's data center.

Computing Resources

Organizations frequently need to optimize the use of the investment in server resources, so that the organization can add new applications while controlling costs as they move from a small server room environment into a data center scale environment. A data center foundation design must consider the computing resources as well as the network and storage transport to ensure an optimal design.

Scaling a data center with conventional servers, networking equipment, and storage resources can pose a significant challenge to a growing organization. Multiple hardware platforms and technologies must be integrated to deliver the expected levels of performance and availability to application end users. These components in the data center also need to be managed and maintained, typically with a diverse set of management tools with different interfaces and approaches.

Server virtualization through hypervisor software applications offers the capability to run multiple application servers on a common hardware platform, allowing an organization to focus on maximizing application capability of the data center while minimizing costs. Increased capability and reduced costs are realized through the following aspects:

- Multiple applications can be combined in a single hardware chassis, reducing the number of boxes that must be accommodated in the data-center space
- Improved resilience and application portability, as hypervisors allow workload resilience and load-sharing across multiple platforms, even in geographically dispersed locations
- Minimized box count reduces power and cooling requirements, as there are fewer lightly-loaded boxes idling away expensive wattage

Streamlining the management of server hardware and its interaction with networking and storage equipment is another important component of using this investment in an efficient manner. The combination of hypervisor software with a computing system that can deploy servers in a consistent template-based method allows the IT organization to reduce the time required to deploy new applications from months or days to hours.

Cisco offers a simplified reference model for managing a small server room as it grows into a full-fledged data center. This model benefits from the ease of use offered by Cisco UCS. Cisco UCS provides a single graphical management tool for the provisioning and management of servers, network interfaces, storage interfaces, and their immediately attached network components. Cisco UCS treats all of these components as a cohesive system, which simplifies these complex interactions and allows a smaller organization to deploy the same efficient technologies as larger enterprises, without a dramatic learning curve.

The primary computing platforms targeted for the Cisco SBA Unified Computing reference architecture are Cisco UCS B-Series Blade Servers and Cisco UCS C-Series Rack-Mount Servers. The Cisco UCS Manager graphical interface provides ease of use that is consistent with the goals of Cisco SBA. When deployed in conjunction with the Cisco SBA data center network foundation, the environment provides the flexibility to support the concurrent use of the Cisco UCS B-Series Blade Servers, Cisco UCS C-Series Rack-Mount Servers, and third-party servers connected to 1- and 10-Gigabit Ethernet connections and the storage network. The flexibility of Cisco UCS allows it to support a single operating system, such as Windows Server, or one of the many hypervisor-based systems.

Cisco UCS Blade Chassis System Components

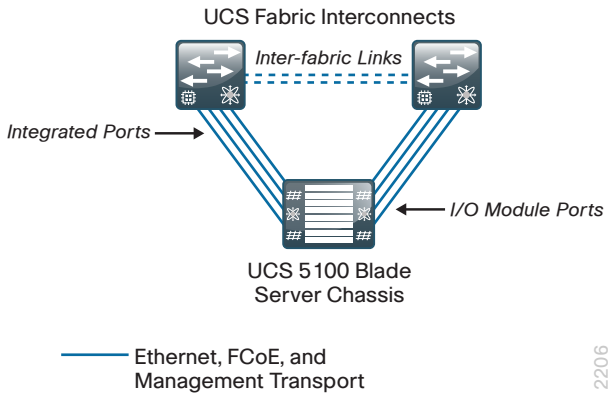
The Cisco UCS Blade Chassis system has a unique architecture that integrates compute, data network access, and storage network access into a common set of components under a single-pane-of-glass management interface. This architectural approach provides a modular way to grow computing resources, lowers the time to provision new resources, and compliments server virtualization by virtualizing the physical server to a profile that can be loaded on demand. The primary components included within this architecture are:

- Cisco UCS Fabric Interconnects—Cisco UCS 6200 Series fabric interconnects provide both network connectivity and management capabilities to the other components in the system. It is recommended that the fabric interconnects are clustered together as a pair, providing resilient management access—as well as 10-Gigabit Ethernet, Fibre Channel, and FCoE capabilities—to the system. Cisco UCS 6200 fabric interconnects provide the flexibility of unified ports, enabling a port to run Ethernet or Fibre Channel. The fabric interconnects support up to twenty Cisco UCS Blade Server Chassis for modular growth.
- Cisco UCS Fabric Extenders—Similar to the Cisco Nexus 2000 FEX, which can connect to the data center foundation Nexus 5500 Series switches, Cisco UCS 2200 Series Fabric Extenders, also referred to as *I/O modules*, logically extend the fabric from the Cisco UCS fabric interconnects into each of the enclosures for Ethernet, FCoE, and management purposes.
- Cisco UCS 5100 Series Blade Server Chassis—Provides an enclosure to house up to eight half-width or four full-width blade servers, their associated fabric extenders, and four power supplies for system resiliency. The recommended design dual-homes every blade server chassis to the two fabric interconnects for increased reliability.
- Cisco UCS B-Series Blade Servers—Allows customers to easily customize their computing resources to the specific needs of their most critical applications. Cisco UCS B-Series Blade Servers are available in half-width or full-width form factors, with a variety of high-performance processors and memory architectures.

- Cisco UCS B-Series Network Adapters—Allows the switching fabric to provide multiple interfaces to a server, via a variety of mezzanine adapter cards:
  - Ethernet adapters—The baseline 10-Gigabit Ethernet adapters can present up to two Ethernet interfaces to a server.
  - Converged network adapters—Cisco converged network adapters are available in multiple models, with chip sets from multiple manufacturers to meet specific needs. These adapters combine Ethernet and FCoE traffic on a single wire and provide two 10-Gigabit Ethernet interfaces and two FC interfaces to a server.
  - Virtual interface cards—The Cisco virtual interface cards (VICs) feature new technology from Cisco, allowing additional network interfaces to be dynamically presented to the server complimenting the hypervisor technologies. The Cisco VIC is capable of supporting up to 256 total virtual interfaces split between virtual network interface cards and FC virtual host bus adapters. The number of virtual interfaces currently supported depends on the Cisco UCS infrastructure, including the fabric interconnect, I/O module, VIC model, and version of Cisco UCS Manager.

Figure 13 shows the physical connections of a Cisco UCS Blade Chassis system to establish the connection between the fabric interconnects and a single blade chassis. The links between the blade chassis and the fabric interconnects carry all server data traffic, centralized storage traffic, as well as management traffic generated by Cisco UCS Manager. The inter-fabric links carry heartbeat and synchronization data for the cluster but no data plane traffic.

Figure 13 - Cisco UCS Blade Chassis System component connections



Cisco UCS Manager

Cisco UCS Manager is embedded software that resides on the fabric interconnects, providing complete configuration and management capabilities for all of the components in the Cisco UCS system. This configuration information is replicated between the two fabric interconnects, providing a highly available solution for this critical function. The most common way to access Cisco UCS Manager for simple tasks is to use a web browser to open the Java-based graphical user interface (GUI). For command-line or programmatic operations against the system, a command-line interface (CLI) and an XML API are also included with the system.

Cisco UCS server platforms provide unique advantages that complement the implementation of hypervisor technologies. The Cisco UCS B-Series Blade Servers with Cisco UCS Manager allow the personality of a server instance to be easily ported to different physical hardware, similar to porting a virtual machine to a different host. Cisco UCS Manager provides the capability to directly integrate network interfaces to the hypervisor system for dynamic network interface allocation to virtual machines.

Cisco UCS Manager provides unified, embedded management of all software and hardware components. Every instance of Cisco UCS Manager and all of the components managed by it form a *domain*. For organizations that deploy multiple Cisco UCS domains, Cisco UCS Central software provides a centralized user interface that allows you to manage multiple, globally distributed Cisco UCS domains with thousands of servers. Cisco UCS Central integrates with Cisco UCS Manager and utilizes it to provide global configuration capabilities for pools, policies, and firmware.

Cisco UCS C-Series Rack Servers

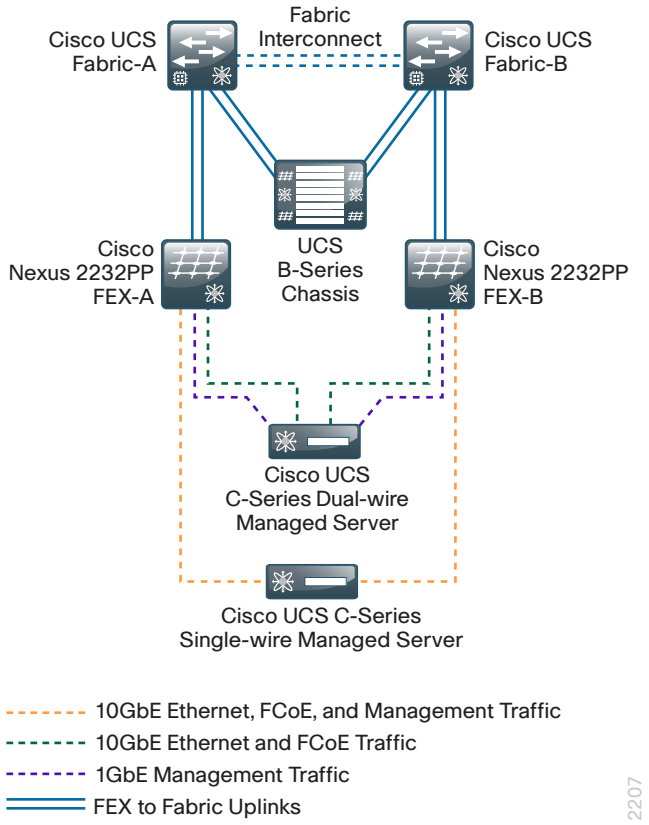
Cisco UCS C-Series servers extend Cisco Unified Computing innovations and benefits to rack-mount servers. Designed to operate in a standalone environment or as part of the Cisco UCS, Cisco UCS C-Series servers can be used to satisfy regional or remote office server room requirements, or as an approach to deploy rack-mounted servers on an incremental basis. Like the Cisco UCS B-Series, the C-Series servers offer a wide array of processor, memory, network adapter, and disk options.

The Cisco Integrated Management Controller (Cisco IMC) is the management service for Cisco C-Series servers. Cisco IMC runs within the server. Cisco IMC allows you to use a web-based GUI or Secure Shell (SSH) Protocol–based CLI to remotely access, configure, administer, and monitor the server. Almost all tasks can be performed in either interface, and the

results of tasks performed in one interface are displayed in the other. You can use Cisco IMC to control power, view and configure server properties and sensors, upgrade firmware, and monitor server status.

To reduce complexity in the data center operations, the Cisco UCS C-Series servers can be managed by the Cisco UCS manager if they are connected to the fabric interconnects via Cisco Nexus 2232PP fabric extenders, as shown in Figure 14. This type of deployment enables the flexibility of both rack-mounted and blade servers with a single-pane-of-glass management of all Cisco UCS servers in the data center.

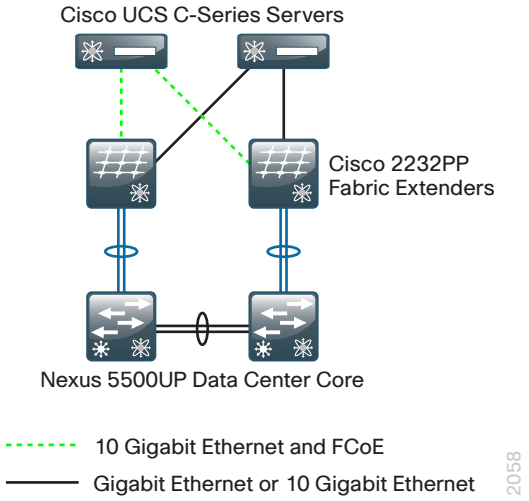
Figure 14 - Cisco UCS C-Series servers connected to Cisco UCS fabric interconnects



Cisco UCS System Network Connectivity

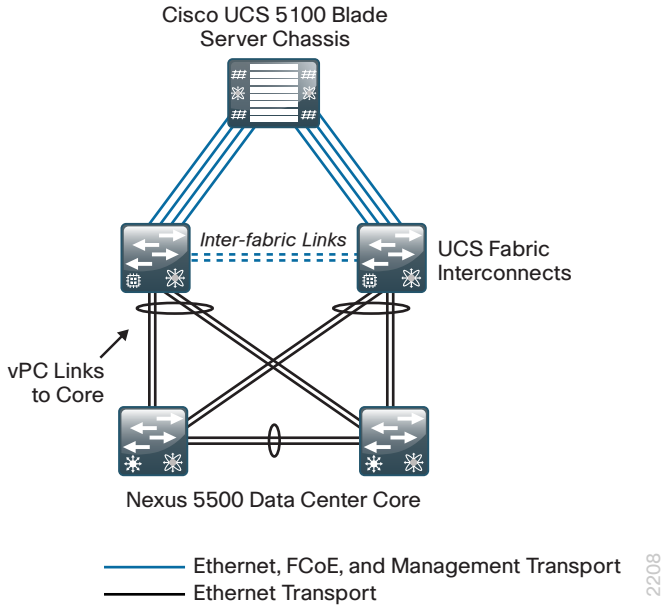
Both Cisco UCS B-Series Blade Servers and C-Series Rack Mount Servers integrate cleanly into the Cisco SBA data center architecture. The data center core Cisco Nexus switching fabric provides connectivity for 10 Gigabit Ethernet, Gigabit Ethernet, FC, and FCoE attachment for Cisco UCS C-Series servers, depending on the throughput requirements of the applications or virtual machines in use and the number of network interface cards installed per server. Figure 15 illustrates dual-homed connections from Cisco UCS C-Series servers to single-homed Cisco FEXs providing 10-Gigabit Ethernet and FCoE connectivity, available either through the Cisco Nexus 2232 FEX or by using 10-Gigabit ports directly on the Cisco Nexus 5500 Series switch pair.

Figure 15 - Cisco UCS C-Series FEX connections



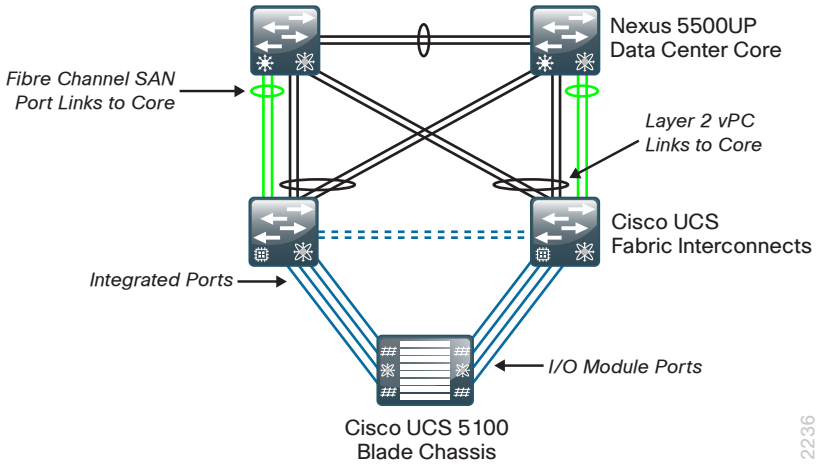
The Cisco UCS fabric interconnects provide connectivity for Cisco UCS Blade Server systems. The fabric interconnects are dual-homed to the data center core for resilient Ethernet connectivity. The dual-homed links use Cisco vPC to provide transparent Layer 2 multichassis EtherChannel for fast failover with no spanning tree loops. The number of links to the core can be increased to accommodate growth of the Cisco UCS server density and traffic. Figure 16 shows the Ethernet connectivity between the fabric interconnects and the Cisco Nexus 5500 Series switch pair.

Figure 16 - Ethernet connectivity between the Cisco UCS fabric interconnects and the data center core



Fibre Channel connectivity can be extended from the data center core to the Cisco UCS fabric interconnects in order to provide SAN connectivity for Cisco UCS Blade Server systems. The following figure shows a Fibre Channel SAN port channel connection to the data center core. As of Cisco UCS Manager release 2.1, you can now provide Fibre Channel to the Cisco UCS fabric interconnects over an FCoE link to the data center core.

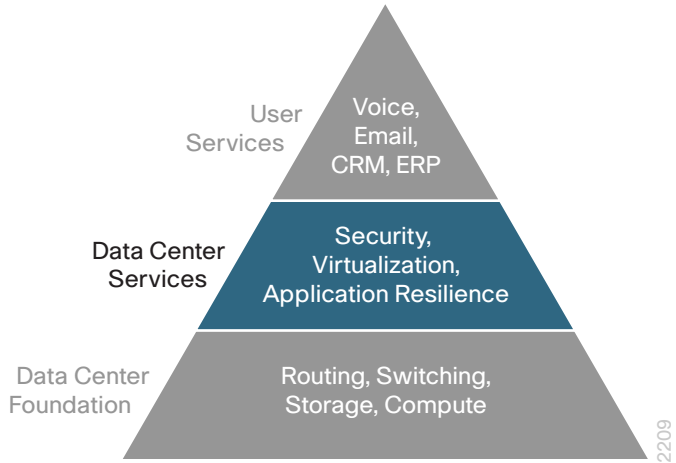
Figure 17 - Fibre Channel connection for Cisco UCS fabric interconnects



Data Center Services

Data center services build on top of the foundation layer and depend on it to provide resilient and flexible connectivity options.

Figure 18 - Services layer of the Cisco SBA data center pyramid

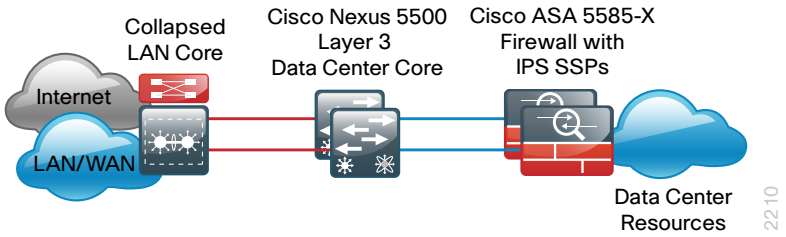


Network Security

The data center contains some of the organization's most valuable assets. Customer and personnel records, financial data, email stores, and intellectual property must be maintained in a secure environment to assure protection and availability. Additionally, portions of networks in specific business sectors may be subject to industry or government regulations that mandate specific security controls to protect customer or client information.

To protect the valuable electronic assets located in the data center, network security ensures the facility is protected from automated or human-operated snooping and tampering, and it helps to prevent the compromise of hosts by resource-consuming worms, viruses, or botnets.

Figure 19 - Inline firewall to protect data resources



The data center security design provides the ability to protect servers based on the VLAN the server is in, allowing you to decide which servers you want to have protected and what level of protection is required. Because everything else outside the protected VLANs hosting the data center resources can be a threat, the security policy associated with protecting those resources has to include the following potential threat vectors:

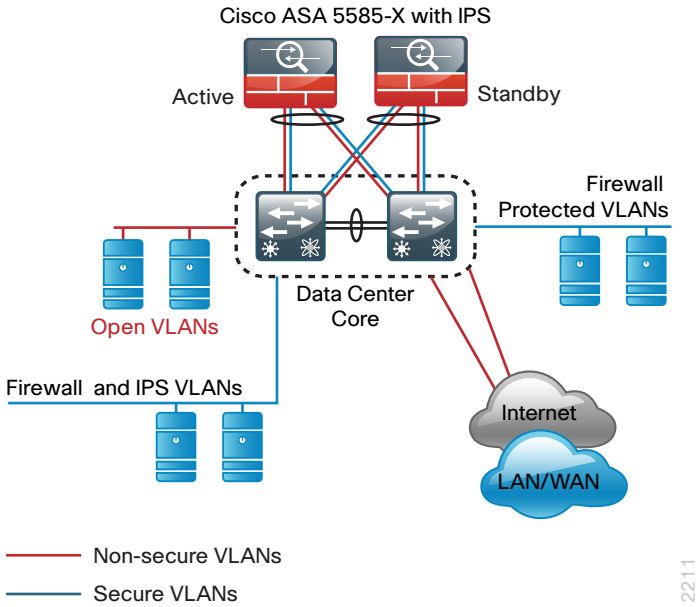
- Internet
- Remote access and teleworker VPN hosts
- Remote office/branch networks
- Business partner connections
- Campus networks
- Unprotected data center networks
- Other protected data center networks

In virtual desktop deployments, where the user's desktop is hosted on a server located in the data center, the data center firewall can provide policy isolation from the production servers located in the same data center domain.

The data center security design employs a pair of high performance Cisco Adaptive Security Appliances (ASA) 5585-X series firewalls with matching Cisco IPS Security Service Processors (SSP) installed. The Cisco ASA firewalls are dual-homed to the data center core Cisco Nexus 5500UP switches using two 10-Gigabit Ethernet links for resiliency.

The pair of links on each Cisco ASA is configured as an EtherChannel providing load balancing, as well as rapid and transparent failure recovery. The Cisco NX-OS vPC feature on the Cisco Nexus 5500UP data core switches allow the EtherChannel from each firewall to span the two data center core switches (multi-Chassis EtherChannel) while logically operating as if it were connected to a single upstream switch. This EtherChannel link is configured as a VLAN trunk in order to support access to multiple secure VLANs in the data center, as shown in Figure 20.

Figure 20 - Data center firewall with protected VLANs



The pair of Cisco ASAs is configured for firewall active-standby high availability operation to ensure that access to the data center is minimally impacted by outages caused by software maintenance or hardware failure. Continuous health check monitoring between the firewall and Cisco IPS pairs ensures that a firewall failover will occur if either the Cisco ASA itself has an issue or the Cisco IPS module becomes unavailable to provide data center class resiliency.

The Cisco SBA server room security design uses the same high availability active-standby firewall design as the Cisco SBA data center does. The server room design utilizes the Cisco ASA 5500-X series for firewall and Cisco IPS protection of the critical servers connected with EtherChannel links to the Cisco Catalyst 3750-X Ethernet switch stack. The Cisco ASA 5500-X series is a scalable midrange security appliance that provides cost-effective performance with the same operational features as the high performance Cisco ASA 5585-X series used in the data center.

In the Cisco SBA data center and server room designs, the Cisco ASAs are configured in routing mode to enforce a secure network between protected subnets and the rest of the network. The alternative method of programming the firewall for transparent mode does provide an ease of use for design; however, hosts might inadvertently be connected to the wrong VLAN, where they would still be able to communicate directly with the rest of the network, resulting in an unwanted security exposure.

The data center Cisco IPSs monitor for and mitigate potential malicious activity that is contained within traffic allowed by the security policy defined on the Cisco ASAs. The Cisco IPS sensors can be deployed in a monitor and report mode known as Intrusion Detection (IDS), or in an active mode intrusion prevention system (IPS) where they can actively thwart attacks. The ability to run in IDS mode or IPS on the same platform is configurable to allow the maximum flexibility in meeting a specific security policy.

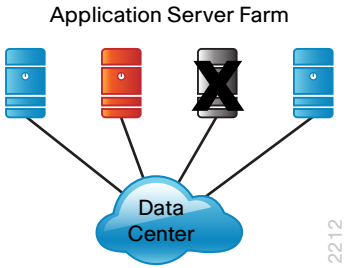
Application Resiliency

Because application performance and availability directly affect employee productivity and customer satisfaction, the IT organization must consider how to improve application availability. The following factors can affect application performance:

- An application server that is part of a pool may be overloaded, affecting those users connected to that server while others are performing well.
- The application server may lose connectivity to database resources, so while the application can respond to a client, it cannot deliver the necessary information.
- Connection processing services like packet encryption or compression, may be robbing server CPU cycles required by the application.

Server load balancers (SLBs) originated in data center designs to balance the load on servers to improve their response to client request, monitor server performance, and allow the pool of servers to grow gracefully to support increased demand.

Figure 21 - Application server farm performance characteristics



The Cisco Application Control Engine (ACE) is Cisco's premier server load balancer providing Layer 4 through 7 switching with server and application monitoring to protect the application environment. Cisco ACE goes beyond traditional SLBs by providing an array of acceleration and server offload benefits, including TCP processing offload, Secure Socket Layer (SSL) offload, compression, and various other acceleration technologies.

Cisco ACE sits in the data center, in front of the application servers, and provides a range of services to maximize server and application availability, security, and asymmetric (from server to client browser) application acceleration. As a result, Cisco ACE gives IT departments more control over application and server infrastructure, which enables them to manage and secure application services more easily and improve performance.

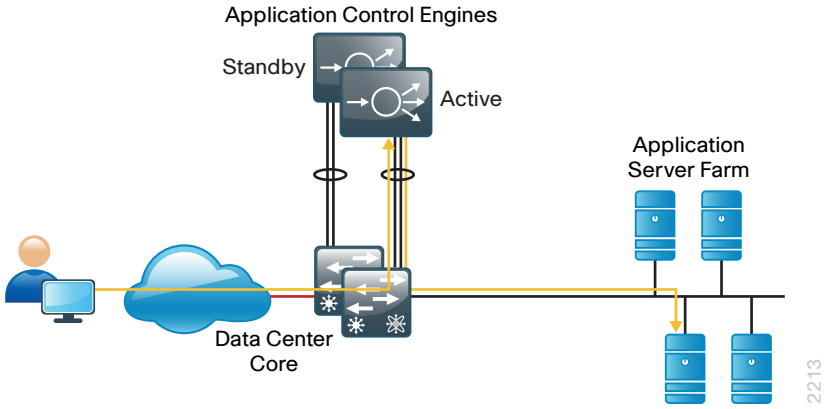
Cisco ACE has a flexible licensing model. The Cisco ACE 4710 used in the data center is available in a number of performance options, from 500 Mbps to 4 Gbps of throughput based on the license purchased. For example, you can start out with a 1 Gbps Cisco ACE and, as your performance requirements increase, upgrade the same hardware to 4 Gbps with a new license. The scalable licensing of Cisco ACE 4710 provides the flexibility of using the same appliance models in the data center, server room, or Internet edge designs.

There are four key benefits provided by Cisco ACE:

- **Scalability**—Cisco ACE scales the performance of a server-based program, such as a web server, by distributing its client requests across multiple servers, known as a server farm. As traffic increases, additional servers can be added to the farm quickly and transparently to the end users. With the advent of server virtualization, application servers can be staged and added dynamically as capacity requirements change.
- **High Availability**—Cisco ACE uses both active and passive techniques to monitor server health. By periodically probing servers and monitoring the return traffic from the real servers, Cisco ACE rapidly detects server failures and quickly reroutes connections to available servers. A variety of health-checking features are supported, including the ability to verify web servers, SSL servers, application servers, databases, FTP servers, streaming media servers, and a host of others.
- **Application Acceleration**—Cisco ACE improves application performance and reduces response time by minimizing latency and compressing data transfers for any HTTP-based application, for any internal or external end user.
- **Server Offload**—Cisco ACE offloads TCP, SSL processing, and compression from the server, which allows more users to be served and handle more requests, and reduce bandwidth requirements by up to 90% without increasing the number of servers.

Cisco ACE hardware is deployed in pairs for high availability: one primary and one secondary. If the primary Cisco ACE fails, the secondary Cisco ACE takes control. When session state redundancy is configured, this failover can take place without disrupting the client-to-server connection. In the Cisco SBA data center design, each Cisco ACE is connected to a different data center core switch so that if either is down for maintenance or failure, the other switch and Cisco ACE continues to service the protected server farms, as shown in Figure 22.

Figure 22 - Client server traffic flow through redundant Cisco ACEs



By using active and passive monitoring techniques to monitor server health, Cisco ACE provides the high availability environment your organization requires for a non-stop business world.

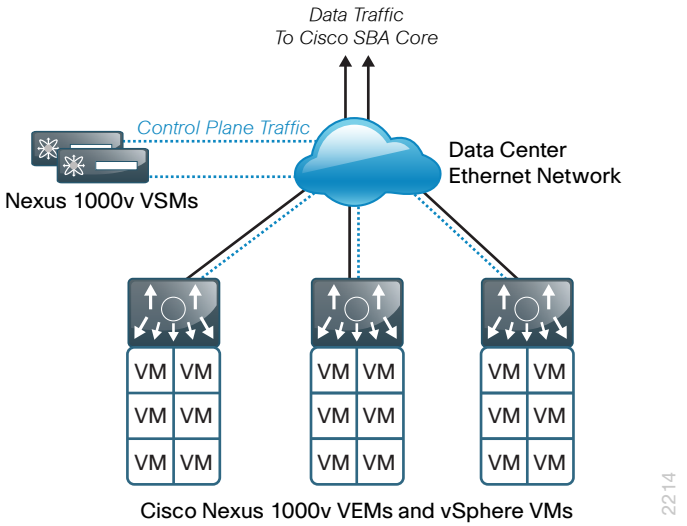
Virtual Switching

IT organizations are using server virtualization or hypervisor technology to optimize their investment in computer resources. One aspect of virtual machines (VMs) is that they may easily be migrated from one hardware platform to another, and in conjunction with centralized storage, VMs improve availability and reduce downtime for the organization. However, server virtualization does introduce its own level of complexity to the data center architecture. What was previously a clearly defined demarcation between server configuration and network configuration is now blended, as elements of the network environment reside in software on the physical server platform. In a basic VMware configuration, port settings must be defined on a per-VM basis, which can become repetitive and potentially error-prone for new server initialization.

The Cisco Nexus 1000V Virtual Distributed Switch is a software-based switch designed for hypervisor environments that implements the same Cisco Nexus operating system as the Cisco Nexus 5500 Series switching platforms that comprise the primary Ethernet switching fabric for the Cisco SBA data center. This allows a consistent method of operation and support for both the physical and virtual switching environments. The Cisco Nexus 1000V allows for policy-based VM connectivity using centrally defined port profiles that may be applied to multiple virtualized servers, simplifying the deployment of new hosts and virtual machines. As virtual machines are moved between hardware platforms for either balancing of workloads or implementation of new hardware, the port configuration migrates with them, increasing the ease of use of the overall solution. The Cisco Nexus 1000V is supported with hypervisor software from VMware as an integrated part of the vSphere server virtualization environment.

The Cisco Nexus 1000V virtual switch provides Layer-2 data center access switching to VMware ESX and ESXi hosts and their associated VMs. The two primary components to the solution are the virtual supervisor module (VSM), which provides the central intelligence and management of the switching control plane, and the virtual Ethernet module (VEM), which resides within the hypervisor of each host. Together, the VSM and multiple VEMs comprise a distributed logical switch, similar to a physical chassis-based switch with redundant supervisors and multiple physical line cards. This model echoes a common distributed architectural approach with the Cisco Nexus 5500/2000 series, as well as the Cisco UCS fabric interconnects and I/O modules. A logical view of the Cisco Nexus 1000V architecture is shown in Figure 23.

Figure 23 - Cisco Nexus 1000V logical view



In the event of loss of communication with the VSM, the VEM has non-stop forwarding capability to continue to switch traffic based on the last known configuration. In short, the Cisco Nexus 1000v brings data center switching and its operational model into the hypervisor to provide a consistent network management model from the core to the virtual machine network interface card.

Cisco Nexus 1000V provides centralized configuration of switching capabilities for VEMs supporting multiple hosts and VMs, allowing you to enable features or profiles in one place instead of reconfiguring multiple switches. By using the capabilities of Cisco NX-OS, the Cisco Nexus 1000V Series provides the following benefits:

- **Flexibility and Scalability**—Port profiles, a Cisco NX-OS feature, provides configuration of ports by category, enabling the solution to scale to a large number of ports. Common software can run all areas of the data center network, including the LAN and SAN.
- **Increased Control**—Common features in the Cisco Nexus 5500 data center core, like quality of service (QoS), Switched Port Analyzer (SPAN) and Encapsulated Remote SPAN (ERSPAN), private VLANs, and access control lists (ACLs), are now available in the VM switch.
- **High Availability**—Synchronized, redundant virtual supervisor modules enable rapid, stateful failover and ensure an always-available virtual machine network.
- **Manageability**—The Cisco Nexus 1000V Series can be accessed through the Cisco CLI, Simple Network Management Protocol (SNMP), XML API, Cisco Data Center Network Manager, and CiscoWorks LAN Management Solution (LMS).

The VSM is also tightly integrated with VMware vCenter Server so that the virtualization administrator can take advantage of the network configuration in the Cisco Nexus 1000V Series switch.

Cisco Nexus 1000V is now offered in two editions, Essential and Advanced:

- **Essential**—Is a no-cost version that offers a rich set of services, including VLANs, loop prevention, port channels, SPAN, ERSPAN, quality of service (QoS) control, Virtual Extensible Local Area Network, and Cisco vPath.
- **Advanced**—Includes the features in the Essential edition and adds Cisco Integrated Security Features, Cisco TrustSec security group access, and Cisco Virtual Security Gateway.

Reader Tip

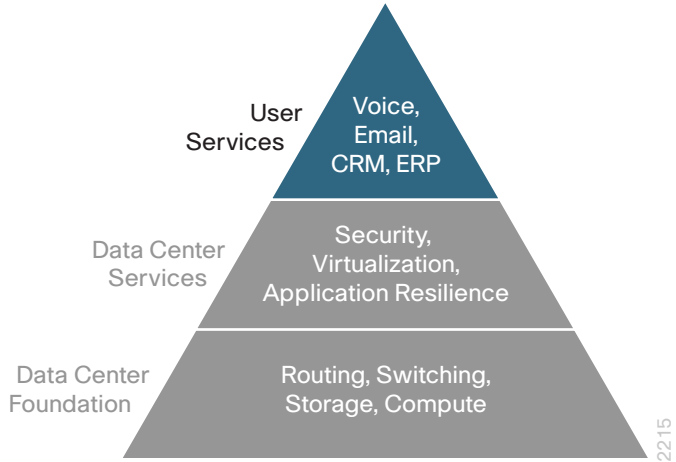
For more information on Cisco Nexus 1000V product-level offerings, see the following:
http://www.cisco.com/en/US/prod/collateral/switches/ps9441/ps9902/data_sheet_c78-492971.html

Notes

User Services

Everyone is familiar with user services; this layer of the pyramid drives the reason for deploying a server room or data center, to support applications that enable employee productivity. The data center, the LAN, and WAN are all built to enable a user to perform daily tasks like checking email, logging in to a business application, or sharing files. The design of a user-oriented application or product determines how easy it is to use. The overall design of the data center foundation and services affects how well the application performs for the end user.

Figure 24 - User services layer of the Cisco SBA data center pyramid



Business Applications

An organization's dependence on information access grows every year, so key applications like e-commerce, enterprise resource planning (ERP), web portals, and even email must be available around the clock to provide uninterrupted service for internal and external users. Availability of these applications can be threatened by network outages, server or application failure, or degraded by poor resource utilization conditions. The resilient design of the data center foundation and the services that protect and enhance it all must work together to protect application availability. The integration of computing resources, virtualization, and the network provide a more responsive data center design where services can be enabled or moved without hours and days of cabling, equipment installs, and difficult operating system customization.

Communications and Collaboration Services

The evolution of communications and collaboration has changed how we work and live. The ability to share ideas with multiple parties at the same time and receive real-time feedback improves productivity and shortens the time needed to make critical decisions. The ability to access these services from the office, home, or on the road transforms where we work and when we work. The following are examples of Cisco communications and collaboration services available to your organization:

- Cisco Unified Communications—This suite of products is designed to deliver voice and video communications that scale from a few users to tens of thousands of users. IP communications-enabled endpoints and control allow you to extend communications to users in all workspaces.
- Video Collaboration with Cisco WebEx—Products like Cisco WebEx transform face-to-face meetings from conference rooms in a single location to worldwide collaboration capabilities. Scheduled and on-demand meetings can be initiated by any user and the combination of video, file sharing, and Q&A panels provide an experience beyond the traditional conference room.
- Video Collaboration with Cisco TelePresence—Some meetings require the intimacy of a face-to-face conference room style meeting, however this can delay meetings due to travel requirements and schedules. Cisco TelePresence uses high-definition video and audio to connect multiple locations together for a conference room style experience that can span long distances. This allows organizations to reduce travel costs and meeting delays with a solution that is as easy to set up as a phone call.

Design Guide Summary

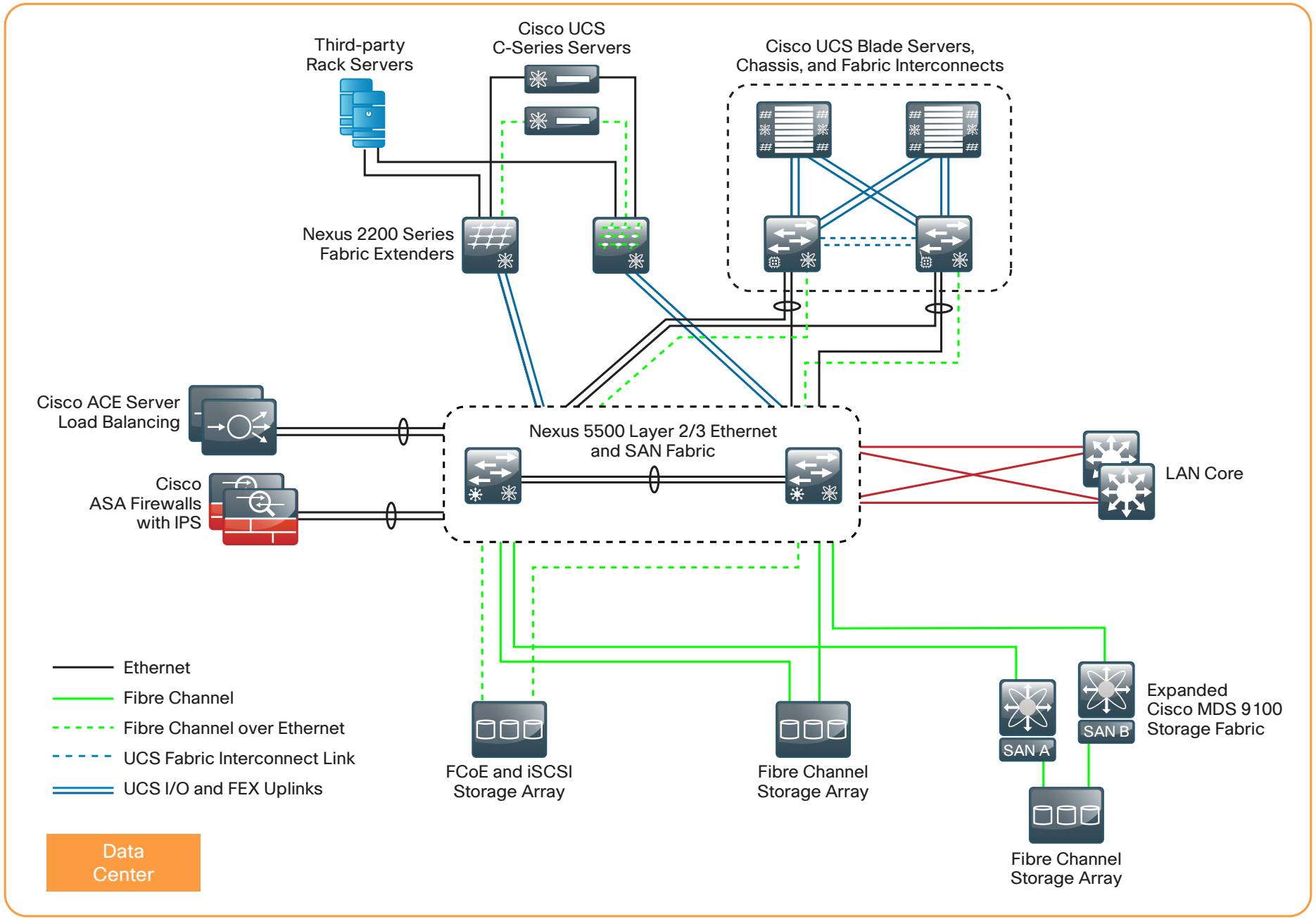
As your organization outgrows your initial server room, you need a data center design that allows you to build a scalable, flexible, and resilient environment without requiring a massive infrastructure investment. The Cisco SBA data center provides you the deployment guidance to migrate your server room to a more resilient and scalable data center. The foundation Ethernet and storage network enable the flexibility of Cisco UCS to support bare-metal operating systems and the powerful hypervisor technology, which allows you to support a wider variety of requirements. Security and application resilience services are layered on top of the foundation to help you customize your data center to meet compliance and operational requirements, and above all to meet your end user needs.

The technologies included in this architecture were carefully selected to provide maximum value for your data center, while maintaining the ability to scale the data center larger as your organization grows.

The Cisco SBA data center deployment guides provide selected technologies with a prescriptive design that is tested together as a solution with ease-of-use in mind to keep installation and operational costs low. The Cisco SBA supplemental guides follow the same prescriptive methodology to layer on Cisco and Cisco-partner products necessary for a successful data center deployment.

Notes

Figure 25 - The Cisco SBA data center architecture



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